



Lenders Roman

Musical inquiry: An autoethnographic exploration to infuse STEM education with sound.

Master's thesis
FACULTY OF EDUCATION
Education and Globalization
2021

University of Oulu

Faculty of Education

Sonic autoethnography: Musical inquiry: An autoethnographic exploration to infuse STEM education with sound (Lenders Roman)

Master's thesis, 79 pages

July 2021

STEM (science, technology, engineering, mathematics) and the arts are often separated in schools. This is due to a historically prevalent Cartesian mind-body dualism. But there is growing interest in allowing students to use art with science, because it entuses students to explore, create and learn. This combination is called STEAM. In this thesis, I used a combination of autoethnography and arts based research to explore the viability of music as a form of STEAM. Music has a lot of potential for creating meaning and has cognitive and social benefits for development, which makes it a useful medium. These benefits have not gone unnoticed, as multiple researchers are experimenting with ways to use music for STEM. However, they mostly use the lyrics as a form of learning, and the potential of the sounds themselves is underused. I therefore used musical inquiry, the usage of musical composition and representative sounds, in my experiments. In these experiments, I followed online courses and reflected on what I learned using musical inquiry and written reflections. My results are that musical inquiry can improve retention and recall of information through its use as a mnemonic device. It can lead to deeper inquiry into the subject matter. It can help put people in a flow state which makes learning more automatic, and it can make learning STEM more enticing. The downsides are that it takes a long time and is not suitable for people without musical experience. I conclude that musical inquiry is a suitable way of learning, but it is just one way of knowing. In general, encouraging students to use art forms that suit them and to seek out their own forms of meaning making is a good way to enhance both the arts and the sciences. Throughout the thesis both my own and other people's music is linked. By interspacing music and theory, I combine art and science not only in the experiments, but in the end product as well. I call this integration sonic autoethnography, which brings reflection to an auditory level.

Keywords: arts based research, autoethnography, education, learning, music, STEAM

Contents

- 1. INTRODUCTION 4**
 - 1.1 Ethics 6
 - 1.2 Why music is my art 8
 - 1.3 When words are not enough 12
- 2 Bridging the gap between art and science 13**
 - 2.1 Education through art 13
 - 2.2 History of the gap between science and art: Cartesian dualism 15
 - 2.3 Examples of steam 17
- 3 Exploring music’s potential for learning STEM..... 21**
 - 3.1 Music’s ability to generate meaning 21
 - 3.2 How I make meaning through music 23
 - 3.3 Music’s social and cognitive benefits 26
 - 3.4 Why music developed across the world..... 27
 - 3.5 Examples of music in the classroom..... 29
 - 3.6 The musical goal of this thesis..... 33
- 4 Methodology..... 35**
 - 4.1 Autoethnography 35
 - 4.2 Arts Based Research 40
 - 4.3 Interweaving music in this thesis 42
 - 4.4 Sonic autoethnography in practice..... 45
- 5 Musical inquiries 48**
 - 5.1 Experiment 1, Smelling something good 51
 - 5.2 Experiment 2: Cross section of the brain, an improvisation 53
 - 5.3 Experiment 3: cables in the brain..... 54
 - 5.4 Experiment 4: Filtering particles 56
 - 5.5 A musical break: Hiking 57
 - 5.6 Experiment 5: Velocity Direction 58
- 6 Discussion/conclusion 63**
 - 6.1 Integrating music in autoethnography 66
 - 6.2 Integrating musical inquiry in the learning process 67
 - 6.3 Assessing the quality of this research 63
- References 72**

1. Introduction

Why have I never done baking in chemistry class? Baking is seen as the chemistry of cooking and as a creative art form. The reason raw batter does not taste the same as the end product is because of the Maillard reaction, which breaks down sugars and amino acids to form the flavors that come together in the final baked good (van Boekel, 2006). Integrating this artistry in chemistry could create a lesson where we connect all the knowledge we learned thus far into a useful and tasty final project. All the while writing down and studying the chemistry behind what goes into making a proper baked good. A form of interdisciplinary learning that connects theoretical knowledge in a creative manner with other disciplines of life. Unfortunately, when I was in high school in the Netherlands between 2009-2014 this type of interdisciplinary learning was hard to find. This was not only for chemistry, but all science classes. The STEM (science, technology, engineering, mathematics) subjects were often separated from the arts classes. This does not encapsulate the complexities of learning. Throughout history we learned by exploring the world with our different senses, engaging with multiple integral phenomena through smell, touch, hearing and seeing. It was an exciting process, excitement that is now missing from STEM. STEAM, the idea to add the Arts to STEM, originated from this realization (Smith, 2013). By allowing students to use art with science it creates a holistic package that enthruses students to explore, create and learn. It can give a new kind of meaning to learning where students develop their own learning styles, according to an art form that fits them. The art form that fits me personally is music, it has been an integral and important part of my life. For almost every situation there is a song that you can pour your heart into. Listening to that song provides comfort and meaning (Ruud, 1997). I also personally experienced the potential of music to make learning more engaging. At the end of high school when the exams were already done, I forgot to finish a math assignment. My math teacher had to punish me, yet she thought that at the end of the year the punishment did not have to be so severe. Knowing that I liked music, she tasked me with creating a math song. It seemed impossible “songs are supposed to be fun” is what I thought. When I looked into it, I realized that math is actually the foundation of good music. All the beautiful harmonies and complicated melodies that I enjoyed so much were built upon it. I started the song based on this knowledge; a metal song appropriately called Mathal. Unfortunately, I never recorded this. But it did make me wonder why we never incorporate music or other art forms in lessons in this way? I only got this chance now because it was the

end of the year, and the teacher did not take the punishment seriously, yet for me this was an eye-opening event that could have helped me with learning math.

I imagined that music could be utilized in numerous educational situations. After all, meaning making is the most active form of learning we can engage in (Zittoun & Brinkmann, 2012). The discovery of the article *Deepening inquiry: What processes of making music can teach us about creativity and ontology for inquiry-based science education* described what I envisioned in a beautiful way (Gershon, Ben-Horin, 2014). In the article music and science were integrated which helped students to deepen their learning by allowing them to take control. As an added bonus, the process offered an exciting variety that was not always found in the natural science class. It sparked the aim of this thesis: to explore how music can be used as an inquiry tool in STEM classes and what the effects of this form of learning are. Through this exploration, I also aim to bridge the gap between arts and science. In this goal music should not merely serve as an instrument to learn science but should create an interplay where both the science and artistry are enhanced. It should also not only be the lyrics of the music that transfer knowledge but also the sounds themselves. Sounds transport knowledge to the listener and can therefore be educational (Gershon, 2011). However, this effect is currently not being utilized in research using music to learn STEM. I therefore detail which sounds I use and why in my experiment of using music for inquiry. To accomplish this the thesis makes use of the integration of two methodologies. A deep dive into these methodologies is written out later in the thesis, but a short introduction is useful. The first one is Arts Based Research (ABR). ABR's focus is to make art part of either the research process, product, or both (Leavy, 2015). Throughout this paper, music will be referenced and linked, including my own. Through this integration the sonic will be introduced to the written, methodologically bridging the gap between art and science. However, the written work is also a main focus through the second methodology, autoethnography. In autoethnography, the 'self' becomes both the researcher and the researched (Jones, Adams & Ellis, 2016). Through intimate reflection and the telling of stories the researcher aims to uncover insights into a cultural phenomenon. In this thesis, I will commonly write from the first-person point of view and there are personal narratives and thoughts woven throughout every paragraph. The musical excerpts I link are also part of this narrative. Music and autoethnography have a lot of similarities and can add onto each other well. Both have the aim of transferring compelling personal stories and inspiring others through their medium Bartleet and Ellis (2009). However, it is difficult to find autoethnographies where music is integrated, even when the subject of the research is music. I therefore also have a second goal, to methodologically examine how

sounds and autoethnography can be combined. There are multiple reasons to use ABR and autoethnography, one important one is making research more accessible and hopefully exciting to read. Gordon (2014, as cited in Leavy, 2015, p.193) states that more than 90% of academic articles are only read by the author, editors, and advisors. That is quite a shame, a lot of wonderful insight can be gathered from human's broad online library of knowledge. However, writing this way does come with unique ethical problems. I will therefore first discuss the ethical considerations before going into a deeply personal memoir.

1.1 Ethics

It is precisely in truthfully laying bare your own emotions where powerful autoethnography lies (Ellis, 2004, as cited in Lapadat, 2017). The same counts for ABR, where provoking art product have to stay true to the self (Leavy, 2015). Emotions are often hidden in other research methods even though they can evoke the strongest responses out of others (Bresler, 2006). In these emotions intimate stories of the self are uncovered, but the self is always implicated in other people's lives (Hernandez & Ngunjiri, 2016). I will also, directly or indirectly, reference others in this thesis. Doing this, I should be aware that the records of what I say about myself, and others will stay accessible on the internet, generally open for all to see (Adams, 2008). Autoethnography acknowledges that it is impossible to predict how these stories will be picked up and therefore difficult to completely negate harm that could be done both to yourself and to others (Tullis, 2016). Because of this there are researchers that criticize the ethicality of the approach, stating the writing takes advantage of close connections such as family and the community (Delamont, 2009). They say that it is almost impossible to fully hide or protect others, because the autoethnography aims to write truthfully about lives occurrences. However, as researchers it is our responsibility to minimize harm and maximize the benefits as much as possible. After all, autoethnography has the eventual aim of improving well-being and is therefore deeply embedded with moral decision making (Lapadat, 2017).

Luckily, numerous approaches have been developed to tackle the moral questions that arise when conducting this type of research. The most common way to do this is utilized throughout all qualitative research, and that is informed consent (Tullis, 2016). Letting participants, or anyone implicated in your stories write an informed consent ensures that their narrative was included voluntarily. It is important to ask for this consent as early on in the process as possible

and with the condition that the people implicated in the stories can always withdraw their consent if they want to. This is the approach I used in this thesis. I have not asked for official written out consent, but I did explicitly ask if their contribution could be included and that they could revoke this whenever they wanted. It is recommended to anonymize the data by changing names, demographic information such as age and using pseudonyms (Tullis, 2016). Complementing this, I also let participants read the sections in which they were involved, which is another technique autoethnography and ABR commonly uses (Tullis, 2016; Nisker, 2008, as cited in Leavy, 2015). In ABR, people implicated in the art or performance should have the opportunity to see or hear it, before it is exposed to the wider public (Nisker, 2008, as cited in Leavy, 2015). According to Lindlof & Taylor (Lindlof & Taylor, 2002, as cited in Tullis, 2016) not only are individuals given the opportunity to check for truth of the writing, but it also allows them to speak about the circumstances for which they were named. In fact, reading back and reflecting on significant events can become healing both for the writer and for the ones who are written about (Giorgio, 2016). In fact, the first story you will read led to me and a friend of mine catching up about stories of the past and recognize how far we have come since then. Reading back his part in the story was shocking, but he also realized that many issues that used to trouble him are now closed chapters of his life. Many of the ethical considerations that I mentioned here count for ABR as well, as both approaches have very similar goals. There is, however, one ethical consideration that is very specific to ABR, and that is the balance between art and research (Leavy, 2015, p. 196). The aim is to both expand knowledge, but also create art that is pleasing and engaging for audience, one should not overtake the other. The question you should ask alongside this is: how experienced are you with the art form you are using and is it necessary? I am a hobbyist musician but have been producing music for 5 years now. Through several courses I have honed my musical skills and feel that I am capable of producing 'good' music. Music is also integral to this thesis and therefore a valid art form for this research. The final thing that I want to do before actually going into the first story is vocalize where I got the data for these stories from and how I intend to use them. This is an important step for the ARB according to Jillian A. Tullis (2016). The data is collected from memories, supported by old songs and journals that I used to write. This could be counted as previously collected data but was never written down with this particular intent. I aim to use my memories to explain how art and specifically music can provide meaning to an experience. Through this meaning we internalize the experience, it becomes part of us, something we can learn from.

1.2 Why music is my art

The art that fits me is music. Music has given me purpose in a time that I had very little perspective. But it is also something that is engrained in my family background. My father and mother are both great hobby pianists. But they are both good in different ways. My mother is a true perfectionist, who could bring little me to tears with subtle played performances of Debussy's Clair de Lune. She reads the sheet music and transforms the notes on the page into sound exceptionally well. My father on the other hand mostly listens to a song and then starts playing it as if he has always known it. His playing is extravagant; maybe even a bit chaotic, but always provokes emotions or dancing feet. We had a grand piano in our living room, which was never left to gather dust. Every morning I woke up to classical songs. It was the perfect breeding ground for an upcoming musician. However, the musical gene seemed to have skipped a generation. My sister got piano lessons from a young age, and she was decent at it. But the long hours of lessons and learning theory did not create enjoyment for her. Eventually she quit lessons. When I became the age for lessons, it seems my parents had given up. Besides asking me: "Are you sure you don't want to try it?" every once in a while, they never pushed me to explore my musicality. Or maybe I was just reluctant, because honestly, classical music did not satisfy me. However, at the time this type of music was my main association with playing the piano. It would take a long time for me to unite with my musical self.

When I turned 14, piano still was not on my mind in any way, but guitar was. All my favorite musicians, from Linking Park to John Mayer, played guitar in their music. It was also widely known at school that the guitar player is the cool guy, the one who ends up with fame and many girlfriends. Not the best motivation, but as a rowdy teenager the perfect incentive. My father is also a pretty good guitar player, so I asked him to give me some lessons. These started out slow, just learning the basic chords, how to keep your arms and hands. I was catching a glimpse of what music could do for me. However, my father, always bursting with enthusiasm, started fingerpicking complicated patterns. I think he got caught in his own world. He tried to convey this world to me by saying: "okay son, now repeat after me". Yet, the enthusiasm that he had did not transmit to me, as I was left frustrated and unmotivated to continue learning. I felt as if music was simply not for me, the genes indeed skipped a generation.

When I was 15, I became extremely insecure about myself. I was constantly worried about my sister, who was dealing with her own issues. We lived quite far apart, so I could only imagine how she was actually feeling based on infrequent telephone calls. When the main vision you

rely on is imagination, you can easily get caught in worst possible outcomes. I guess the mind is an over-exaggeration machine. My sister took the time to rediscover who she was, and why she was feeling the way she did. During long therapy sessions, she was guided through her past which led to the discovery of the problem. Past trauma, that had been buried long ago. Finally, my sister knew what had been troubling her and could move towards positive recovery. However, as I would soon discover, past trauma was also brewing inside me, and an upcoming event with a friend would usher in its full appearance.

My best friend, who I will call Johan, moved in with me and my parents. He did not have any place to go at the time. It was nice, we played video games in the evening, wrestled in the yard, and often talked about where we wanted to be in life. However, what me and my parents did not know, was that my friend had a very bad depression. He was skillful in hiding this, always funny, always in a laughing mood. But loneliness got the better of him. He started to join when I met my friends, I did not see any harm in that. The opposite actually, I thought it would be great if he and my other friends could become closer. He became part of the group, but I became more distant from him than ever before. One night, I overheard a conversation between one of my best female friends and Johan. I was sending text message to this female friend as well, but for an hour already I noticed that her responses got curt. I knew that Johan and she talked often, so out of curiosity, and also because I felt something was wrong, I put my ear to the thin walls. I can still feel my arms tightening after I overheard them even while I am writing this. My friend said: "I'm not sure if I can take it if you leave, maybe I'll cut myself again, or jump in front of the train". Astounded I pulled my ear from the wall, fell flat on the bed, and started crying in a fetal position. I realized at that moment that he was emotionally blackmailing some of my friends. This was not a purposeful act; he did not really understand the impact of what he was doing. But it was affecting my friends, especially my female friends. Perhaps they were drawn to him out of a caring mother instinct. One after another, three of my friends started to become distant towards other people. If you had a conversation with them, you felt negativity underlying every sentence. The distance in their eyes was if they were never really looking at you, but always towards something quite concerning. One day, I arrived at my house after working at my part-time job. When I opened the wooden fence door, I saw Johan mindlessly and slowly raking leaves in the backyard. The whole aura of the house was lacking energy, as if a bomb just went off, and this silence was the aftermath. My father was leaning over the counter, looking into the drain. I asked him: "What happened here?" "Why is Johan raking leaves in the yard?". My father looked at me, afraid but also strict. The face he gave when he was shocked

by the amount of anger, he could have within him. When wants to keep that anger inside himself, but simply does not have the willpower to do so anymore. He spoke to me: “I fell out against Johan, after I found out what he had done. You might want to check in on your friend”. I did not know how he found out about this, but it did not matter at the time. I walked up to Johan, who despite everything I could still call a friend. “Johan?”. No response. The only answer I got was a blank expressionless face looking at me.

Johan left soon afterwards, and we did not speak for two years. The events I previously described sunk themselves into my outlook on life, which was now bleakly colored. This was demotivating enough, but it also came with self-confidence issues, which accumulated over year of bullying in primary school. A two for one package of self-loathing. The end result: a constant anxious state that I could not easily let go off. I started seeing things during the night, flashes of figures that could come straight out of a horror movie. It seemed like I had forgotten to speak, self-conscious of every single word and what kind of impression it would leave of me. I barely uttered a word. I had been seeing a psychiatrist for a couple of weeks, but it was the first time I brought up the figures I saw at night. I still don't know what the psychiatrist was thinking when he said to me: “mmm, it could be that you are developing a psychosis. But do not worry, the odds are extremely small of that happening. Unless, you have someone close in your family who has similar mental issues”. I still had to tell him that my father had dealt with a psychosis.

When I woke up one morning, I was panic stricken. It felt as if a huge hand was increasing its grip on my body. I walked into the corner of my room, squatted down, and put my arms across my legs to create a hole where I could put my face, scream, and forget about everything. I stayed in that position for an hour, all the while thinking about what I should do, or if doing anything was even worth it. If my future is to become mentally unstable, then why would I even work so hard? Isn't it better to give up? I had a conversation with my parents, which could barely be called an actual conversation. They asked if they could help me to relax. I responded by saying they could stay with me. They did. They just stayed on the couch and stared worryingly at their son. I needed a new perspective, something to hold onto, and the first thing that I required was connecting with primal beauty. Walking in the nearby forest always seemed to calm me down even in the direst of situations, but this time was eye-opening. While walking around, I focused my attention on the elements that resided within this nature's beauty. The wind softly stroking the tops of the trees, slightly bending them, yet always letting them go. The crackling of water of a nearby creak where two ducks were guiding their ducklings' home. The rugged feeling of

wood when you put your hands on the bark, or the hard earth that felt surprisingly comfortable when you walked on it barefooted. I sat down at a crossroads in the middle of the forest, with four benches. One at each opposite side of the road. I sat in one and let the feelings I had overwhelm me. I did not cry this time, maybe that already happened enough, but I recognized that sadness was in me. Luckily, in my current focused state I could accept that sadness. Not everything was good, and it was an unknown when things would become better, but that was okay. After calming down, I went back home and sat down on the couch. For a while, I was staring at the TV, a black screen that was turned off. And just like the TV, it felt that I also was not getting any reception. Nothing was entering my mind, not even simple thoughts. At least, until I noticed the guitar that was neatly standing next to the TV, ready to be picked up. After picking up the guitar, I took power into my own hands. My father could not teach me anything last time, so I had to do it myself. I started looking up how to play an easy but beautiful song and found “Horse with no name” to be suitable. It was just two chords, so it should be easy to play. I later even discovered that the meaning of the song really fits the situation I was in at that time. “A horse with No Name is a metaphor for a vehicle to get away from life’s confusion into a quiet, peaceful place” (Wikimedia foundation, 2021). The chords were easy to grasp, and before I knew it, I was playing my first guitar song. My self-esteem was rushing, as some energy found its way back inside me. If learning one song could give me that much confidence, then learning the guitar could be something I am passionate about. A hobby that can replace my addiction to video games, of which the main motivation was escapism. I discovered a passion that could give meaning to my life and that could be used to transform negative experiences into art.



Figure 1. Me playing guitar

1.3 When words are not enough

This is why I wanted to share this story; it is an important part of my connection to art. The bad time I was in while discovering playing music shows the power of art, and specifically music, in creating meaning. It is what many autoethnographers before me have described as well. Their stories reflect the same healing effects of songwriting. For example, David who wanted to bridge the silence after his friend was confronted with sudden tragedy (Carless & Douglas, 2010). Music helped find a means of communication that simple words could not. While sitting together with his friend, he was trying his best to find a way of consolidation. When conscious thinking did not fill this communication gap, he let his consciousness flow freely and transferred highly sensitive and emotional information through the comfort of a song. The striking metaphors in lyrics and narrative qualities of melody lines and leitmotifs, can move a person in ways that normal words cannot. “It leads towards a more open sense of discovering alternative stories” (Carless & Douglas, 2010, p. 30). Songwriting also helped Chris J. Patti, another autoethnographer, to deal with his father’s death (Patti, 2010). The story “Musical artefacts of my father’s death” is an elaborate explanation of how musical writing/composing can help someone to process turbulent times in his or her life. Music is just one of many art forms that people gravitate to when they need to express themselves. There are also crafts, theater, poetry, drawing, painting and many more. All of these art forms have the incredible power of expression, which is exactly the power where art educationalists see possibilities. The skills developed through this expression are as vital as literacy and numeracy. Because they help us impart meaning on the world around us. “a sense of contributing to an eternal conversation reaching backward and forward beyond time” (Wilson, 2010).

2. Bridging the gap between art and science

2.1 Education through art

I came across an innovative idea related to art education early on in my Bachelor of Educational Sciences. For an essay we had to pick one educational philosopher and delve into their ideas for education. I picked Herbert Read, an art educationalist and poet. I did not know then that I stumbled upon a British visionary who is still seen as a great inspiration for many art educationalists. His book *Education Through Art* stems from the idea that art should be the basis of education (Read, 1943; in Barchana-Lorand, 2015). He extensively studied children's art to see the inner expression that comes from a human who is not yet tainted by external societal pressures. According to Herbert, education should aim to create artists out of all of us, with art being defined as a broad term that encompasses all expressive human endeavors. He sees art as the cure for blight and evils of humanity, it shapes us into becoming thoughtful and decent beings. The ideas of Herbert Read are heralded by art educationalists around the world. This makes sense because it puts art at the core of good learning. There are however also critiques. According to Dorit Barchana-Lorand, art is put on a pedestal of importance, which may result in the dwindling importance of the discipline. They only serve to give promises to art educationists, while not trying to persuade the art education sceptic (Barchana-Lorand, 2015).

This sentiment can be placed in a larger discussion on what art education should entail and what its place in the curriculum is. By analyzing this discussion, you get a glimpse of the developments and history of the discipline, in which to situate your own view. Throughout the 21st century multiple handbooks on art education have been written, offering fresh perspectives while simultaneously building on the work of the last. Janeke Wienk analyzed the four dominant handbooks that were released between 2000-2017 (Wienk, 2020). The first book was written by Elliot Eisner, and grounds arts education in scientific research traditions of the social sciences and psychology (Eisner, 2004, as cited in Wienk, 2020). The book sets this off as a starting point, knowing well that this is not the ideal lens to look at art education. To end on a critical note and provide an anchor point for future authors, the author ends with the limitations of this approach. He describes the difficulties of an instrumental approach to art education. To research art for its psychological benefits, we risk ignoring art itself. Educational research conducted in this way does not even involve art, but tries to look at it from the outside in. Bresler

(2007, as cited in Wienk, 2020) builds on this knowledge. In her book, the arts, and each discipline (drama, music, literature, and visual arts) are celebrated for its unique contribution. Art is a messy process, but in this mess lies the beauty and uniqueness that is not found in other disciplines. It constructs meaning through powerful emotions and constant experimentation, quite often leading to unexpected results. To emphasize the special qualities of art she intertwines personal poems and reflections in the book with a variety of writing styles. The book is also a contribution of multiple international authors, with the aim of shifting the gaze from a pure western focus, commonly found in art education. The third book is a clear accumulation of the first two. It tries to overcome the dichotomy of an instrumental approach to arts education, which Eisner described, and the uniqueness of education established in the second book (Fleming, 2015; in Wienk, 2020). In the uniqueness view, art is the exclusive creative spot in the curriculum. Fleming disagrees and states that it is a good way of describing the usefulness of arts, which goes in an instrumental direction, but that creativity is important across all disciplines. Therefore “[d]escribing an activity as ‘creative’, has to be seen as the start and not the end of dialogue, discussion, and justification” (Fleming, 2010). Validation of the arts is a trend throughout all the books. However, using the validation of arts education in order to advocate for it against a global thread of marginalization is the main focus of the final book (Barton & Baguley, 2017; in Wienk, 2020). They emphasize that the arts develop imagination and lead to new patterns of thinking. This gets linked to the 21st century skills debate where creativity and problem solving are key points thereby providing a solid case for the arts in the curriculum.

I stand somewhere between this last advocacy approach and Flemings focus on breaking the dichotomy. The arts in education provide powerful tools to develop a multitude skills and develop character, but it should not be seen as merely an instrument for increasing students’ moral convictions or intellectual pursuits. However, I also recognize the growing threat that arts education is facing in an environment that values outcomes and accountability of learning. Art is often seen by educational policy makers as a field that results in little economic productivity (Barchana-Lorand, 2020). Around the world, art programs are marginalized in the general curriculum. In my local context of the Netherlands the same has happened. Different political parties cut the expenses on arts education in primary and secondary schools when pressures on education are rising (van Waaijen, 2019). In order to argue for its unique spot in the curriculum, including the arts in STEM is a good approach. It shows how thinking in an artful manner is helpful outside of the multitude of art disciplines such as music and literature. However, combining arts with STEM should never subjugate the arts as a mere tool for the expenditure of the

sciences. The practice of STEAM can form a holistic learning process. Amplifying both the arts and science while simultaneously showing how valuable they are apart from each other. The missing ingredient, the creative aspect of art that is transferable to other disciplines, can be found in John Dewey's position in *Art in Experience* (Dewey, 1934; in Eisner & Powell, 2002). He states that art is found within a manifold of daily human activities. It is found in all activities that require a high quality of attention and emotion and is not only restricted to artful activities such as painting and composing, but also with a gardener that is fully devoted to taking care of plant. It cannot replace other educational activities, such as mathematics or physics, but can be presented within those activities when the activity is undergone with a degree of care and emotion. I do not believe art is what he is describing here, and it is even problematic to exaggerate arts role in this way. However, I do think that Dewey captured an essence of arts uniqueness, which could be used to amplify the effectiveness of STEM. Some would call this essence creativity, but this term has become overused in validating artful thinking, thereby draining any discussion of meaning. I therefore prefer the term artistry. Artistry is thinking and undertaking with a high degree of attentiveness and on instinctive judgment, to create a unique product be this physical or theoretical. This does have similarities with the way John Dewey saw quality education, because he thought that the focus should be on explorations and intrinsic judgments, not only established facts (Goldblatt, 2006). With this framework, we can keep celebrating art education as an independent and unique endeavor, while simultaneously looking how artistry can cure some STEMs current ailments.

2.2 History of the gap between science and art: Cartesian dualism

A conversation about STEAM as a potent collaboration should start with an honest and critical talk about the relation between the STEM and the A. Otherwise, we risk the arts being absorbed into an instrumental subservient function of the sciences (Smith, 2013). To start discussing how the arts and sciences can complement each other, it is valuable to ascertain why they are separated in the first place. This separation is often linked to the western Cartesian view of cognition (Eisner & Powell, 2002). In this view, called the mind-body dualism, the mind and body are seen as separate domains. Rational thinking is located within the domain of the mind while understanding through the senses such as touch, smell and all other senses, is in the domain of the body (Eisner & Powell, 2002). This splits science from the senses because science is seen as a rational act located in the mind, while the bodily senses mostly act as a distraction for the mind. This led to the re-establishment of a hierarchy of the senses, which finds its root in Plato

and Aristotle (McKay, 2005). Sight was seen as the closest sense that can provide perceptions on which the mind can reliably perceive changes in environment. This is why metaphors such as “shedding a light on something” or “knowledge as illuminating” are so prevalent (Roodenburg, 2014). It is seen as the ‘truest sense’, and this itself already separates arts and science. The sense of touch that is, for example, used when participating in handicrafts is deemed as manual and therefore dirty labor (Howes, 2010).

Yet, even within the sense of sight, mind-body dualism led to a dichotomy, which favored the sciences over the arts. It split the perceiver of something and the perceived, the subject and the object (McKay, 2005). This disembodies our experiences and leads to the view of one objective truth. Art is a subjective expression based on all our bodily experiences and that does not fit well with the idea of a preferred objective truth. This has also bled into our educational system; objective truth is preferred. As a consequence, the idea of multiple truths leads to resistance among students, who often want to hear how they have to see things. The individual meaning can be disregarded, in favor of a school design based on the efficiency and effectiveness. Under the leading hand of psychology, the education system design received some similarities with factories. (Eisner, 2003). The object of learning in this view is disconnected from the individual learner and rather is connected to universal standards of performance (Kitts, 2015). I am not trying to say that these are inherently only bad developments, that would put me in the same dichotomy of correct/false knowledge, but I do think that we can critically touch upon these developments. Because it has led to the gap between arts and science that dominated history and, in a way, still does. Science was rational and the arts emotional. Science could be tested; the arts is subjective and undependable knowledge.

This all comes down to the value and purpose that was given to aesthetics, the philosophy of beauty and sometimes called the philosophy of art (Garoian & Mathews, 1996). Cartesian Dualism informed Kant’s philosophy on aesthetic judgments, in which aesthetics was seen to be based on feelings and emotions, whereas cognitive decisions are purely based on concepts (Johnson, 2015). Again, in this perception a gap is opened between the rational and the emotional. The arts are thus not adding onto our understanding or meaning of the world. Embodied experience is placed outside the realm of knowledge. It is not surprising that creativity was seen as an activity for artists and not scientists (Garoian & Mathews, 1996). In art education, this disallows the self to be involved in grasping new knowledge, there is a disconnect between who you are and what you are (Johnson, 2015). Mark Johnson in *Aesthetics and the embodied mind* therefore comes with a new definition of Aesthetics, that brings the self-back in what we are

experiencing in art. Art does not have a fixed universal meaning or representation, but when we are presented with it, there are multiple ways for meaning to arise. Similarly, if someone produces art based on knowledge that they have acquired, then that individual can attribute multiple meanings to that knowledge. Through this process, the individual gain ownership over that knowledge, they have integrated it into the way they perceive the world. With this definition, we can see how the arts can enhance the sciences. It unites the sciences and the senses and adds to it through embodied experience, creating the opportunity for individual meaning creation.

2.3 Examples of STEAM

From this short delve into the history of Cartesian dualism and how it informed our view of the arts and aesthetics, we can move into examples of how STEAM can reconnect these two worlds. Often STEAM is implemented in schools in the form of a project. There is a wide variety of inspiring examples, for example a problem-based learning exercise in which students of arts and environmental engineering have to design a new concept for sustainable energy use in the local community (Costantino, 2018). This project focused solely on university students, but STEAM can be especially enticing for younger children. For example, as a 3-month lesson plan on oceanic ecology in the kindergarten, where students learn about math art and science of ocean flora and fauna, made extra motivating with a school trip to the beach (Hunter-Doniger, 2018). Or a collaborative project based on restoration where both first-year architectural students local school children and different scientists and artists work together to design and learn from a nature restoration project, resulting in beautifully crafted species hotels (see figure 2) (MacDonald et al., 2020). Many STEAM projects started since schools were tasked with teaching 21st century skills (Mohd Hawari & Mohd Noor, 2020). By including these 21st century skills, which includes among others critical thinking, creativity and collaboration, school have to focus on developing talented and creative individuals. This is a shift from the production focus Eisner attributed to schools (E. W. Eisner, 2003).

STEAM infuses multiple of these valued skills into teaching practice. First of all, STEAM can provide real world connections to what students are learning. It allows for a bridge to be built between multiple disciplines such as arts, biology, sociology etc. which better represents the way people encounter and solve obstacles in working life (MacDonald et al., 2020). Climate change for example is a risky problem that we are all currently facing, containing a mess of

disciplinary connections. But it is exactly in embracing this mess that 21st century skills can emerge. The second benefit goes hand in hand with this, and that is collaboration. Multiple of the mentioned examples have shown that STEAM fosters collaboration and the skill of articulating your ideas and understanding to others (Barrett et al., 2015). But it also cultivates an awareness of one's own learning process (Costantino, 2018). Students are pushed beyond mere memorization. Through critical reflection and application of the subject matter (Hunter-Doniger, 2015, as cited in Hunter-Doniger, 2018). In this process students allocate their own meaning to what they are learning. This is enhanced by the opportunity to interact through a way of knowing that is comfortable to them, some will work with their hands mostly, others might write and perform drama. This performativity is a big part of the third benefit, increased accessibility for all. In STEAM collaborations, students are provoked to present information in a clear and engaging way (Guyotte et al., 2015). It opens up learning to the wider public, for example through an open gallery on sustainable energy (Costantino, 2018). Throughout this process students establish new relationships between the school and the wider community (MacDonald et al., 2020). Finally, this also results in increased accessibility into STEM subjects which are made more engaging by linking it to real life practice and emotional expression (Smith, 2013).



Figure 2. Species hotel 2 (MacDonald et al., 2020)

From personal experience, I know how motivating it can be to discover your own way of meaningful learning. Like I said in my introductory story, high school was not the best time for me. Because of anxiety, I lost my motivation to learn. I could not focus anymore, and my grades were rapidly decreasing. Instead of doing my homework, I started to binge watch YouTube videos or playing an abundance of video games. By sheer chance I stumbled upon a channel called *CrashCourse*, which contained educational videos on many different fields, from biology

and chemistry to history and civil sciences. The videos not only taught you about these concepts, but also gave interesting real-world examples or stories to go alongside the more theoretical science. As a quick example, learning about human anatomy, but also combining this with Rembrandt's painting of a human dissection. I found myself drawn to a world of science, because of its connection with other fields. Instead of learning theory, I would imagine how I could apply that theory, delving into the realm endless possibilities. This harmonizes with the way Mark Johnson (2015) sees the power of aesthetics. It shows you an array of pathways to traverse, not just one set path that everyone walks. Learning became a fun journey, almost as fun as the video games that had me stuck to the screen most of my years. This was because, learning started to feel similar. In video games, especially the Role-Playing Games I played, you take part in an adventure. You start of weak, but as you gather experience and explore new areas you develop a better understanding of the game world and how to beat the upcoming challenges. Through a combination of story, experimentation, and difficulties you are pushed further to discover. I needed to craft a personal story before I started learning something. The contents of the story must contain what I can use this knowledge for, how it contributes to my understanding of the world in a broader sense. Even when subject matter does delve into problem solving, it is often within boundaries of the specific discipline, which hinders the skills to look beyond that and see the multitude of possibilities (Costantino, 2018). By linking my learning to a story, I encouraged myself to see connections that would have otherwise stayed hidden. To be honest, this did not increase my grades that much. I was sometimes learning content that was not useful for the test, and this had negative effects on my results. I spent less time learning just the content for the test by heart, and instead filled my head with more knowledge than necessary. However, the questions that I did know how to answer were often correct and I could give more elaborate explanations on why this was the case. But, most importantly, I could still recall information from the course weeks after it ended, while I used to apply a "shop-&-drop" method of learning - quickly rehearsing all that was needed and immediately forgetting it afterwards. I think that Eisner & Powell (2002), and many others, identify similar problems. The education system is not successful in enticing learners to use their imagination and go on a self-discovery of what works for them. It does not advocate for multiple ways of knowing, but mainly utilizes a one-size fits all approach. It is the classic story of asking a monkey, elephant, and fish to climb a tree as an exam (see figure 3). Using artistry to add on to the ways of knowing can create equal grounds for all learners to thrive. The arts are captivating for learners, because they help us delve deep into human emotions and can stir our thinking in new and exciting

ways. For this reason, educators are seeing a lot of potential in arts for meaningful learning (Yorks & Kasl, 2006, as cited in in Leavy, 2015).

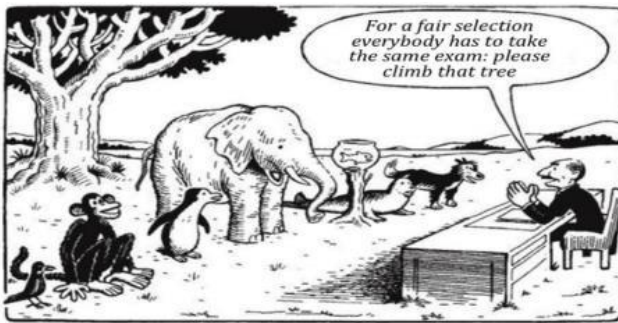


Figure 3. Now, climb that tree (Russel, 2012).

This potential of STEAM is being spurred on by the interest in 21st century skills, however, there is also a significant hurdle to its further implementation. Time is one of the biggest challenges of both teachers and students alike, which implements STEAM in education mostly in the form of projects (Hunter-Doniger, 2018). Also, to successfully run even one project teachers of different disciplines have to commit to frequent collaboration. However, if the arts became intrinsically integrated in the curriculum instead of being seen as a side project, then teacher would get sufficient practice and get more used to this type of working. This is why Hunter-Doniger advocates (2018) for an art infused school: ‘the walls of the Façade of separation between art and non-art subjects is not only broken; a solid structure of art and academic excellence is built from the rubble’. Eisner and Powell (2002) give a framework for how such a school can be established. First of all, they suggest creating a curriculum that considers different forms of artistry. This would allow students to experiment with different ways of knowing, to draw on experience and to combine this all to create their own truth. Even within the objective truth STEM subject, students would be encouraged to engage in their own learning journey. They discover novelties and experience setbacks along this journey, to eventually come to their own understanding. Secondly, they believe the school environment should be changed. School buildings are often made with efficiency in mind, there are very few aesthetically pleasing designs. A more appealing environment could be conducive to learning, improving students cognitive and creative abilities.

“A student is not a container you have to fill but a torch you have to light up.”

-Albert Einstein

3. Exploring music's potential for learning STEM

For this thesis, I want to explore the combination of artistry and education further. For this I will stick to the form of art that is closest to me, music. As the introductory passage shows, music has played an integral role in giving meaning in my life. Creating meaning out of learning experiences is one of the main benefits of STEAM (Hunter-Doniger, 2015, as cited in Hunter-Doniger, 2018). I could even go so far as saying it is integral. Learning something is creating a meaningful relationship with the thing you are trying to learn in order to make sense out of it and emplace it in your mental frames (Zittoun & Brinkmann, 2012). You make the subject matter you are trying to learn your own by fitting it into your context of life. In this chapter, I aim to explore music's potential for creating meaningful learning. I will first describe in what ways music can create meaning. Then I will examine music's effects on cognitive & social abilities. This serves as an extra argument for music's implementation in STEM subjects. Finally, I will look at how it is already utilized in different school subjects.

3.1 Music's ability to generate meaning

Listening to music from an early age can foster the ability to express and experience emotions (Ruud, 1997). It is a good means to convey recognizable feelings. Because of this, listening to a song can function as mirror of our own lives and can contribute to a greater understanding of who we are and the connections we have with others. Through these connections it can also convey a sense of authenticity, the idea that the way you perceive yourself and live your life is in line with your worldview and values. From my experience, this can especially be the case when creating music. Not often, but sometimes when I make music, I feel some sort of "flow". In this "flow" state, the creation process happens automatically, almost unconsciously. You already hear the melody that is deep within you, a connection to how you really feel. All your emotions lay bare, the only thing left to do is pick and choose which you want to convey within the song. The vulnerability can give us access to information and understanding that we normally could not reach (Carless & Douglas, 2010). These aspects of music and songwriting make it highly personal, but that does not mean it is purely an individual experience. Music can actually create connections and a sense of belonging to broader society (Ruud, 1997). For example, when writing music, we are often inspired by other musicians and want to capture the essence of their creations in our own musical endeavors. Through the formation of our own distinct musical taste, we feel connected to certain cultures, subcultures, or events in history. Musical

meaning can be connected to these events through a process of narrativization. Narrativization in music is the idea that people experience music as multiple episodes of a sequential narrative, rather than just abstract sounds (Margulis et al., 2019). People with similar cultural backgrounds can experience the same narrative when a song plays. This is because we develop strong connections through the context of our backgrounds, which instills significance into different sounds. Just think of the sound of a bell. A particular bell sound can be strongly connected to church or another religious activity, while for another group the bell reminds them of the school bell when the break starts. In an experiment by Margulis (2017, as cited in Margulis et al., 2019), people with shared cultural backgrounds listened to the same musical excerpts. Participants generated very similar stories based on these excerpts, for example of a cat chasing a mouse or a fancy ballroom dance. Through this shared narrative, people experience a being with other people, a deep relationship with others (Ruud, 1997). Ruud even describes this as a fulfilment of the necessity of people to experience life as part of a larger whole, meaning that in order to give meaning to existence, we need this larger sense of belonging. It is then not surprising that going to concerts or listening to beautiful music can for some people be an almost religious experience.

Using the process of music making to give meaning to experiences has long been utilized by music therapists (Meadows & Wimpenny, 2016). A good example of this is musical improvisation, which has been proven useful in the clinical context to enhance health and well-being. Client and therapist express pressure and release in this musical exchange, which eventually help the client to overcome their barriers or mental blockades. It is mainly utilized when this blockade has to do with a drastic change in their lives. By taking risks in the music, trying out something new, you can move past this change and learn to accept it, allowing a new you to come to the forefront. “Beauty in the music can be a source of insight and meaning (an agent of change), and/or a way of experiencing oneself musically” (Meadows & Wimpenny, 2016). The music in the end is a metaphor for the challenges that the client has to overcome, which is where meaning in the music is created. Douglas Keith (Keith, 2007) explored an idea of co-constructing meaning in therapy. In an experiment, he journaled together with the client about their impressions, recorded the improvisations they made together and then analyzed those together afterwards. Besides talking about the music, the client was also asked to listen to recorded improvisations and stop the music at a time when something felt meaningful. This provided a basis for discussions about significance of the piece. Interestingly, during the reflections participants often could not make sense of their music themselves. The sounds, rhythm and

melodies do carry some weight, but it is mostly the process of creating the sounds where meaning can be identified. It also helped if a title for the music was made before playing, to anchor the experience to something concrete (Keith, 2007; & Meadows & Wimpenny, 2016). Some participants failed to create meaning when this reference point in the form of a title was not there, due to a lack of structure in creative process. This is especially the case for people with little musical experience.

3.2 How I make meaning through music

I have now described theory on how meaning is created through music. From this meaning creation it becomes easier to see how music can start meaningful learning. But as described, how meaning is created through artistry can never be boiled to down to one simple truth. It is also up to the learner, their background, and perspectives. That is why I think it is good to give an explanation on how I make meaning through music. Sometimes a cumulation of events can feel overwhelming. Everything is happening in quick succession, which provides little room to breathe and reflect on what occurred. This is why I originally started writing poetry in high school. It helped me to make sense out of (negative) emotions. I think that when people can give meaning to an occurrence themselves, they retake control over the memory of that event. By doing this, even a negative experience can be turned into a life's lesson, or at least something that is easier to deal with. When I started adding music to my poetry it became an exceptionally powerful tool. I want to explore this after learning that some rappers also supported their creative outlet of writing by making an accompanying musical piece, often letting music itself represent what is in the lyrics. An illustration of this is the song *Street Lights* by Kanye West (2018) (Listen to the song [here](#)). It is a song about the repetitiveness of life, the normality of it all and the monotony of time and the goals we pursue. To illustrate this, the lyrics repeat themselves:

*“Seems like, street lights, glowin
Happen to be just like moments, passin
In front of me so I hopped in, the cab and
I paid my fare see I know my destination
But I'm just not there.”*

(West, 2018).

Over these repeating lyrics, a wobbling, almost eerie noise repeats itself. However, other instruments keep coming in after each verse, creating a tightening tension. It seems like the writer

is getting more frustrated with this monotony and wants something in life to change. In the finale of the song there is a big climax, after which all instruments go away except for a piano playing sad chords. It is the final acceptance of the writer of the situation. For me, this is beautiful songwriting, which drew me in to do the same. My original goal when I bought my first music production software, was to support the poems that I already had written. But while producing my first song, something happened. I fell in love with creating music itself. There is so much intricacy and theory in writing a good song, but at the same time the simplest songs can be the most captivating. It is a very expressive art form that can be both intimate and quiet & explosive and bombastic. Currently, I often write songs to make sense of experiences in my life, especially when these are difficult to process. To give an insight into the meaning creation behind the writing process, I will describe how & why the song *Frozen Frames* was written. You can click this link: [Song 1: Frozen Frames](#), to listen to it. Throughout the following passage, I will describe the song and what part I am talking about in *cursive*, so you can find it back while listening.

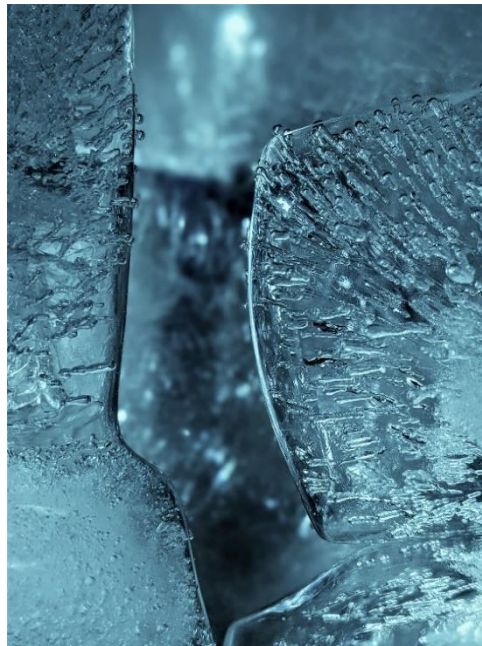


Figure 4. Frozen glass (Wilkinson, 2021).

I do not like goodbyes, and I do not think a lot of people do. I can never find the right words to say. At that moment, standing at the door or in the train station, about to enter a new space,

it feels like you are forced to close off different parts of your life. As if you take part in a television series that just got cancelled and the writers had to quickly tie the threads together without any meaningful buildup. It is all so sudden. When I was about to leave Finland, where I lived and studied for one year, I felt this stronger than ever. Many friendships I made felt like they could be lifelong friends if distance allows it. But within that close group of friends, there was also a girl. After we spent an afternoon sharing personal poems in our own language, I gained a lot of affection for this girl. During this time, I felt both an intense longing to return to my girlfriend, but I also lived out a fantasy in my head of being with this girl. I started putting this longing into a simple motif that I played on the piano. *This is the first part of the song from 0:00-0:45. It invokes a lingering feeling of wanting release, which was how I felt at that moment. I wanted to kiss this girl, but my morals did not allow me to relieve myself of that pressure. Instead, I imagined an intimate touch through the melody.* As my inevitable leave of Finland approached, I started to continue working on the song. However, there was no progression of chords or melodies that felt right to me. In frustration, I figuratively crumpled up and threw away all my ideas. There was another feeling that was lurking in the longing, something more intricate than a simple crush on a girl. It did not allow me to feel satisfied with my current conclusion. I fantasized about being with the girl and starting a life in Finland. A simpler life in the quiet north, far away from the crowded Netherlands. That was it! The fantasy of me being with this girl represented a bigger theme, me staying in Finland. As the date of my departure drew closer there came a sadness with knowing that Finnish life would stay imagination. *The line "keep me in these frozen frames" represents this sadness. The song as a whole is written from the perspective of someone who looks back on enjoyable times and wants to stay in those memories. This is stated in the two verses of the song. The first verse starts the story with this person laying out the options and questioning if leaving is really necessary. I can continue living here. The chorus counters this. You have to forget that fantasy and clear your mind.* However, I had to accept that I would go away and my life in Finland, at least for now, was ending. At the same time, this acceptance brought forth a happiness and appreciation of how beautiful my time there was. *The final part of the song (3:19-4:02) came naturally while I was playing around on the keys. I do know quite some music theory, but I still often write songs by improvising. Just like in the music therapy sessions that were described earlier, improvisations naturally evolve to create an emotional narrative. In this case, the final chords I played felt like they carried sorrow, but also moved me toward closure. After I played this progression, I started to reflect on what it meant. It is a very generic lesson. I would have to say goodbye to a lot of people who I had grown fond of, but the*

times we shared will stay with me. The final lyrics start with: "this is my acceptance speech" because it is me accepting this reality.

3.3 Music's social and cognitive benefits

We established that music has a lot of potential for creating meaning. Both listening to and creating music has strong emotional significance. This can help individuals in exploring their own authenticity, process events and connect them to a larger whole. But are there other ways besides this in which music can benefit learning? To uncover this, we can start by looking at theories on music evolution. There are researchers that believe that music originally evolved to create sincere emotional communication (Juslin & Västfjäll, 2008; Levitin, 2008, as cited in Snowden et al., 2015). Indeed, just like animals can use sounds to signal certain emotions, it is theorized that early humans used music to induce a certain emotional state in others. Groups with shared emotions have better social cohesion, increasing cooperation within the group (Patel, 2010). Music still serves as a tool for social cohesion today. In an experimental study, two groups of 4-year-olds were tested in a task where they needed cooperation (Kirschner & Tomasello, 2010). One of the groups marched together while singing before the task, while another marched without singing. The group of children that sang together before the task performed significantly better. Because of these social cohesion benefits researchers argue for the so called adaptationist theory of music in which music was invented because of natural selection and helped human species to survive. However, neuroscientific research is increasingly showing that nonadaptation's theories are true (Patel, 2010), meaning that music does not build upon traits that were important for natural selection. Instead, it builds upon diverse functions of the brain that already existed but not as important for survival.

This does not mean that playing music does not have any long-term benefits. In fact, it has a variety of positive effects on nonmusical abilities. Actively engaging with music by regularly singing or playing activates the plasticity-based-mechanisms of our brain. This means that it can have positive effects on creating new connections or rewiring existing brain circuitry. These effects are not only seen during early development of a child, but even throughout our lives, despite our brain becoming less flexible when we get older. The skills that we can increase this way are, among others, communicational or social cohesion increases, better memory, stress reduction, and better executive function (Patel, 2010). Music has great potential to increase learning, and memory. A study on six-year-old children was done to see the long-term effects

of music lessons (Schellenberg, 2004). Big groups were randomly assigned to keyboard and voice lessons, drama lessons or no lessons. After a year, the group that took music lessons had small increases in their IQ that the other two groups did not have. Music lessons, taught individually or in small groups, may provide additional boosts in IQ because they are similar to lessons in school, but more enjoyable. They require memorization, (learning scales, chords, notes, music notation) and motor skills, which helps boost your IQ. A later similar study with third graders also found enhanced reading and improved pitch discrimination in students that took musical lessons, and not in students who took painting (Moreno et al., 2009). Music also enhances shorter term memorization. Students who had to learn neuroanatomical terms retained more information when it was presented in the form of a song, after they were tested 10 days later (Panksepp and Bernatzky, 2002, as cited in Patel, 2010). These effects on memory could be related to the emotional capacity of music. Research has shown that stimuli that carry emotions are remembered better than non-emotional stimuli (Eschrich et al., 2008). This is because emotions are used in the brain as contextual information that links to the matter that was remembered.

3.4 Why music developed across the world

The widespread usage of music around the world further shows its potent potential. Everywhere around the world, people developed their own distinct style of music, for different purposes. Personally, I love listening to so called world music. An assortment of music that encompasses many different styles from around the world, but often finding their basis in traditional music or an intermingling of different cultures. For example, I am a big fan of *AfroCelt sound system*, a band combining African and Celtic influences. A perfect fusion of west and south. When I listen to songs like Release (Real world record, 2014) (click [here](#) to listen). When you listen to the unique sounds from traditional instruments, you get transported into an entirely different atmosphere and space. When I hear the sounds of the hajhuj, a sort of 3 string lute often used in Gnawa music, I see myself dancing, in trance, in a small village in the middle of a desert. When I hear the Irish fiddle, playing fairytale melodies accompanied by a hurdy gurdy, I land in an Irish bar. My friends dancing on the tables as we talk of giants and leprechauns endangering our travels. The Indonesian Gamelan, with its dissonant tones, brings me into an Indonesian village where a wajang doll performance is being orchestrated (see figure 5).



Figure 5. A wajang doll performance on Java (Wayang Golek Performance, 2013).

However, despite the wide variety of music and musical instruments, there are universalities when it comes to the tones that are used. All music, around the world matches the chromatic scale (Schwartz et al, 2003; in Snowden et al., 2015). This is the 12th note scale if you for example play all notes on the piano without skipping one. The notes on these scale have very similar resonance as the human vocal tract has, which can indicate a strong relationship between music and speech. More specifically the intervals within the chromatic scale, namely the octave (12 semitones), the fifth (7 semitones), the fourth (5 semitones), the major third (4 semitones) and the major sixth (9 semitones) are found both in speech and in music around the world. It is no surprise that music is often called a universal language. This universality can also create enticing musical combinations. Music can transcend the boundaries of language, and it is therefore not surprising that it is also being used to create better intercultural understanding, especially for young people (Crawford, 2017).

There might be another reason for why music is universally used in different cultures, and that is for learning. Throughout the ages, songs have been used to transfer knowledge across generations. Epics sing of gods and heroes who have to triumph over some form of impending doom and ballads talk about interesting narratives, with love and passion. They can tell stories with thoughtful lessons. For example, the story of narcissus who fell in love with himself, which teaches about the harm of too much self-love. Another example is the Finnish national epic, *the Kalevala*. This is a collection of poems, put together by Elias Lönnrot in the 1800's. He bundled these by traveling across Finland in search for singers and old folk songs that parents taught their children. Even though the bundle is a written work, and was mandatory to read in Finnish schools, the role of music to create the story is apparent. Still now *the Kalevala* is performed in

song during Kalevala day, to tell stories of old, because these stories had an important role in shaping Finnish culture (Kallioniemi & Kärki, 2009). The power of epics and ballads lies in its use mnemonics, which are specific words or images that we can connect to what we learn, making it easier to store or retrieve (Snowdon et al., 2015). For example, the characters in the stories are easily distinguishable by their clothing, behavior, and the element they represent (Either a natural element such as thunder, or a human element such as pride). Because of these features, the songs and stories are more easily remembered. When I think about this in more depth, it makes a lot of sense that children's songs and rhymes are used to teach our earliest lessons. Children's tv shows often use songs, together with images, to teach a wide array of subjects from numbers to colors. Many people, including myself, have learned the alphabet through the ABC song. A song about a famous captain that conquered a Spanish warship taught me about history. Even as I grew older, songs taught me wise lessons. The song *Biko*, by Peter Gabriel taught me about a South-African freedom fighter and the sacrifices he made (Peter Gabriel, 2013) (click [here](#) to listen). Songs have remarkable power to enter into our heads and keep these lessons close to our heart. This even transcends mental diseases like Alzheimer, as a study has shown that songs with a fond memory connected to it, can sometimes still be recognized by Alzheimer patients (Cuddy & Duffin, 2005)., while other details were otherwise forgotten.

3.5 Examples of music in the classroom

Music's abilities for remembering content and develop students creative and intellectual capacities have not gone unrecognized in education. As I would discover, there is an entire community of researchers and educators that have implemented music in their lessons (Pellegrino, 2013; Tinari & Khandke, 2000; Watson & Beymer, 2009; Grossman & Watson, 2015). The most logical implementation, outside of music class, is perhaps languages. A teacher can use the lyrics of a song in a different language and give students the task to translate and analyze them. My third grade German teacher did this once, which was the first of the two times that I experienced music being used as a learning strategy. He grandiosely introduced the task, stating "Nicht ist wie es scheint!". He then started the song: "hast du etwas zeit für mich? Dann singe ich ein lied für dich". It was *99 luftballons* (NENA, 2021) (click [here](#) to listen), a cheerful song about a party with balloons, or so I thought. This song was a great choice, because the lyrics truly tell a different story than the song would imply. It is a factionary tale written in cold war times, about 99 balloons in the sky being picked up in the scanner as an enemy unidentified

flying object. Because of this error a war is started, perhaps as an excuse for countries to gain power. True translating and analyzing these lyrics, we not only learned German, but also got a history lesson. This is the first topic where music can provide additional inquiry, history. Music has served as inspiration, protest wisdom and is woven into culture throughout human life. Its power is felt in deep Mongolian throat singing, nineteenth-century labor song, rebellious punk rock and human right recalling hip hop. As such, it is a significant historical artifact that should be included in the classroom (Pellegrino, 2013).

Anthony M. Pellegrino developed four models to help history teachers utilize music with each subsequent model becoming more student centered and controlled. It ranges from close reading (analyzing song lyrics) and inquiry (link analysis to context of the song) all the way to creative development (allowing students to create their own song). This also indicates a range for the amount of meaning that students can allocate to the topic. In the beginning they analyze lyrics, and the meaning given is mostly determined by the songwriter, or what the teacher intends to teach. At the end, full meaning-giving options are given to students. Even without deliberate intent, all music-based learning strategies that I will discuss fit somewhere in this model. For example, providing a list of songs such as *Money* by Pink Floyd or *Fast car* by Tracy Chapman and task student with analyzing the lyrics and relating this to broader economical concepts (Tinari & Khandke, 2000). This fits well on the inquiry level as a student who analyzes 'Fast Car' relates this to broader research on poverty and poverty programs. Or giving students the project to write a Praise song for English, in which they can be proud of their place and the inherent meaning it has for them and thereby give them the opportunity to present their youth community (Watson & Beymer, 2019). This emboldens their spirits as their youthful knowledge and life experiences get recognized and celebrated. It shows a common theme of empowerment that I find all utilizations of music in the classroom, but another common theme is interdisciplinarity. Especially when engaging on the inquiry level, students emplace the songs into a broader context of history, economics, sociology, and language.

Yet, does this interdisciplinarity also transfer to more STEM related courses? I initially did not expect to find many examples of this, so I was pleasantly surprised when I discovered VOICES. VOICES is an international group of STEM and ARTS teachers, songwriters, and researchers who researcher the use of song in STEM and share this knowledge for everyone's benefit. They also keep an annual conference for this purpose. Browsing through this website and encountering all the innovative uses of song created an amazing pull towards STEM. When I saw a Louisiana high school teacher using rap to teach the circulatory system, I was ready to grab my

backpack and retake biology (click [here](#) to listen). It sparks enthusiasm when a teacher goes the extra mile by creating music that relates to her student's worlds. A study in a university natural history class to see if music videos changed the attitudes of students towards science (Grossman & Watson, 2015). The results showed that students had more positive perceptions towards the subject. This was partly helped by the personal involvement of the teacher, who made the songs by playing kazoo, guitar, and ukulele. Another study compared the results on a test by learning with music videos, with other videos without music (Crowther et al., 2016). They found that test results were similar, but music videos were more enjoyable, and the knowledge was retained for longer. Positive results on using music for STEM have even created a musical genre in itself, Science songs. Generally defined by a catchy beat, clear structure, and off course science lyrics, all with the goal of getting stuck in your head (Governor et al., 2013). A good example is the album Here comes the science by They might be giants, infectious rocky tunes that get the body bouncing and brain working (Weinkauff, 2009) (click [here](#) to listen).

Propagators of science songs say that the impact lies in relating the generation of digital learners, who consume knowledge instantaneously via a variety of media. They listen to podcasts and music almost constantly, so it is a logical step to use this in the classroom. The end goal is to create engagement, which science song can do by introducing a novel way of learning and often creating a generous amount of learner independence true individual meaning creation (Kiran, 2020). What are different ways that science songs can be implemented in STEM? As discussed, using music videos is a good way (Crowther et al., 2016; Grossman & Watson, 2015), but also analyzing lyrics of science songs (Governor et al., 2013). Then there are also more novel approaches such as the project SMILES which uses song enthuse students into liking statistics. Students have to answer questions and the answers are used as input for the song. The songs then get sung over instrumentation by a professional singer. Entering the wrong answers creates funny results, the words do not rhyme or there is an anticlimactic ending. I tried this method and was truly amused by the result. A giddy sing with a man singing: "Correlation does not imply causation" will definitely help me retain the information. For all these great examples of song in STEM, there are a few that imply the creative portion of songwriting. One example was based around the idea of Writing to learn, where students are assigned to write about what they learn in their own words, thereby going beyond acquisition of knowledge into areas of greater understanding (Reynolds et al., 2012). In a comparable way, during songwriting to learn students make decisions on how to express their ideas and how to put this into songs (Crowther et al., 2017). This increases the connections to what they learn, while also increasing

enjoyment. However, in this study teacher-written songs were often seen as more helpful than self-written songs. The reason for this is simple, not everyone has songwriting experience. It can help to write parody songs based on real songs instead of original compositions, such as *Your Axon is a Wonderland* as a parody on a famous John Mayer song (Crowther, 2012). Or condense the song into a rap, which requires less musical knowledge to write if you stick to a basic beat. Still, students may find it difficult translate complex information to song. To help with this, Crowther, Ma and Breckler developed a songwriting template (see figure 6).

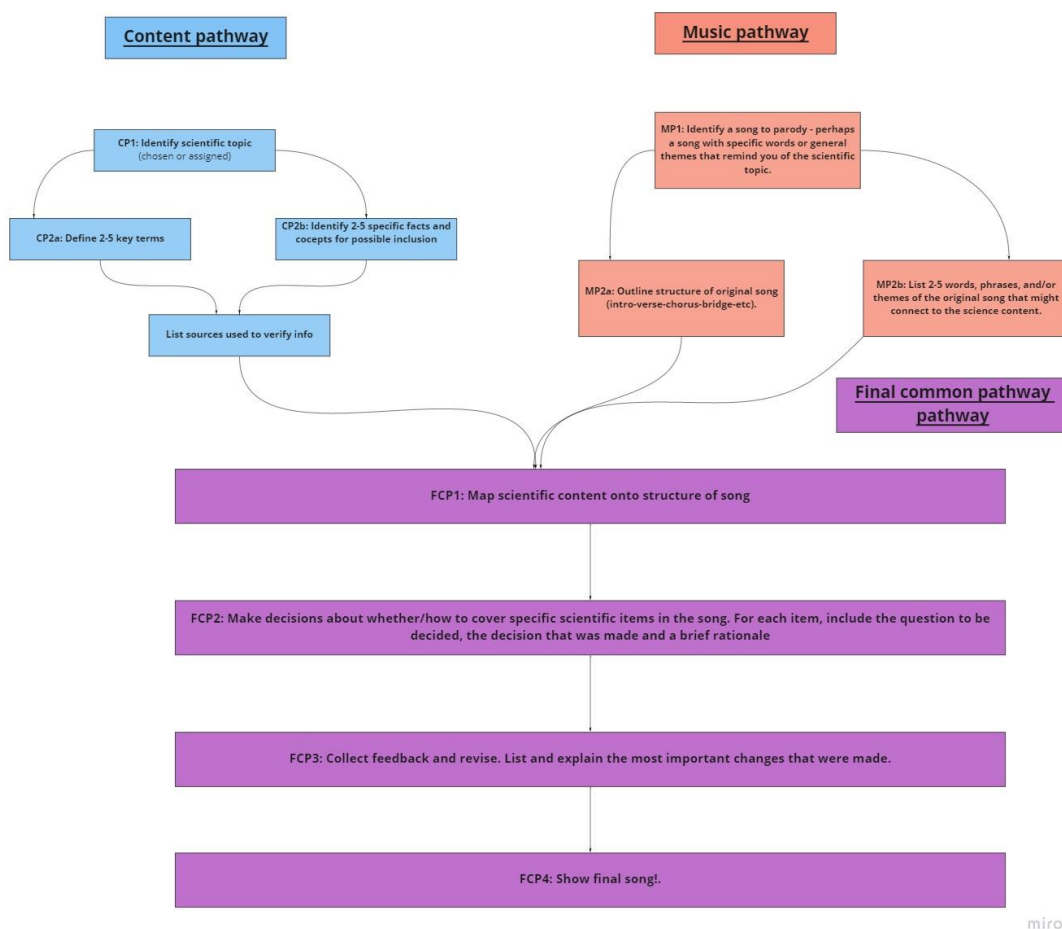


Figure 6. Songwriting template.

Note. Adapted from *using science songs to enhance learning: an interdisciplinary approach*, by G. J. Crowther, A.J. Ma, & J. L. Breckler, 2017, p. 121.

Such a template may help students, but it is only fair to acknowledge that using songs is not for every teacher. It certainly helps to have an amount of musical interest and confidence in order to transport that motivation onto your pupils (Lum, 2008). This does not imply that you have

to be an eager instrument playing, concert going individual, just an ounce of interest in music in general should be enough. It is also good if the songs that relate to your class are songs that resonate with you. It has less impact if a Malay teacher, with a fondness for Latin American music and dislike for any other style, uses Malay songs for learning. But research has shown that even a teacher without a distinct enthusiasm for music can be successful in utilizing it in the classroom when provided with the right tools and music (Governor et al., 2013). They are glad to have tried it as it is active learning that helps words stick in the brain.

3.6 The musical goal of this thesis

Previous research combined with my personal experience convince me that music has a lot of potential to incorporate artistry into our learning process. It can enrich the way we come to know about the world by introducing artistic imagination and reflections. But apart from that, music education also has proven benefits for broader personal and educational development. For example, social skills such as empathy and motor skill developments (Kirschner & Tomasello, 2010; Patel, 2010; Snowdon et al., 2015). These are widely implementable skills that help connect the benefits of music to other fields. Despite these positive effects, music education alongside the other arts is declining. Speaking close to home, budget cuts in the Netherlands have had a significant impact on the local infrastructure of culture education, which in some regions is crumbling rapidly. Because of this, practicing of the arts has become inaccessible for many people. Children are often the ones who mostly rely on these activities in their spare time, and the consequences here are felt the hardest. Budget cuts have currently made music education in primary school only accessible for one thirds of the 7.000 schools (Over meer muziek in de klas, z.d.).

The goal of this thesis is therefore to explore the viability of using music as an artistic form to enhance learning. Thereby ensuring its unique spot in the future development of curricula. A form of learning that helps students shape their own way of thinking, through experimentation and self-reflectivity. The way I want to explore the idea of introducing music as a different way of knowing in learning is through what I call musical inquiry. Musical inquiry is the usage of musical composition and representative sounds to reflect on subject matter that is learned. An emphasis here is not only on lyrics as inquiry, but also the sounds themselves. This is a focus that I have not found in other examples of music for STEM, it is always the lyrics in which the

lyrics is processed. However, as established, sounds themselves carry the power of narrativization (Margulis et al, 2019). Through this narrativization, strong connections to the learning content can be formed. You can bring outward the complicated cognitive processes that happen while discovering new knowledge, while also engaging sonic forms of knowledge. My aim is to answer the question: How can musical inquiry influence the learning process for STEM subjects? I aim to answer this question through exploration of different research articles and self-experimentation. However, I do want to take the critique on Herbert Read's Education Through Art into consideration. The goal of this research therefore is not to emplace musical reflections as the new holy grail of learning methods. It is to explore the feasibility of a novel way of knowing. Besides this there is also a second methodological goal, that is to explore how music can be integrated in an autoethnographic paper, the full combination of ABR and autoethnography. These methodologies can flow together like an abstract painting, highlighting both their unique colors but also combining to form a new one (see figure 7). I will elaborate on this methodological question in the next section.



Figure 7. Abstract waves (Garageband, n.d.).

4. Methodology

This research requires an intersection between two provocative methodologies. In this section I will tell why these methodologies provide necessary components for this research, but also share my journey of discovering how these work. ABR and autoethnography have very similar goals and principles. Both aim to make research more accessible, enticing, and personal (Leavy, 2015; Adams, Ellis & Jones, 2017). Nonetheless, it is still good to explain the important differences before talking about how the two methodologies complement each other in this thesis. I will first go into autoethnography. This is a good starting point because many of the aspects of autoethnography are shared with ABR, but ABR adds a musical component that I will talk about later.

4.1 Autoethnography

Autoethnography sits at the intersection between autobiography and ethnography (Adams, Ellis & Jones, 2017). From ethnography it takes the ideas of emplacing yourself in another culture or a particular experience and using observations and interviews to discover novel insights. From autobiography it takes the in-depth analysis of self and intimate reflection with the aim gaining understanding of who you are and through this also helping others. It stems from the belief that personal experience contains ‘golden nuggets’ of cultural or political perspectives that researchers are not able to explore in other forms of research. In order to uncover this information, an autoethnographer engages in constant in-depth self-reflection, which is called “reflexivity” (Adams, Ellis & Jones, 2017). The goal of this reflexivity is to blend the personal with the cultural and from this deduce insights about broader societal questions.

When I first heard about this idea of reflexivity and the “self” as research subject in a qualitative research class in Finland, I had difficulty taking it seriously. At the time it chafed against my existing beliefs about ‘good science’. In my Bachelor of Educational Science, we were tasked with reading countless books on the scientific method and how to conduct valid and reliable research. These methods were often positivistic in nature, fully based on the researcher being as objective as possible. I could not even imagine using “I” in a research paper. You had to stay away from your writing, almost as if you are ghostwriting for someone else. This was my view of social research, a highly impersonal endeavor that aims for the objective truth. We were also highly urged to use quantitative methodologies. Qualitative research seemed like a taboo subject, only whispered about in the college halls after class. I did participate in one extra course

on qualitative research from the bachelors of anthropology, but even here emplacing the researcher within the research was not touched upon. Research almost entirely written from the researcher's point of view sounded to me like something that does not provide any useful knowledge. It also sounded easy. With a bare minimum of effort, you can still call yourself an academic. Apparently, this is a conception that more students have had. As Jillian A. Tullis (2017) points out, the sentence: "I'll just write an autoethnography" passes many a student's lips. In all honesty, this was also a factor for me considering this methodology. Writing a thesis in the middle of the corona crisis is a stressful endeavor. My first thesis idea was supposed to be a case study analysis in an innovative school for refugee children. Everything was arranged, I had established a welcoming relationship with the principal, and I could even provide a few music lessons for the children. I felt a tremble in my voice when I spoke about it, produced by excitement that could hardly contain itself. When Corona first started, the time that elapsed between responses to my emails extended. From three days, to six, to eventually two weeks. I understood well that continuing this thesis topic became less likely by the day and overcome by this uncertainty, I called the principal. As I suspected, we could not continue the ideas, or explore others. After this incident, I was left distraught and restless. What should I do now? I started flirting with the idea by reading some autoethnographies, while simultaneously searching for other possible topics. I would soon find myself entranced by the personal depth of autoethnography, by reading the first chapters of the *Handbook of Autoethnography* (Adams, Ellis & Jones, 2017). It provided me with a more grounded foundation of autoethnography.

Despite the wide variety of approaches there are to the methodology (Chang, 2017) there are four characteristics consistent amongst all of them (Ellis, 2016). (1): Critique or comment on existent culture or societal characteristics. Personal stories are a powerful medium for providing broader social commentary (Chang, 2016). Daily life is always packaged within a broader societal context. Many people have experienced similar pains as us, either in the past or present, but it is easy to forget this when we are encumbered by day-to-day life. Autoethnography provides a mirror to society, by examining one perspective, we are probably representing multiple. (2): Make contributions to existing research. Just like other research methods, the topic is chosen with care about the broader contribution and often involves referencing previous research. However, referencing previous work is not a necessity and it is up to the researcher to determine what approach works best. For example, Carolyn Ellis's *Maternal Connections* (1996) does not contain any formal scientific references but does neatly position itself between broader stories about mother and daughter relationships. In contrast, Costello, Feller & Sammon (2018) see

referencing and establishing a theoretical framework as a necessity for valid and reliable autoethnography. (3): Embrace vulnerability with purpose. The stories are of a very personal nature and the writer therefore should keep their goal in mind. Basically, you should constantly decide for yourself if the narrative you open up adds to the point you are making and if you want this to be accessible for all. Within the exposure of the vulnerable self lies the reality shaking nature of autoethnography, but these once private stories will permanently stay on the internet, unchangeable (Adams, 2008). Finally (4): Creating back and forth relationship with your readers in order to invoke a reply. It tries to make research more accessible for a broader public, which definitely resonates with me. My experience is that academia a field located within a bubble. At least within the field of education, hundreds of interesting articles are written every week, all with the glorified idea that they will change something for the better. But it feels like all this research barely reaches the general public. An article was even written titled: How to write consistently boring scientific literature, to stress the point that most people do not like reading scientific articles (Sand-Jensen, 2007).

Autoethnography aims to make research not only accessible, but also exciting to read. It is written in a similar way as a novel or autobiography and pays attention to story. I am an avid reader and also enjoy writing short stories and poems, so this characteristic of the methodology was convincing. But there was another aspect that appealed to me. Just like many others the lack of established rules or rather the openness to many different ways of knowing (Anderson, & Glass-Coffin, 2016). I do not know many research methods outside of ABR and autoethnography where researchers can write the script of a drama or through poetry. But Randolph and Weems (2010) did this with autoethnography, and wonderfully examined and critiqued the way they were treated at the university based on their race and gender. It is also rare to find the biggest part of a paper being the vivid recount of a conversation (Bartleet and Ellis, 2009). Autoethnography opens multiple pathways of possibilities, similarly to aesthetics in the view of Mark Ronson (2015). Because of this approach to research, it perfectly fits the endeavors of this paper. An experimental exploration of musical inquiry, perhaps musical reflexivity, to support the learning process of STEM.

The arguments in favor of autoethnography were captivating, but there was one voice in my head that rang louder. Partly sparked on by the literal voices of people around me, I was convinced that autoethnography would not “sit well” on my resumé. I could already envision sitting in front of a neatly varnished wooden table, a potential employer looking critically on the other end. We just went over my experiences; she was quite impressed with my societal contribution

in volunteering for the climate movement. But one spot still stood unexplored “I see that you wrote an autoethnography, what does that mean?”. After telling the story she would look at me with surprise, trying out of politeness to hide her discontent. “You will hear from us”, she says with a smile, but I never get a call back. I was plagued by these contemplations, which pushed me to another option. But I could not shake a gnawing feeling. In the hours that I was free, I found myself looking up videos and articles both on the potentiality of music in schools and on autoethnography. It was one read in particular that shook me emotionally and helped me to find the courage to start this research. It was a powerful and shocking account by Carol Rambo-Ronai and her story of childhood sexual abuse (Ronai, 1995). Her autoethnography was raw as she exposed a lot of vulnerable moments in her early life. I was physically shaken as the words of pain tore into my head. She explains in excruciating detail about the shame she felt during and after the horrifying experiences. It is powerful writing, so powerful in fact that her peers found it inappropriate. They warned her that overexposure in this way could harm her career and I was shocked. How can people say that these important stories have to remain under the rug? Here is someone who finally wants to pick that rug up and shake it from all sides until all the dirt falls off. I noticed in that moment that I was being an incredible hypocrite. Certainly, my research ideas did not carry the same emotional weight, but the topic is definitely something I believe in, and think should be told. Why would I let fear get the better of me? Luckily, Carol stayed course and finished the writing, in the hopes that someone could draw strength from her personal account. And someone did, Karen D. Barley wrote her sexual abuse story as an autoethnography almost 15 years later, feeling supported by the words of a fellow researcher (Barley, 2020).

This is how I came to autoethnography, but the choice of pursuing this type of research would still be followed by many hurdles in the process of actually conducting it. I was struggling with questions such as: Is my topic really fit for this methodology? How do I balance the theory with the personal? How in depth do I have to go with my reflections? Conducting this research was a chaotic process, because of lack of clear rules to follow. Costello, Feller and Sammon state that you should start with a clear idea of what you are trying to achieve and how the personal reflections add onto this (Costello, Feller & Sammon, 2018). Others start from a personal experience (Chang, 2016), and through their writing they discover their goals. It all comes down to the type of style that you choose, of which there are four main categories: (Chang, 2016, p. 118). (1): The imaginative-creative style, which is the most experimental form. It incorporates poetry, performances, or perhaps even music. The ethnodrama on racism and sexism from the

researchers I discussed earlier fits this form (Randolph & Weems, 2010). (2): The confessional-emotive style. The goal with this style is to provoke an emotional response through non-fictional writing. (3): The descriptive-realist style. The idea here is to give a very detailed account in a story, depict the researcher's life in a very accurate manner. (4): the final form is analytical-interpretive writing which is the closest to 'traditional' academic research. The narration is not the main vehicle of inquiry but functions more as a support.

These styles give somewhat of a categorization, an anchor point to ground research in. However, there is still a lack of clear-cut procedure to conducting this type of research, which can be challenging especially for newcomers (Anderson, & Glass-Coffin, 2016). As a result, many go into this venture without having an entirely clear picture of what they will encounter, improvising, experimenting, and changing their methods along the way. This is certainly how it felt for me, but I did try to ground myself a little bit. As a start, I decided to write a layered autoethnography (Barley, 2020). This means that you interchange sections about personal experience with sections exploring relevant literature related to those experiences. This enhances both, the personal experience gets a form of validation that this is a broader societal issue, and the theory becomes more accessible, relatable and readable through the personal account. It also provides a good way for the researcher to grasp their own experiences better. The article *experience and context in the making of a Chicano activist* (Romo, 2004) is a wonderful example. It provides background information based on the latest data on the lack of socio-economic mobility for ethnic minorities in America. He then describes vividly how several shocking experiences made him abandon the idea of the school as a great equalizer. Both the theory and the personal beautifully come together in how he got his incredible drive to change the educational system and thereby society, by bettering the way teachers are taught.

The layered account corresponds with the *analytical-interpretive* style. Costello et al. state that the layered approach ensures completeness and its scientific value. (Costello, Feller & Sammon, 2018, p. 20). Language should be purposeful, and its interpretation should be within the writing and not left to the reader" (Costello, Feller & Sammon, 2018, p. 27). I personally do not agree with this. I always believed that learning sticks better when it is not presented on a silver platter but uncovered through rigorous processing in the individuals mind. Despite this, I do think the layered approach fits this research best. That is because one of the major points of autoethnography, critiquing cultural practices, seems to me harder to explain. Indeed, the stories that I have read so far were powerful because they could expose and put pressure on

pain spots within society. However, this thesis has the aim of exploring and gaining understanding of the possible usage of music as an inquiry tool. This does not seem to fit the criteria of auto ethnographic writing at first glance. It is not immediately clear what kind of culture I am critiquing. But I think the thorough theoretical framework interspaced with personal reflections, makes it easier to deduce what kind of culture I am trying to critique, and what personal and historical beliefs these are founded upon. There is another reason why I am using this form. I do not feel comfortable enough with writing a full autoethnographic piece where the lines between theory and experience are more blurred. I have just started dipping my toes in the water, and that already feels like a deep dive. But I also still feel an itch to expose my creative side more extensively.

4.2 Arts Based Research

This is where ABR and the musical inquiries come into play, which could also be seen as the imaginative-creative style. arts based research is a form of qualitative research that uses artistic processes to understand the subjectivity of human experience and, sometimes, translate this into art forms themselves. Patricia Leavy has written extensively on the approach in her book *Methods Meets Arts* (Leavy, 2015). I draw mainly on her book for developing my understanding of ARB. ABR fits the purpose of this thesis well, because it highlights the parallels between art and science. It has proven successful in a wide range of scientific fields and is now being used by health care researchers, educational scientists, and psychologists, who apply the arts for the healing and the ability to confer emotion. Both art and science want to explore, understand, and represent what it is to be human. How they differ and what ABR uniquely adds to research is that there is room for artistic expression and spontaneity. Spontaneous expression is important for an artist, inspiration can occur at any moment. Perhaps you are standing in line at the supermarket, and you see children begging their mom to get them a candy bar. It could give you inspiration to write a project about wanting the things in life that are actually bad for you. Inspiration can strike at any moment, even while working on mundane tasks.

I can relate to the role that spontaneity plays in emerging inspiration. I once had an inspiring moment, while I was working at a Kiosk on the big train station of Utrecht. A swarm of people, carrying suitcases and wearing neat business attire had just left my store, leaving empty racks and a mess behind. As I was cleaning up, my mind started wandering. All these busy people desperately want their coffee and a little snack before following each other into the crowded

train carts. Logistical systems moving around flocks of brainwashed people, hurrying for their next business meeting. Granted, at the time I was not nuanced in my beliefs. While thinking about this, I could hear a song starting to shape. Tribal drums were bellowing; echoing forth a constant harsh beat to force people to move forward. Horns, which are generally associated with motivating music, were playing a dissonant almost annoying melody. I started to hum this melody, and spontaneously words appeared out of my mouth, with the same dystopian theme. “We leven normaal, hoe kan het ook anders” (translation: We are living normally, how could it be different). The rest of the day, I sang this previously non-existent song. Back home, I immediately grabbed my laptop, loaded up the most annoying horn sound I could find, and played the melody that was stuck in my head. The result was the following song: Song 2, We leven normaal (click this [link](#) to listen). *The song starts off with jungle sounds, representing the concrete jungle of the city that many people live in. Suddenly, a scream wakes you up from this reality, and briefly shows you that this type of living is not actually sane. That many people accept living unsatisfying lives because it is deemed “normal”. The lyrics of the song (in Dutch) are about shaking off this idea. Stop burning your instincts and start thinking about how we can actually move forward as a society. In a way, this is a protest song rebelling against the established order. To support this idea, the song uses tribal drums that could easily be used during a parade to push people forward. An organ is playing notes of a (diminished) chord on the background, which creates an eerie almost alien sound. This is used to establish the dystopia that we are residing in. Most people work unfulfilling jobs and barely get enough to make it through the week. They are selling away their lives, without many alternatives. As soon as you enter this type of work mindset, your years start to flow together, and soon you look back on 20 years where barely anything has changed.*

I formed meaning out of my experience by incorporating it in a song and this is why ABR fits my experimental pursuit. It allows qualitative researchers to let the process of meaning making come to the forefront, by adding additional tools for representation. This can be in the form of poetry, a sculpture, a video, or a song. Creating music and integrating that into this thesis, alongside written reflections, will make the process of creating meaning out of both the existing theory and lecture content during the experiment more explicit. By making this more explicit, I hope to eradicate the artificial divide between art, more specifically music, and the other sciences.

“After silence, that which comes nearest to expressing the inexpressible is music.”

-Aldous Huxley (1931)

4.3 Interweaving music in this thesis

Even though there are many opportunities with using music as a medium for ABR, it is actually one of the least used practices (Leavy, 2015, p. 103). Generally, when research was about music, it was researching music as the content or providing some kind of intervention using music, but this does not constitute an integration of musical arts-based components. However, “[i]f done correctly music can help researchers access, illuminate, describe and explain what is often rendered invisible by other research practices” (p. 97). This is due to music’s capability of representing complex concepts, through orchestration (Daykin, 2004). Multiple layers come together to create a harmonious whole. Some of the most complex music, such as songs by Jacob Collier (Collier, 2020) (click this [link](#) for a breakdown of one of his songs), have around 80 different layers ranging from instrumentation, sound effects (FX), multiple singing voices, drums, and samples. Even in my own projects, I sometimes end up with 40 different layers of sounds. All sounds come together, without cancelling each other out, which makes music a promising medium for research. With text, you are not able to read multiple lines at once but are constricted to reading sentence by sentence. This limitation does not exist within the realm of sounds.

However, music does not speak for itself. A listener may have a very different interpretation from what you originally intended. This is what makes it an art form, but also raises questions about how it can be used in research. Daykin (2004), for example, questions its use as a representational form, because of the limits in representing something clearly. But, on the other hand, the ambiguous nature can lend itself to compelling experiments, for example research from Margulis et al (2019) where he shed light on differences in narrativization that occur when people from different cultures listen to the same sounds. I personally believe that the latter shows the strength of using music in research. It allows for the option of multiple possible explanations, which breaks Cartesian dualistic gap between arts and science and the idea of one objective truth. You and I can listen to the same song, get comforted by the words and sounds of the singer, but for completely different reasons. Apart from that, there is another reality that is explored by using music, which is not common in other research forms. That is the reality of sounds and of hearing. The western culture is a culture of sight (McKay, 2005). Because of this,

methodologies are often based on the visual world e.g., incorporating visual observations, using pictures, or using graphs. These are definitely useful and important tools, but hearing is also an important sense that helps us acquire knowledge. For example, in an interview the nuances of how someone speaks can tell a lot about their mood. Developing your listening skills as a qualitative researcher can be very beneficial for including a different dimension of knowledge creation in your research (Leavy 2015, p. 102). An example of how this can be included is found in Walter S. Gershon's work *Sounds as educational systems* (Gershon, 2011). In this paper, he transcribed a short interview and included markers such as: "(sec)" to indicate lengths of silences or "... " to indicate interruptions in speech. He also often indicated the way things were said between brackets. This is a good way to incorporate the world of sounds into interview transcripts.

It seems like a logical step to incorporate music into autoethnography. In an article called *Music autoethnographies* Bartleet and Ellis (2009) conclude that music and autoethnography are identical in nature. Both have the aim of transferring compelling personal stories and inspiring others through their medium. They also both carry a close connection to the body and actively overcome the mind-body split that is so prevalent in most academic writing. They examine the idea that autoethnography still has space for an investigation in the sonic dimension "that goes beyond text and moves into the auditory word of musical sounds and relationship" (Bartleet & Ellis, 2009). However, when it comes to practice it is still very difficult to find any concrete examples of this investigation. When I searched for musical autoethnographies, I first stumbled upon an article called *Behind the Baton: Exploring autoethnographic writing in a musical context* (Bartleet, 2009a). I was hoping to see an actual integration of music into the writing, perhaps a link to music she conducted, or a composition that deeply touched her heart. It would have been a great example of how I could integrate my own music in the writing, which for me is the best way of exposing vulnerability. But I found nothing like this. In fact, I had a lot of trouble finding any integration of composition, song or even sounds within autoethnographic texts. Even within the entirety of the book *Music autoethnographies: Making autoethnography sing/making music personal*, I found no integration of actual music (Bartleet & Ellis, 2010). They are aesthetically pleasing stories about musicians, sometimes even using musical words such as harmony, counterpoint, strings to heighten the musical aspect. But no actual music. Why isn't that book sold with an accompanying CD?

Music has the unique ability to transfer complex information and therefore should logically find its place in autoethnography. This would result in a comprehensive integration of ABR and autoethnography. Yet, it seems that I cannot find guidance on how to create this mix within most autoethnographic works. This made me wonder about other possible places where I could turn to. I went back to the source, my initial inspiration and the first place where I came across music emplaced within the article. Deepening inquiry by Walter S. Gershon and Oded Ben-Horin (2014). Gershon gave urban P-8 students the exercise to make music about science classes, in order to explore the process of writing songs as a method for learning. He is a big propagator of sonic ethnography, and utilized that in this research (Gershon, 2019).

The idea of sonic ethnography is not to propose that sound is more important than other ways of knowing, but to explore and propose that sonic worlds have a lot of potential for qualitative researchers. It is based around in depth listening while conducting interviews, and recording not only the voices of participant, but also the environment. This adds a new layer of transparency into our findings as qualitative researchers. A lot of useful information is traditionally deemed as “noise”. When researchers collect field recordings, they often try their best to filter out the “noise” in order to get an accurate transcription. This could be considered a logical step and does help to decipher meaning behind the message. But it also neglects the sonic world in which that meaning was formed. In order to deepen this layer, ethnomusicologists and other researchers using an ethnomethodology often translate local sounds as books and films (Nakamura, 2013). However, this focuses our attention mostly on the ocular, rather than the audible. We are always aware of our vision, but often forget how much we can sense with our ears. When you just stop and listen, to the waves on the beach, the rustling in a local café, the boiling of oil, then you slowly generate a landscape of sounds, a “soundscape”. This is what Antonio Marazzi did in his paper, *Aural Anthropology, a way of listening* (Marazzi, 2019). His thought-provoking soundscape of the canals of Venice can be found alongside others on <http://www.sensorystudies.org/sound-gallery/>. Sonic ethnography tries to accomplish the same thing, allowing research to deepen their ways of knowing by offering other ways to understand daily interactions, embedded within the sociocultural context. What I try to do is apply this concept to autoethnography in a performative form, which makes this paper a sonic-autoethnography. By doing this, I externalize my internal reflections, that are mostly visual, or text based, into sounds and songs. This is the experiment I am conducting and sonic-autoethnography, the combination between ABR and autoethnography, is my methodology for doing this.

4.4 Sonic autoethnography in practice

In this thesis both this research report as well as the songs that are intertwined are part of the end product. The report is going to be in the form of a layered account and to help with determining what the different layers should contain, I will use the layer framework of Costello et al. (Costello, Feller & Sammon, 2018) (see figure 8). I do not fully agree with how this model depicts scientific contribution as something that is only achieved when all layers are present. As discussed, autoethnography is valued because of its openness, there are many ways for achieving scientific contribution. However, I do believe that this depiction can provide some much-needed grounding in the approach, which especially for a novel researcher is very welcome.

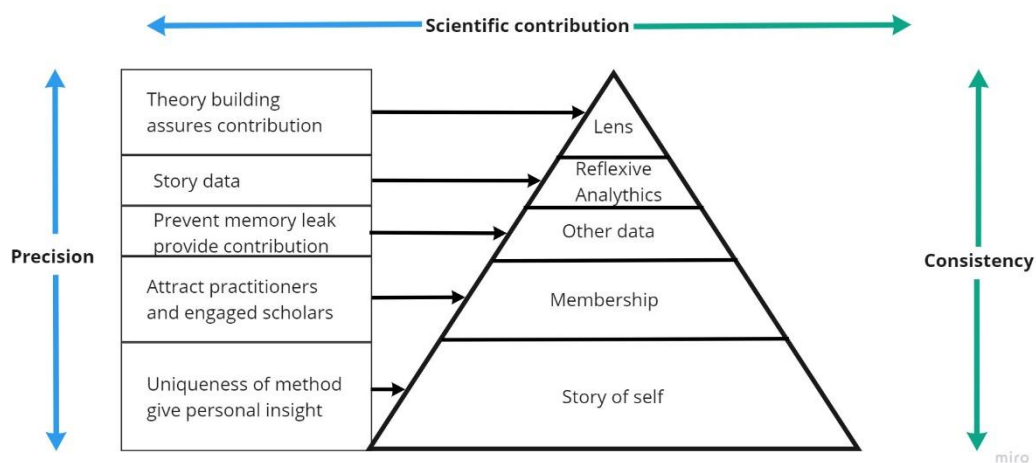


Figure 8. The layered approach

Note. Adapted from *A layer framework for a precise, consistent, and contributive autoethnography*, by J. Costello, J. Feller, & D. Sammon, 2018, p. 4.

Story of self

We have already delved into the importance of the story of self in the previous paragraph. The model starts with this as the ground layer, the foundation on which the rest of the elements are build. I wrote my stories of self mostly using a free writing technique. This technique means that you do not think about every sentence that you write, but just try to let your fingers flow over the keys and see what will appear out of your stream of consciousness. I have delved into a wide variety of sources and every page I finished could trigger a response, which I then wrote down in a journal. Many autoethnographers use this same technique (Chang, 2016). As a result, you end up with a lot of material to work with. I think only 30% of everything that I wrote

eventually ended up being used. I focused on deepening my writing by including body reflexivity (Valtone & Haanpää, 2018). Focusing on the subtle bodily experiences in and recognizing the importance of these to our sense of self. Body-reflexivity accepts the messiness of individual experience which cannot easily be classified and because of this it also embraces the goals of this thesis, bringing the sensuous back into learning.

Membership

Membership is providing an as accurate as possible description of who you are as a person and what groups you are a part of. Membership of what you are trying to study provides a better scope and insight into the inquiry. In order to incorporate membership in this thesis, I started with a short personal story that tells who I am and the experiences that shaped me. I also gave an intimate insight into why music means so much for me. I am not a professional musician, but it is a passionate and important hobby for me. I am in the process of becoming an educational researcher, but am currently a student of the educational sciences. I feel that in the interplay of roles I take in my life, I can provide a unique insight in this research.

Other data

Other data is used to support the truthfulness of the personal of the stories of self. When autoethnographers write their stories they often reflect on what has happened in the past, but we cannot recount our memories in exactly the same way every time. It is therefore good to talk with important people of that event, recollect old journals and perhaps even books or songs that were from the period you are recalling (e.g., Goodall, 2006; in Chang, 2016). The data I consulted in this paper consisted of old diaries I kept when I was in high-school and conversations with my parents and girlfriend. Through these talks I could both more accurately reflect on the past, but also structure my thoughts in the present. Another important source were old songs I wrote. These songs always reflect an idea or mindset that I used to have or some emotional significant event in my life. When I listen to these songs, I get transported back to how I used to think in a more magnetic manner than when I merely remember out my head. Songs are time machines, and to take you with me I offer background information on why the song was written and what it means to me. This information was written in cursive to differentiate it from the rest of the reflection. The songs themselves are also linked within the thesis, so it is up to you, the reader, to decide if you want to go in blind while listening to the music or if you want more context. I therefore leave it to you to decide if you want my meaning attached to the song, or if you want to instill your own meaning.

Reflexive analytics

This is the analysis the researcher uses to process their stories. The most common data processing technique in qualitative research is coding, and this is sometimes also used in autoethnography (Chang, 2016). However, many autoethnographers also use reflexivity and their intuition to decide what is relevant for the story and the research contribution they want to make. This is what I have done in this research. I wrote journals on my experience and could notice quite well what the recurring insights were.

Lens

The lens is the theoretical framework. It connects your personal experience to the work of others and thereby to broader cultural experiences. Through the lens your inquiry gets zoomed on a specific cultural experience. For this research, I went from the broad definition of art and art education to STEAM, and its benefits then finally to music and its particular potential for learning. Through examples of how STEAM and specifically music is already utilized I demonstrated its capabilities for transforming learning as we know it now. I also examined where the gap currently lies that this particular paper is trying to fill.

This research framework that I just described informed the content and style of the thesis. I try to reconnect aesthetics and specifically sounds and music to learning and research in two ways. The first way is the product of this thesis itself. Through the integration of music, I actively try to break the Cartesian dualism and the gap between Arts and Sciences that is frequently found in our ideas of good learning. The second way I try to overcome this dualism, is through the experiment of musical inquiries. In these inquiries I will interspace autoethnographic reflections on the process with musical excerpts and explanations. This is what the next chapter is going to be about.

5. Musical inquiries

The experiment consists of multiple musical inquiries that I produced based on online courses. The course that I have based my first musical reflections on is called Master Neuroscience and Neuroanatomy (Dr. Najeebs lectures, 2019). It is from the website Udemy.com. Udemy is an online learning and teaching marketplace with over 130000 courses. With subjects ranging from marketing, data science, psychology, music, economy, biology and much more. Elaborate course plans first need to be approved by the Udemy team, after which the instructor gets support in filming and updating the course. The main way of delivering the content is through filmed lessons, but the instructor can provide quizzes, PDFs and other materials in addition. This course is given by Dr. Najeeb who has been teaching medical sciences for over 32 years. He used filmed classes that he gave to his medical students. I picked this topic because it is a STEM subject with difficult to grasp concepts, which are not commonly translated to music. At the same time, it is still connected to something physical and describable, namely the many components of the central nervous system. These components interact with each other, based on what your senses are picking up. There is motion connected to what happens in the nervous system, which can be translated into a narrative. For example, you walk through the streets hit your toe on something hard. Pain receptors from nerves in your toe move information to your brain, which sends motor responses to your leg, moving you away from the source of pain. These are actions and related motivations that are happening in real time, which can then be associated with musical elements such as rhythm, melody, and tension. Motion helps us create a story out of the sounds we are listening to (Levinson, 2004b).

The idea of musical inquiry is largely based on the article Deepening inquiry (Gershon & Ben-Horin, 2014), where the aim was to explore the two uses of music as an educational tool and to communicate scientific ideas. In the first project a group of students was tasked with logging the process of creating a song out of Isaac Newton and Galileo's theories. They had to write down and reflect on the sounds they used, the decision-making process and the process of inquiry into the content of the lecture. They ended up making a rap song, where the Newton and Galileo challenge each other's theories in a verbal boxing match. Through this project the students were pushed to articulate scientific ideas into sounds, sounds that they could recollect in the future. The examples are inspiring, but I did notice that the musical elements themselves did not really show what was being represented. It was mostly the lyrical content that made clear what scientific topic was made musical. I feel that the inquiry could be deepened even

more if the sounds actively represent the subject matter. After all, images of a story can occur in our minds by pure instrumental listening (Margulis et al., 2019). That is why I want the sounds themselves to represent the subject matter in my musical inquiries. The choice in these sounds will require an even deeper inquiry into the subject matter, which provides the educational basis of the reflection. The way I will organize these inquiries is by using form (Bresler 2005; Leavy, 2015, pp. 102-103). Form is the way the different parts of a song are organized in terms of variation, repetition, and harmony. There are different aspects to form which helps with defining how different segments of a song are structured, as well as how they relate to each other. There are different terms that can be used to describe form according to Bresler.

1. *Dynamics of loudness or softness*. This can determine how the music develops, building tension and resolutions. *Silence* can also be considered a dynamic and can often be utilized to powerful effect.
2. *Timbre*. This is basically the musical color and tone, which are an important part of the meaning that is being transferred. Bresler mainly considers timbre in the same way as Gershon, as a means of conveying extra information about the way people speak in interviews. However, timbre can also be seen as the instruments and sounds that are used, and the qualities of those sounds.
3. *Melody*. This is the guiding line that pushes the song forward and the main determinant of the kind of emotions the artist wants to invoke. The melody is very often the starting point of the construction of a song because it captures the spirit of the whole.
4. *Polyphony*. This refers to the number of sounds that are being played at the same time.

These terms do encapsulate a lot of what music is, but there is one concept that I am missing. Rhythm is a very important indicator of what kind of song you are listening to. Generally, rhythm is the repetition of a certain pattern over time. Within this pattern, the relationship between beats that are emphasized and the ones that are not is also important. Many technical details can go into accurately describing both rhythm and melody, however for the sake of accessibility I will write out my descriptions in easily understandable words. I also will not use every term to describe every song, because it really varies per song what aspects are relevant. As a reader, it is up to you to decide if you want this extra piece of context, or if you would like to come to your own conclusions based on the sounds you will hear. There is also power in full independent meaning creation, based on your own reference frames and experiences. The music that is within this thesis is not mine, but openly shared and owned by you as soon as you press the play button.

Music production takes a lot of focused attention and is a great form of artistry. To elaborate, let me shortly explain how to produce music, so you know what the process looks like. I use a program called Ableton as my Digital Audio Workstation (DAW). In this program you can insert multiple tracks in either (1) audio or (2) midi format. With audio tracks you can record sound and it will display that sounds via a wave (see figure 9).



Figure 9. A soundwave (GDJ, n.d).

You can manipulate this sound wave in many different ways, for example you can cut, extend, shift the pitch, and add effects. However, what you played or recorded stays the way it is. This is different from the second type of track, the midi track. With midi you can select or create a sound and then either use a midi-keyboard to play in the notes or use your mouse to draw in notes. The result looks something like the image below.

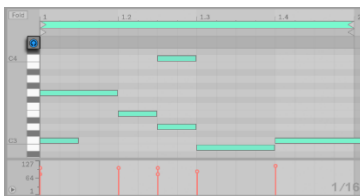


Figure 10. MIDI (Editing MIDI notes and velocities, n.d.).

The big difference is that with midi, you change the sound even after recording, or you can change the notes and thereby the recording altogether. By layering different sounds on multiple tracks, you create a composition, almost as if you are a one-man band. But there is one final step to making music actually sound good and that is mixing. Mixing in essence is making sure all the different sounds are in balance. Like a big complex auditory puzzle. You have probably seen the following image.



Figure 10. Mixing panel (Roberts, 2017).

This is a mixing panel, which you will find in a professional studio. A similar layout can be found in your DAW. By dragging the sliders up and down you can adjust the volume of different layers, thereby making sure that they can all be heard, and no sound is overtaking the other. There are many more intricacies in mixing, such as equalization, compression, reverb, filtering, panning just to name a few.

With all these steps to take, music production is already a daunting process. As a result, I was clueless on where to start for the musical reflections. But after sitting behind my computer for 5 hours, reading writing, doubting, and deleting my written work, I decided that it was time for a change in activity. It was then that I started experiment 1, sitting behind my desk at 14:00.

4.5 Experiment 1: Smelling something good

This was a first deep dive to test the viability of my research idea. I started by watching the first lesson of Dr. Najeeb's lectures called: introduction to neuroanatomy part 1. It was about the Nervous system, how this is divided and how the different components of the system function. I was captivated by Dr. Najeeb's way of teaching. He uses clear concepts and drawings to transfer his information, which helps considerably with taking notes. He also interacts with the class and makes jokes, which makes the lesson more interesting to watch. After finishing the lesson, I took a 5-minute rest and then proceeded to take a final look at my notes. This was quite a complex lesson. A big part was about how the central nervous systems (CNS) and the peripheral nervous system (PNS) interact. The central nervous system continuously collects information, compares, or contrasts that to old information and then delivers a response to the peripheral. The PNS consists of the Sensory PNS (which contains all the senses), further divided into specialized senses (Hearing, smelling, tasting, that can only be done by one specific organ) and the general senses. How was I going to make music out of this? Caught in angst I closed my eyes and tried to imagine what the concepts would sound like. I am a visual thinker but connected

to the images I hear a soundscape as well. However, these concepts were not easily made visible in the mind's eye, so I had to think about it in another way. More like a story that you can see unfold. With this realization, figures started to take shape. A man smelling something nice, receiving sensory inputs and the CNS sending motor responses so the man moves towards the smell. Perhaps love at first smell? Perhaps the first steps into the rose garden. It did not matter, because I knew what I was going to produce. The song is called Smelling something good ([click here to listen](#)).

Form

Rhythm: In the beginning a baseline and kick-drum play a consistent rhythm. This relates to the CNS scanning for inputs, but since it does not receive any there is no change in rhythm. Starting from 0:07 the rhythm becomes faster, since it has received the input of a nice smell.

Dynamics: Dynamics play a big part in this song. For the first 4 seconds, there is not a lot happening. Then a few sprinkled notes appear, and the baseline starts to go up. This represents the CNS picking up the scent and reacting by sending a motor response. The motor response moves the person closer to the smell, which creates a lot of sensory input. This is 0:07 in the song where a lot is happening at once.

Timbre: I used synthetic sounds like bleeps and a low sonar sound for the bass because I imagined the CNS as a scanner. As soon as sensory information, it sends out a response. The heart rate (drum) goes faster (an autonomic response), information keeps coming in (different beeps) and the snare (Somatic motor response) comes in. The snare could be legs, hands or some other thing moving because of the sensory input. It is a voluntary response.

On first observation, it is interesting to think about the sounds of the different concepts. This did force me to think about the topic in a different way. However, a lot of details are lost in the music making process, which are important for the lecture. I believe that music can only be used when you want to represent concepts. In this case, the concept of how the CNS and PNS interact is something that can be conveyed. But the more detailed descriptions of the different systems are a lot harder to write out in music. For example, how the sensory PNS is divided into specialized senses and general senses, which are then further divided. You could use different sounds to represent the special senses and general senses, or chords for special and notes for general. This is something to experiment with. But if you go into different names and locations of the brain, it becomes a lot harder. I was reluctant to acknowledge this, but I do think

you need lyrics to make the song more representative of the lecture. Or else, too much information is lost in musical translation. Perhaps a technique can be developed to do this more easily. This was the first time I made a musical reflection like this. The resulting music is not pleasant to listen to but does convey a very general lesson.

4.6 Experiment 2: Cross section of the brain, an improvisation

I followed the lecture “Introduction to neuroanatomy part 2”. This lesson delved deeper into neurons, the function cells of the CNS. The cell core of the neurons is called grey matter and nerve fibers that go out of the neurons (Axons) are called white matter. These axons transport information out of the neuron and can be very long, sometimes reaching from the spinal cord until your feet. Musically there was a lot to work with. Neurons charging up to fire electrical current throughout the axons. Nerve endings turning on because of contact through the senses. I wanted to represent these motions in lyrics this time. To do this, I first played around with a sound I found called mark 2: sparkle chorus. I felt that this had an electronic wobbly feel to it, almost like a signal that is being sent through an axon. I was inspired by the music therapist’s improvisation sessions (Keith, 2007). Here they first improvised both music and lyrics and analyzed what this meant afterwards. I started to play randomly based on what I thought was fitting to the lesson. Whilst playing the keys I sang about the different concepts: “cables to the brain, grey and white matter, does it really matter”. Unfortunately I didn’t record the singing, but I did record the spontaneous expression in what is now titled: Cross section of the brain ([click here to listen](#)). Because this is only one layer and there is no real thought to it, I will only describe the aspect of melody. I wanted to symbolize the current flowing through the nerve fibers that then come together in the brain to create a reaction. All the different signals intersecting and arranging themselves to form motion. Two things happened to me in this process. First, making music while singing about the lecture content gives me energy. Even though it was 21:00 at the time, I felt rejuvenated to continue my reflective process. Considering my brain seemed dormant after the multitude of challenging concepts, this was a good sign. Perhaps making a musical reflection is a quick way to get an energy boost, while still engaging with your learning. Definitely quicker than wholly producing a song from scratch. Secondly, there was also a factor that distracted me from learning. A lot of my attention went to the music, as you can hear in the excerpt, I tried to make it sound “nice” in a way. The result was eventual disengagement from the lesson, which is why I stopped the recording. Afterwards I played a basic progression and sang over that, which helped in focusing again. I

continued to sing as if I was an electrical current moving through the CNS, and I named all the things I encountered. This grounded the reflections, and even resulted in rhymes being created. It helped that the teacher of these lessons already makes exceptional visualizations of what you have to learn, perhaps this would be more difficult with other lectures. The imagery of cables in the brain is striking and immediately transports you into a visual learning zone. So, striking in fact, that I ended up creating a song out of it that, at least to me, is actually attractive to listen to. I call this experiment 3.

4.7 Experiment 3: cables in the brain

“I don’t want to go insane, but I’ve got cables in my brain”. Based on this line and other rhymes I came up with in the improvisation, I ended up making this song Cables in the brain ([click here to listen](#)).

Form

Rhythm: The rhythm is very consistent, because of the arpeggiating sound that stays consistent through the song. Arpeggiation is the repeating cycling through a set of notes.

Dynamics: The song is based around the arpeggiating electric sound on top of which sounds get added. It seems to build towards something, which becomes more apparent at 0:40 when a clinking sounds start playing faster sequential notes. This comes to a climax when the drums start playing. My singing follows the same dynamic, going from a low voice to a higher pitch, to a small harmony with multiple voices.

Timbre: The sounds used are metallic and electric, to show the electrical currents that go back and forth in the nerve fibers. I used actual sounds of electrical currents to make this metaphor even more apparent. There are also soft chords held under this mixture of voltages, which could be described as angelic. For me this represented the reticular formation, a crucial bundle of neurons (nuclei) in the brain stem where white matter and grey matter mixes and moves in all directions. It is stated that this plays a crucial role in maintaining consciousness, which is an almost spiritual concept to me.

Polyphony: There are many layers, but all build on the Arpeggiation, which stays consistent. This is the consistent flow of cognitive activity, while the new sounds show changes based on new neurological input.

It becomes even more apparent that the imagery of motion in metaphors helps to anchor the knowledge that I have gained. However, creating this song was by no means a fast process. Therefore, I hope that listening to this song later will help me recollect my knowledge, especially because the sound is aesthetically pleasant to listen to.

At this point, I did not grasp the usefulness of musical reflections just yet. I saw potential, yet this also seemed more like a pedagogical ideology without real purpose in the classrooms. I was questioning if my motivation was not anchored in self-indulgent behavior. In the end, making music and learning were two activities that I find pleasurable. A common criticism of autoethnography is that it is so self-absorbed that the findings are not relatable to anyone else that you might be writing for (Delmont, 2009). Was this a trap that I had fallen prey to? I did share the reflections of my experiments with people close to me, my loving girlfriend who listens with eager ears to my stories and my best friend and artistic companion with who I share my ideas. But isn't this sharing of my research mainly to amplify the focus on myself? Questioning my reasoning, I decided to spend a day to go beyond my own reasoning and read up on projects with a similar aim. At this moment, two special discoveries would help me to continue the project. The Dutch queen, in honor of her 50th birthday, made a statement and signed a manifesto on the importance of music in the classroom. She was already a 10-year ambassador for the project More Music in the Classroom. Due to this support, music was now accessible in primary schools for two thirds of the children in the Netherlands. A third more than I had previously thought. This was a heartening broadcast to behold. However, this was still about music as a separate subject, not about the integration into STEM.

This is where another inspiring discovery lit my way, the Global Science Opera (GSO). The GSO is a collaborative initiative which combines different European projects into an international Opera. Educational operas were already existent, but almost exclusively focused on topics such as bullying, love, and gender-equality. Definitely important topics, but Oded, the creator of GSO, felt that the driving forces behind arts could also be utilized to promote the sciences. This is why he started Write a Science Opera in Denmark. The entire premise is that students engage in deeper inquiry into the science topics because they have to build a story, music, props, and a script around this. The GSO lifts this premise up by simultaneously interacting with students from all over the world. The scientific engagement thereby adds a layer of intercultural exchange. The first GSO "Skylight" was held in 2015. 35 countries participated in this event, sharing their scientific understanding in an artistic manner through video recordings. In a way, it was ahead of its time, as it already engaged in this communicational manner long

before Corona forced us all to do the same. Since then, GSO has been an annual event with a new scientific theme every year. You can find all the recordings [here](#) and I strongly advise you to do so. After watching an acted and sung out discussion between Spanish students and marine scientists about the importance of the ocean, followed by Japanese students playing out an eco-system that is brought out of balance, you are hooked! My musical reflections so far had been a lonely process of internal contemplation and music making, but I felt comforted by the idea that children around the world had experienced the impact of music for STEM themes. With newfound energy, I started experiment 4.

4.8 Experiment 4: Filtering particles

The lesson I followed was called the blood-brain barrier part 1. The blood-brain barrier is a physiological divide between our CNS and the other blood circulating systems in our body. It protects our brain from all the fluctuations that happen in our blood, since neurons need a stable system to thrive. The entire concept of this barrier was fascinating to me and with this intrigue I started composing. Despite the complexity of the lesson, the song came together quite quickly. From the beginning I knew I wanted to juxtapose a stable segment with sounds in balance, with a segment that is chaotic. This would represent the stable environment the brain needs to operate in the right way, with the relative messiness of the blood that provides the nutrients. The resulting song is called Filtering Particles ([click here to listen](#)).

Form

Rhythm: The rhythm is relaxed and quite slow in tempo. Even in the second section, the drums and bass keep this slow level consistent. This shows that, despite the fluctuations in the blood, the brain levels stay stable.

Dynamics: The dynamic is a contrast between the stable environment of the brain and the messy blood circulation.

Timbre: Both the drums and bass are used to represent stability. The wavy rising sound that appears at the start resembles the flow of blood that maintains this balance. In the second segment (0:43) percussive sounds and a string instrument comes in, which resembles the nutrients and many different particles that move through the blood, creating a mix between mess and stability.

I notice that you have to go with your gut feeling when making these reflections. Do not overthink your choices and you will enter a flow state. Look at the notes and concepts of the lessons, visualize these processes and choose the sounds on instinct. You have to convert a lot of knowledge into something more simplistic and it is nearly impossible to represent everything in your song. This is a good thing, because it forces you to get to the core of what you have learned. In this case, I had to think about what sounds represent particles going through the cells and the disarray that happens outside in the arteries and capillaries. I do see the educational value of making this song. I spent more time thinking and looking through my notes than I usually would, and this was made more enjoyable than normal. Looking through notes over and over again is tedious but doing this with a song in mind is rejuvenating. I also noticed the lyrics and sounds got stuck in my head, but in a way that was relaxing. No nightmares about difficult numbers chasing me down, but calm recollection of knowledge. It is satisfying. This helped anchor the concepts in my mind even further. After finishing the song, I went and listened to my previous experiment: cables in the brain. In a flash I remembered exactly why I chose the sounds and what they meant, which was further supported by the lyrics. Perhaps you could listen to a musical piece before a test to quickly recall your learnings.

4.9 A musical break: Hiking

Unfortunately, we cannot control the external factors in our lives. Some events have an extreme emotionally disruptive effect. As I verbalized in the chapter how I make meaning out of music, I often use music to process these experiences and make sense out of them. During the writing of this thesis, I was brought to a pause due to a personal trauma. I do not feel I have to elaborate on what exactly happened; it does not really add onto understanding the broader research. However, I do feel that it can offer insight too, because I once again found incredible healing in music. When I could barely get any more words on the page, I decided to go for a long walk to a nearby forest. Just like almost 10 years ago, the elemental sounds of the forest soothed some wounds. Birds were chirping and a small stream rumbled to the side of the sandy gravel path. My feet felt solid on its natural grounds, so much so that I decided to take off my shoes and experience earth to skin sensations. The forest and its natural beauty blew new life in me, I was overflowed by it. When I came back home, I had an unbelievable amount of tension in my body. Tendons felt so tight, I could barely maneuver my fingers around the keys of my electric piano. But I knew that I had to put this experience into music. The vision was clear. I saw an old man with a long white beard, hunters cap and brown shorts with a walking stick who was preparing

to hike up a grassy mountain. The hill transitioned from a town to a meadow at the mid-section with a forest starting at the halfway point and reaching to the top. The old man had walked this path every year since he was born, but this time felt different. The final hike, a sad and reflective departure. The decoration of the terrain along the way, represented life passing along. Without looking back, he traversed difficult rocky terrain and forded an angry river. He was greeted by birds, deer, and wolves, almost as if saying goodbye. I felt incredible consolidation at this image. Life flows from ups to downs, but at the end of the climb, we can look back and appreciate all these moments as they bring us to the beautiful top.

This is what the song Hiking represents for me ([click here to listen](#)). It is a realization once again that despite music's potential for learning, it should never be seen as a mere tool for the sciences. It can offer so much than that. But it also made me think about positive ripple effects that a further integration of music can have on individuals lives. If, for example, the students from Gershon's and Ben-Horin's (2014) research found making music about the sciences a joyful experience. Then it might not only drive them to pursue a career in research, but it might also help them to discover a heartwarming new hobby. Of course, this exploration already starts in an actual arts and music class. However, music classes can be very theoretical, not focused on the joy of making music (Hallam & McQueen, 2018). Because of this, some teachers have trouble aligning students' musical experiences outside of school and those inside of school. The integration of music in STEM provides an extra opportunity for a student's musical self-interests to come to the foreground. By allowing the option to produce a musical piece instead of a written essay for the mandatory assignment. After all, I am also seeing more company job applications that are open to songs and other creative forms of self-representation as a substitute for the mandatory cover letter. But what if a teacher wants to give the entire class a musical assignment? How can a student without a strong background in music still participate? This is where the aforementioned model developed by Crowther (2012) comes into play (see figure 6 & 11). For my next and final musical experiment, I wanted to test the usability of this model.

4.10 Experiment 5: Velocity Direction

For this final experiment I wanted to test if the musical reflection technique would also work for another topic. A topic that could be considered more abstract due to its mathematical content. Also, a topic that I have never had the pleasure to be confident in - college level physics.

I followed several free lessons on one-dimensional motion from Khan Academy (One-dimensional motion | AP®/College Physics 1 | Science. n.d.). The lessons tackled the topic in sequences with every lesson slowly building up the complexity of exercises. This was not a high-level difficulty of physics, but for me it was still a big challenge. I dragged the model of Crowther (2012) into a word document and started filling it in.

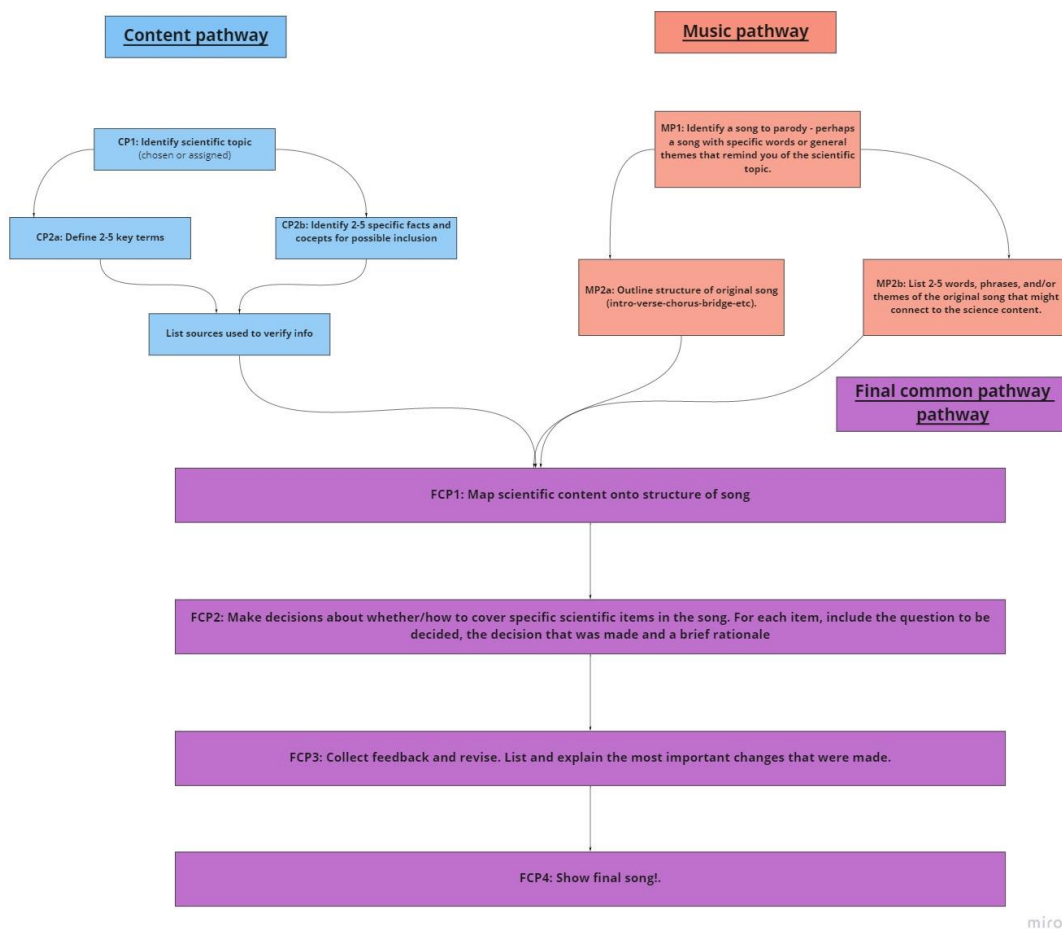


Figure 6. Songwriting template.

Note. Adapted from *using science songs to enhance learning: an interdisciplinary approach*, by G. J. Crowther, A.J. Ma, & J. L. Breckler, 2017, p. 121.

I first determined the topic, which was motion. Then I determined the most important concepts of the topic, which was a good exercise. For me, physics always feels like a chaotic mess of components, so finding some structure within that was helpful. I decided to use the following concepts: Distance and displacement, Speed and velocity, Position-time, the formula $Velocity = Displacement \text{ over } change \text{ in } time$ and the idea that you can draw a square within a graph to calculate the velocity. Then for music I wanted to choose a song with a fast rhythm and a lot of

energy. Immediately, Blinding Lights by the Weeknd came to mind. I copied the lyrics of the songs and identified sections of the song that I could change to fit the scientific concept. I noticed that I could change the lyrics to fit my needs quite quickly, but I also have not transformed the entire song, just a section of it. I think that my experience in songwriting helped with rewriting these lyrics.

The most difficult part came in outlining and creating the structure of the song. I decided to produce the song, or at least a basic version of it, from scratch. However, due to fear of copyright issues I replaced some of the instruments with a guitar. When the instrumental part of the song was done, I recorded the changed lyrics. Here is the comparison between the original and the changed lyrics (see table 1).

Table 1. Original vs changed lyrics

Original	Changed
<i>Verse 1</i>	<i>Verse 1</i>
I've been tryin' to call	I've been tryin' to walk
I've been on my own for long enough	Getting some distance from my mind
Maybe you can show me how to love, maybe	Displacing to the right in overdrive, maybe
I'm going through withdrawals	I have to make a drawing
You don't even have to do too much	You don't even have to do too much
You can turn me on with just a touch, baby	You can find it out with just a touch, easy
Pre-chorus	Pre-chorus
I look around and	Velocity direction (oh)
Sin City's cold and empty (oh)	Speed a chaotic attraction (oh)
No one's around to judge me (oh)	-----
I can't see clearly when you're gone	I can't see clearly where it's going
Chorus	Chorus
And I said, ooh, I'm blinded by the lights	And I said, ooh, I'm blinded by lines
No, I can't sleep until I feel your touch	No, I can't read until I know the time
I said, ooh, I'm drowning in the night	I said, ooh, Displacement over time.
Oh, when I'm like this, you're the one I trust	Oh, when I know this, I will be alright

The main changes and their validations are the following:

1. In the first verse I changed the words and sentences, so they related to movement. Distance refers to how far something is from the initial point not considering a direction, whereas displacement has a particular direction. In this song it is to the right.
2. I have to make a drawing refers to a technique to calculate velocity based on a graph. You can make a square or triangle and use the base and height of these to calculate velocity at different points in time.
3. The difference between velocity (which has a specific directions) and speed (which does not consider direction), is made clear in the pre-chorus of the song.
4. In the chorus I reference the formula for calculating velocity, *Displacement divided by the change in time*.

I did not completely cover all elements in the framework, a question was not included for every decision, mainly because it felt quite intuitive how I wanted to change the lyrics. I also did not collect feedback, but I did do a control check using the Khan Academy website (One-dimensional motion | AP[®]/College Physics 1 | Science. n.d.). You can listen to the final song here. I do have to warn you, my singing is not super on point for the entire song, so listen at your own discretion ([click here to listen](#)).

What did I learn from using this model? I certainly see its potential for incorporating a musical project in a science class. In my particular example I remade the original song from scratch and substituted different elements to make it my own. But students do not have to do this in order to create their own science song parody. They can easily grab an instrumental version of an existing song and sing their own lyrics over it, which can also be a fun group project. There are multiple compelling factors for this approach. First of all, just like with all musical experiments so far, it helps you to break down complex matter into its core elements. When you write a science song, you are pushed to find the most essential concepts, because you can never include every single element in the song. The model highlights this in step CP2a and CP2b. The second benefit of this approach is that it creates hooks for new knowledge to be neatly hung on. It feels like an auditory form of the method of Loci, a memory enhancing strategy that uses visualizations of spaces that you know well to anchor new information in your memory (Dalglish, Bird, Hill, Dunn & Golden, 2013). This memory strategy is proven to help with long term memory retention and recall, because it uses a familiar environment in a novel way. The final benefit of this approach is that is a lot of fun to transform a song that you like. At least for me, learning

physics is not the on the top of my list of satisfactory activities. But, with this exercise, I was happy to delve a little deeper into the subject matter and finish some extra exercises in order to be able to make a science song out of it. Despite my false singing, I also listen back to this song with joy. I can imagine that this happiness becomes even more apparent when you create such a science song with a group of fellow students. You can enjoy each other's science puns or fall over laughing when somebody just about reaches the high note on a particular tune. It is an amusing way to inquire deeper into the subject matter and it can help make STEM more accessible for students who do not have a natural inclination towards the topic.

6. Discussion

In this thesis I attempted to bridge the dualistic Cartesian gap that separated the arts from the sciences in schools. I build upon the growing support for adding the A to STEM to build a foundation to answer two questions. First of all, how can musical inquiry influence the learning process for STEM subjects. The second question was more intertwined in the methodological DNA of this thesis: How can music be integrated into an autoethnography? Before answering these questions, it is good to give an overall assessment of the quality of this research with regards to the standards of the methodologies used. I critically reflect on my approach that in the end produced the answers to the questions.

5.1 Assessing the quality of this research

There are many commonalities between ABR and autoethnography in terms of goals and therefore quality requirements. Here I will explain these different criteria and how I took them into account in this paper.

Accessibility: Both methodologies aim to make research accessible for a wider audience (Adams, Linn, & Ellis, 2015; Leavy, 2015). After all Gordon (2014, as cited in Leavy, 2015, p.193) states that more than 90% of academic articles are only read by the author, editors, and advisors. Kaj Sand-Jensen (2007) a freshwater biologist wrote an on-point comment on the boring nature of scientific articles aptly titled *How to write consistently boring scientific literature*. One of the main elements she touches upon, is that research is often written in jargon, which makes it convoluted and difficult to understand. ABR also has specific ideas about distributing your research article to nonacademic stakeholders, perhaps in the form of a video or song. Researchers are encouraged, and it is in a way their obligation to spread the research to a wide audience. Ambiguity is seen as a strength in ABR, because it allows for a multiple meanings to form out of the researchers work (Leavy, 2015). But the researcher is still responsible for the meanings that can occur and how this affects audiences, which in practice means that a balance must be struck between open and closed interpretations. In my research I focused on easy writing that could reel the reader into my world. The enthusiasm that I have for the subject matter should be readable within the words, but also listenable in the music. In this sense, this paper is indeed accessible. However, I did use both musical terminology and considerable complicated concepts both in the theory and in the experiment itself. I always tried to explain this in an easy manner, while maintaining the deeper layers. I do not believe that I always succeeded in this

regard. Besides, the paper could be written more concisely. This would certainly make it more fun to read, but I still have to develop these skills. I will talk a bit more about this in aesthetic responsibility. Finally, I currently do not have any channels for marketing this paper to broader audiences. I did put the musical inquiries from this thesis on Soundcloud, where they are openly accessible. and I do not intent to look for these. Thereby a major criteria of audience engagement is not met.

Valuing the personal: Adding a personal emotional dimension in a truthful way is important. Autoethnography values the perspective of self in research and how this relates to the context and broader societal processes (Adams, Linn, & Ellis, 2015). Therefore, embodied experiences should be an essential part of the research, which involves exposing your personal life and perhaps the lives of those around you. Similarly, in ABR researchers are encouraged to stay true to their emotions (Leavy, 2015, p.191). Anger, frustration, joy, and sadness all help make the resulting end product feel alive and relatable to readers. This increases audience engagement and thereby the reach to impact society. You also have to be explicit in showing how you work, since there are many ways of conducting this kind of research. I layered personal stories both of past and present throughout this paper. But I feel that interchanging layers of personal reflection with theory not necessarily resulted in the most reflexive and deep writing. When I look back on it, the stories I used almost serve an instrumental function to support the ideas that could be derived from theory. In autoethnography, the perspectives of the researcher should be at the foreground in providing social commentary (Anderson & Glass-Coffin, 2016), and I am not sure if I succeeded in that regard. For a long time, I wondered if I was even adequately critiquing a cultural phenomenon. I was, but it felt hidden below the surface in my earlier drafts. So, I made this more explicit by adding explanation on the Cartesian split and how this instigated the gap between art and science. I did make my doubts throughout the process of writing obvious, which added a layer of reflexivity and self-awareness (Barley, 2020). Truthfully, I captured how new information informed my decisions, insecurities about this research topic, and doubts about the methodology.

Contributing to knowledge: ABR and autoethnography are praised for their unique contribution to knowledge. Illuminating aspects of life that other approaches either do not value or shy away from. Because this is such a unique way of doing research, you need to be especially aware of the social significance of your research purpose and how well that is realized (Leavy, 2015, p.192). Researcher should provide insider insights in their full complexities, not just shed a light on a topic, but provide actual worth for your readers (Barone and Eisner, 2011, p.193).

As described in the previous segment, the goals of this research provide insight into how teachers and researchers can incorporate musical elements in their activities. No other methodologies would be able to accomplish this mainly because they do not allow for the researcher to fully involve themselves in the experiment to create an artful end product.

Ethically and aesthetically responsible: The final criteria have to do with responsibility, and I therefore place these in same category. First, as researchers in general we have to consider ethics. But, with these methodologies, perhaps even more so, as the stories you tell always involve people around you (Hernandez & Ngunjiri, 2016). These relationships will come up in your writing and artful endeavors and should be addressed. In the introduction I wrote an ethics section to make sure the reader from the beginning onwards knew that I took the implications of my stories into consideration. I aimed to expel any idea that I wrote down whatever came to mind without permission. In the end once an article is published, it will probably stay on the internet forever (Adams, 2008). Despite my efforts, we can never truly know how the dice will roll, but I made sure to take responsibility of what I included.

Then there is another form of responsibility, an aesthetic one. Autoethnographers need to consider the importance of developing their writing and representational skills and train analytical thinking (Adams, Linn, & Ellis, 2015, p. 103). Also, in ABR, the aesthetical elements of the final product need to be well thought out. “An artistic rendering must get to the heart of the issue and present that essence in a coherent form in order to achieve aesthetic power” (Leavy, 2015, p. 196). Powerful art can grab people’s attention, but if the artist sees the artistry as a side element, then they risk it becoming negligible. On the other hand, the arts-based researcher should not spend all their efforts on their craft and then spend little energy on the research itself. A fine balance needs to be struck between making art, while at the same time providing research of worth. In this research, the layered approach helped to balance out these two aspects. I also ensured that my role in music making was clear from the beginning. I am no professional musician, but I am an experienced hobbyist, at least moderately skilled in music production. I spent additional time to making the musical excerpts sound well mixed and hopefully pleasant to listen to. Concurrently, I aimed at showing the raw products of some of the musical inquiries, to open up exactly how I experienced these. Certainly, more work could have gone into producing finer songs, but the sharper edges also have their educational worth. For my writing I think the same applies. I do enjoy writing and have written both poems, song lyrics, student

journals and policy advice, yet this does not make me a successful entertaining writer of autoethnographic works. I have spent time drafting and rewriting several pieces, with the aim of providing a good reading experience.

This critical examination of the research can serve as a background for the answers to the research questions. Especially for the first one, which is the methodological question: how can we integrate sounds/music into autoethnography, thereby creating a sonic autoethnography? I tried out a novel way of integrating music and sounds into autoethnography, but as stated my self-reflections were not my main source for critiquing culture. That is why I end with a suggestion for making sonic autoethnography centered around auditory reflections.

5.2 Integrating music in autoethnography

Qualitative research has always preferred sight, and therefore the written words over hearing. Even though there are many opportunities with using music as a medium for ABR, it is actually one of the least used practices (Leavy, 2015, p. 103). Yet, a lot of sonic dimensions can be lost in translation in this way (Gershon, 2019). I also found that in all the articles I read about music, that none actually integrated music in the research itself. Even within the book *Making autoethnography sing/making music personal* (Bartleet & Ellis, 2010) I found no links to songs, or an added mp3 file. I turned to sonic ethnography, because it is the only place where I did find songs inserted in the written works (Gershon & Ben-Horin, 2014). Inspired, I conceived a way to incorporate music by combining elements of autoethnography and ABR, which I call sonic autoethnography. Infused in this paper are multiple references to songs that carry an emotional weight for me. Some I wrote myself. I linked these to a Soundcloud page and provided a description of what the song means for me. Other times I referenced and linked an important song for a certain event, such as my love for world music and the virtue it carries for dissolving cultural barriers. The goal of these musical links was to support my arguments by inviting you into my sonic world. It also added a personal dimension, after all music comes close to expressing the inexpressible (Huxley, 1931). I used a layered approach based on a framework by Costello et al. (2018) to organize these musical reflections in the thesis. My own songs followed this layered approach, where theoretical or methodological writing was alternated with a written autoethnographic reflection and a musical fragment. By doing this, I blurred the lines between (qualitative) science and art, which is an overarching goal of both ABR and autoethnography (Leavy, 2015; Adams, Linn, & Ellis, 2015).

This is, however, just a first step, a tiptoe in the realm of possibilities. The layered approach made it easier to know when to write and link music and when to delve into other aspects of research. In the future it would be good to experiment even more with how to sprinkle excerpts of music in research. Perhaps even reducing the need for a written work altogether and letting the sounds speak for themselves. I imagine this being done almost like a podcast, where the interviews of the research are happening in real time and are mixed with other audio fragments. Or it could be done as GSO does, but with the opera being made into a soundscape. Processed in an interesting way, so it really feels like you are surrounded by a wall of sounds. There are, of course, practical and ethical questions that still need to be explored. For example, if you want to record sounds in a market square and you vaguely hear a conversation on the background, can you still use that recording? Is the researcher responsible for making sure the sounds are well mixed and pleasant to listen to, or can you just use a regular non-mixed recording? we need daring ventures in order to uncover and solve these questions. But it certainly is an endeavor worth undertaking, I feel that this paper would not have reached the same depths of both personal reflexivity and scientific rigor if I kept it purely in writing.

5.3 Integrating musical inquiry in the learning process

The second question requires a critical look at the musical experiments and supporting literature to see what we can learn from this. Through the literature it became clear music can help us to find information and gain understanding that we often do not reach (Carless & Douglas, 2010). Because of this ability to lay bare emotions, it can help us derive meaning from a wide variety of experiences (Ruud, 1997). In education, this can help with gaining control over the learning process, by making it your own. It also became clear that music has multiple benefits such as social cohesion increases, better memory and stress reduction (Patel, 2010) and increased memory and learning capacity (Schellenberg, 2004). It was not surprising to learn that many researchers are already busy with using music for science partly because of these benefits (Pellegrino, 2013; Tinari & Khandke, 2000; Watson & Beymer, 2009; Grossman & Watson, 2015). Based on the insights of previous literature, I devised multiple approach to conduct musical inquiries. These all had different effects, such as the musical improvisations which provide a quicker way to gain energy and musically reflect on what is learned. However, there were also some overarching effects that were noticeable in all experiments and the literature.

Firstly, music can improve retention and recall of information through its use as a mnemonic device (Crowther & Breckler, 2017). A mnemonic device uses anchor points to make storage and retrieval of information easier, for example the sentence: Elephants and Donkeys Grow Big Ears helps people memorize the guitar strings in standard tuning: EADGBE. Music is used as a mnemonic device especially in primary schools, where children more easily learn academic material through melody and rhythm (Hayes, 2009). But it can also be utilized for this purpose in higher education during biology lessons (Crowther, 2012). In most example of classroom usage, the songs are made by the teachers, but I found in my experiments that creating the mnemonic yourself can be a big boost to remembering knowledge. This effect was even stronger for me when the song I created parodied an existing song. When you hear a recognizable melody and the driving drums, you are already in familiar territory. It then becomes easier to insert new lyrics to make it a science song, creating an auditory method of loci (Dalglish, Bird, Hill, Dunn & Golden, 2013). However, one strong effect was lost in this way, and it is also a technique that I have not read about in previous research. That is when the mnemonic devices are not only the words, but also the sounds themselves. Sounds transport knowledge to the listener and can therefore be educational (Gershon, 2011). This is due to narrativization that occurs when we listen to particular soundscapes and allocate meaning to it based on our backgrounds (Margulis et al., 2019). In the musical experiment, I chose or created sounds that according to me fit the subject matter I was trying to learn. For example, in experiment 3: cables in the brain, I incorporated the sound of electricity to represent the electrical activity in the nervous system. By doing this, I, as a learner, gain control over the narrative and therefore the meaning of the sounds. The sounds but also the lyrics get stuck in my head for a while after I created the song, which reinforces the memorization. I was lying in bed and could still hear the pulse of the rhythm in my heart and the rhyming lyrics that I had created all by myself. When I listen back to the song, I still get transported to a visual of nerve fibers and energy moving and sparkling between them.

The second benefit that I found is that creating musical songs forces you towards deeper inquiry into the subject matter. This was a common finding in experiments where students write their own science songs (Crowther, 2012; Crowther & Breckler, 2017; Gershon & Ben-Horin, 2014) and also the reason why the GSO was started. I found myself both being pushed to delve into the subject matter to discover what I could write a song about, but at the same time I also had to make difficult choices of relevancy. When writing a science song, you do not have a lot of space to write complex information. Therefore, you have to break down the topic into its core

elements, and I found this very helpful. It also helped if you created titles before writing the songs, which was a technique I used in all inquiries. This is based on good practices of music therapy with clients who do not have a musical background (Keith, 2007; & Meadows & Wimpenny, 2016).

The third benefit is that making musical inquiries could put me in a flow state. In this state making music and recalling the information I learned became automatic, almost instinctively. I became absorbed by the process. It is a similar sensation as David described when he wrote a song to help a dear friend deal with trauma (Carless & Douglas, 2010, p. 30). He lets his consciousness flow, and the consoling words and music came automatically. Getting into this state feels rewarding, and I experience it as a great benefit in my learning process. Research on the flow state shows that it occurs when practitioners are engaged and attentive with their own work, at just the right level of challenge (Custodero, 2002). Getting in the flow state becomes easier when the activity does have well defined rules, which are determined by the one who is participating in the activity. In this interplay between boundaries and limitless possibility, your sense of skill and creativity are heightened to a new level. It gives a surge of confidence and energy, which is beneficial when delving into difficult topics. The description seems similar to the way described artistry and with the aesthetic definition Mark Johnson (2015). Artistry helps bring attentiveness and the option of multiple meaning for the learner into STEM. It seems that the flow state is a viable element to help this integration.

The final benefit, and perhaps the most important one, is that it is fun. There were two reasons for STEAM to arise, one is that scientific subjects needed to be infused with more creativity and the second one is that adding art makes it more compelling (Smith, 2013). In the latter, adding musical inquiry definitely works. I occasionally found myself getting extra motivation during writing and making music. For example, when I tried a musical improvisation and played a few chords while singing about what I just learned. The reason for this could be that music making does not shy away from emotions. Emotions commonly have to be hidden during science classes, which is a shame. Allowing for emotions to evolve creates intense (positive) experiences that help with long term memorization (King, Ritchi, Sandhu & Henderson, 2015). This is because emotional stimuli are better remembered than non-emotional ones (Eschrich et al., 2008). Another important aspect that makes it compelling, is that it adds variety to the way you can learn. Throughout this thesis, I emphasized the point that musical inquiry is not the holy grail of learning, it is simply another way of knowing. And this variety keeps learning

engaging and surprising. Varying tasks and projects, but keeping elements such as the content the same, propels learners to explore more possible links and improves capabilities to transfer knowledge to other disciplines (Schilling, Vidal, Ployhart & Marangoni, 2003).

Despite these advantages, there are also some disadvantages to musical inquiry for STEM. Firstly, I noticed that making musical reflections takes a long time. You have to analyze the STEM lesson for concepts, write compelling lyrics with these concepts, choose the right sounds, make the music, and then record. That is a lot of work when the alternative of simply writing notes or making a mind map works just as well. But it does lead to a memorable experience and listening to a science song that you made yourself is a valuable way to recall information. I love music and would rather listen back to a song years after I made it, then go back through my year-old notebooks. Even when I do not have the intent to recall information, I still listen to the song because I am proud of my work. Also, as an alternative a student can start an improvisation. Here they do not record or really give thought to what they play, they let the flow take them and thereby anchor the concepts in their memory. However, this leads me to the second disadvantage. Both for students and teachers, this method of learning does not work as well when you do not have musical experience (Lum, 2008). It is hard work to write your own songs, the added complexity on top of learning STEM can discourage many people and make the learning process unnecessarily difficult. There are tools that have been developed, teachers can use existing science songs (Governor et al., 2013) and students can use the model of Crowther (2012) to parody an existing song. I personally think that students should at least be given the option to write a musical piece instead of a written essay. This allows a student's musical self-interests to come to the foreground, allowing the student to gain control of the learning process.

What does this mean for musical inquiry as a form of STEAM? First, it is good to again establish the underlying goal of this thesis: To explore the viability of a novel way of knowing by infusing artistry into STEM, thereby proving support for STEAMS further usage. However, in this advocacy approach for STEAM it is essential that art becomes holistically integrated and does not become an instrument subservient to STEM. I do not think that musical inquiry fully serves this purpose. Since it takes a lot of time to work in this way, it is easier done on a project basis than as full-on integration. However, I did find myself absorbed and in flow through the process of creating music. During these moments of high attentiveness, the song became the goal, the enjoyment of production the inquiry and the content of the lecture almost became the medium to make an original piece of work. So, there was a balance between different focus

points, and because of this learning became varied and enthusiastic, with nice end products to complement the experience. The target shifted from learning facts by heart, to trusting intrinsic judgments and gaining ownership of your learning (Goldblatt, 2006). The integration of STEAM is not holistic, but more on a project basis. However, it does allow the user to allocate their own meaning to learning. Besides that, it creates a memorable experience that students will not easily forget. When a teacher bursts into song in a classroom, or you work as a group to produce a performance for GSO. You complement someone on their courage, or perhaps cry because someone created a touching song for an infectious diseases class. These are all experience that get to the emotional essence of humanity. It is then no wonder that science songs and concepts like GSO have started appearing as forms of STEAM. They add an intimate creative layer that STEM is sometimes missing.

Music is just one of the many art forms that can complement STEM in this way, in practicality all arts have something to teach the sciences. Encouraging that and encouraging people to seek out their own form of meaning is an amazing way to enhance both the arts and the sciences. The STEAM engine has just started to kick into full gear, and we have to stay open for the limitless possibilities where it can bring us.

“The goal of both the sciences and the arts is to transform reality as we know it and therefore escape its limitations” (Csikszentmihalyi, 1993, p. 322).

References

- Adams, T. E. (2008). A review of narrative ethics. *Qualitative inquiry*, 14(2), 175-194.
- Adams, T. E., Ellis, C., & Jones, S. H. (2017). Autoethnography. *The international encyclopedia of communication research methods*, 1-11
- Adams, T. E., Linn, H. J. S., & Ellis, C. (2015). *Autoethnography*. Oxford University Press.
- Amicone, G., Petruccioli, I., De Dominicis, S., Gherardini, A., Costantino, V., Perucchini, P., & Bonaiuto, M. (2018). Green breaks: the restorative effect of the school environment's green areas on children's cognitive performance. *Frontiers in Psychology*, 9, 1579.
<https://doi.org/10.3389/fpsyg.2018.01579>
- Anderson, L., & Glass-Coffin, B. (2016). I learn by going: autoethnographic modes of inquiry. In Jones, S. H., Adams, T. E., & Ellis, C. (Eds.), *Handbook of autoethnography* (pp. 57-83). Routledge.
- Barchana-Lorand, D. (2020). 'Core subjects' policy and arts education for the rich. *International Journal of Art & Design Education*, 39(3), 498-508.
<https://doi.org/10.1111/jade.12305>
- Barley, K. D. (2020). Finding a good book to live in: a reflective autoethnography on childhood sexual abuse, literature and the epiphany. *The Qualitative Report*, 25(2), 487-503.
- Barone, T., & Eisner, E. W. (2011). *Arts based research*. Sage.
- Barrett, T., Anttila, E., Webster, P., & Haseman, B. (2015). Collaborative creativity in STEAM: Narratives of art education students' experiences in transdisciplinary spaces. *International Journal of Education & the Arts*, 16(15).
- Bartleet, B. L., & Ellis, C. (2009). *Music autoethnographies: Making autoethnography sing/making music personal*. Australian Academic Press
- Bartleet, B.-L. (2009). Behind the baton: Exploring autoethnographic writing in a musical context. *Journal of Contemporary Ethnography*, 38(6), 713-733.
<https://doi.org/10.1177/0891241609341638>
- Bartleet, B.-L., & Ellis, C. (2010). *Music autoethnographies: making autoethnography sing: making music personal*. Australian Academic Press.
- Bochner, A. P., & Ellis, C. (2003). An introduction to the arts and narrative research: Art as inquiry. *Qualitative inquiry*, 9(4), 506-514.
- Bresler, L. (2005). What musicianship can teach educational research. *Music education research*, 7(2), 169-183.

- Bresler, L. (2006). Toward connectedness: Aesthetically based research. *Studies in Art Education*, 48(1), 52–69. <https://doi.org/10.1080/00393541.2006.11650499>
- Carless, D., & Douglas, K. (2010). Songwriting and the creation of knowledge. In Bartleet, B. L., & Ellis, C. (eds.). *Music autoethnographies: making autoethnography sing: making music persona* (pp. 23-38). Australian Academic Press.
- Chang, H. (2016). Individual and collaborative autoethnography as method: a social scientist's perspective. In Jones, S. H., Adams, T. E., & Ellis, C. (Eds.), *Handbook of autoethnography* (pp. 107-122). Routledge.
- Collier, J. (2020, 21 mei). *LOGIC SESSION BREAKDOWN: "All I Need (with Mahalia & Ty Dolla \$ign)"* [Video]. YouTube. https://www.youtube.com/watch?v=sRIjprauHgk&t=3931s&ab_channel=JacobCollierJacobCollierOfficieelartiestenkanaal
- Costantino, T. (2018). STEAM by another name: Transdisciplinary practice in art and design education. *Arts Education Policy Review*, 119(2), 100–106. <https://doi.org/10.1080/10632913.2017.1292973>
- Costello, J., Feller, J., & Sammon, D. (2018). A layer framework for precise, consistent and contributive autoethnography. In Norrgrann, A., & Syrjälä, H. (Eds.), *Multifaceted autoethnography: Theoretical advancements, practical considerations, and field illustrations* (pp. 19-32). Nova
- Crawford, R. (2017). Creating unity through celebrating diversity: a case study that explores the impact of music education on refugee background students. *International Journal of Music Education*, 35(3), 343–356. <https://doi.org/10.1177/0255761416659511>
- Crowther, G. (2012). Using science songs to enhance learning: an interdisciplinary approach. *CBE—Life Sciences Education*, 11(1), 26–30. <https://doi.org/10.1187/cbe.11-08-0068>
- Crowther, G. J., Ma, A. J., & Breckler, J. L. (2017). Songwriting to learn: Can students learn A&P by writing content-rich lyrics? *HAPS Educator*, 21(2), 119–123. <https://doi.org/10.21692/haps.2017.025>
- Crowther, G. J., McFadden, T., Fleming, J. S., & Davis, K. (2016). Leveraging the power of music to improve science education. *International Journal of Science Education*, 38(1), 73–95. <https://doi.org/10.1080/09500693.2015.1126001>
- Csikszentmihalyi, M. (1993). *The evolving self: A psychology for the third millennium*. Harper Collins.
- Cuddy, L. L., & Duffin, J. (2005). Music, memory, and Alzheimer's disease: is music recognition spared in dementia, and how can it be assessed? *Medical Hypotheses*, 64(2), 229–235. <https://doi.org/10.1016/j.mehy.2004.09.005>

- Custodero, L. A. (2002). Seeking challenge, finding skill: Flow experience and music education. *Arts education policy review*, 103(3), 3-9.
- Dalgleish, T., Navrady, L., Bird, E., Hill, E., Dunn, B. D., & Golden, A. M. (2013). Method-of-loci as a mnemonic device to facilitate access to self-affirming personal memories for individuals with depression. *Clinical Psychological Science*, 1(2), 156-162.
- Daykin, N. (2004). The role of music in an arts based qualitative inquiry. *International Journal of Qualitative Methods*, 3(2), 36–44. <https://doi.org/10.1177/160940690400300203>
- Dr. Najeebs lectures. (2019). *Master Neuroscience and Neuroanatomy*. Udemy: Master neuroscience and neuroanatomy. Retrieved from <https://www.udemy.com/course/neuroanatomy/>.
- Editing MIDI Notes and Velocities (n.d.) [image]. Retrieved from <https://www.ableton.com/en/manual/editing-midi-notes-and-velocities/>
- Eisner, E. W. (2003). Artistry in Education. *Scandinavian Journal of Educational Research*, 47(3), 373–384. <https://doi.org/10.1080/00313830308603>
- Eisner, E., & Powell, K. (2002). Special series on arts-based educational research: Art In science? *Curriculum Inquiry*, 32(2), 131–159. <https://doi.org/10.1111/1467-873X.00219>
- Ellis, C. (1996). Maternal connections. *Composing ethnography: Alternative forms of qualitative writing*, 240-243.
- Eschrich, S., Münte, T. F., & Altenmüller, E. O. (2008). Unforgettable film music: The role of emotion in episodic long-term memory for music. *BMC Neuroscience*, 7.
- Fleming, M. (2010). Arts in education and creativity: A literature review.
- Garageband (n.d.). Abstract kunst achtergrond [image]. Retrieved from <https://pixabay.com/nl/photos/abstract-kunst-achtergrond-verf-2468874/>
- Garoian, C. R., & Mathews, J. D. (1996). A common impulse in art and science. *Leonardo*, 29(3), 193. <https://doi.org/10.2307/1576244>
- GDJ (n.d.). Geluid wave golfvorm auditieve [image]. Retrieved <https://pixabay.com/nl/vectors/geluid-wave-golfvorm-auditieve-1781570/>
- Gershon, W. S. (2011). Embodied knowledge: Sounds as educational systems. *JCT (Online)*, 27(2), 66.
- Gershon, W. S. (2019). Sonic Ethnography in Theory and Practice. In W. S. Gershon, *Oxford Research Encyclopedia of Education*. Oxford University Press. <https://doi.org/10.1093/acrefore/9780190264093.013.547>

- Gershon, W. S., & Ben-Horin, O. (2014). Deepening inquiry: What processes of making music can teach us about creativity and ontology for inquiry based science education. *International Journal of Education & the Arts*, 15(19).
- Giorgio, G. A. (2016). Reflections on writing through memory in autoethnography. In Jones, S. H., Adams, T. E., & Ellis, C. (Eds.), *Handbook of autoethnography* (pp. 406-424). Routledge.
- Goldblatt, P. F. (2006). How John Dewey's theories underpin art and art education. *Education and Culture*, 22(1), 17–34. <https://doi.org/10.1353/eac.2006.0001>
- Governor, D., Hall, J., & Jackson, D. (2013). Teaching and Learning Science Through Song: Exploring the experiences of students and teachers. *International Journal of Science Education*, 35(18), 3117–3140. <https://doi.org/10.1080/09500693.2012.690542>
- Grossman, G. D., & Watson, C. E. (2015). The use of original music videos to teach natural history. *Journal of Natural History Education and Experience*, 9(1), 1-7.
- Guyotte, K. W., Sochacka, N. W., Costantino, T. E., Kellam, N. N., & Walther, J. (2015). Collaborative creativity in STEAM: Narratives of art education students' experiences in trans-disciplinary spaces. *International journal of education & the arts*, 16(15).
- Hallam, S., Creech, A., & McQueen, H. (2018). Pupils' perceptions of informal learning in school music lessons. *Music Education Research*, 20(2), 213-230.
- Hayes, O. C. (2009). The Use of Melodic and Rhythmic Mnemonics to Improve Memory and Recall in Elementary Students in the Content Areas. *Online Submission*.
- Hernandez, K. A. C., & Ngunjiri, F. W. (2016). Relationships and communities in autoethnography. In Jones, S. H., Adams, T. E., & Ellis, C. (Eds.), *Handbook of autoethnography* (pp. 107-122). Routledge.
- Howes, D. (2010). The craft of the senses. *Occasional Papers, Centre for Sensory Studies, Concordia*.
- Hunter-Doniger, T. (2018). Art Infusion: Ideal Conditions for STEAM. *Art Education*, 71(2), 22–27. <https://doi.org/10.1080/00043125.2018.1414534>
- Huxley, A. (1931). The rest is silence. *Music at Night and other Essays*.
- Johnson, M. (2015). The aesthetics of embodied life. In Scarinzi, A. (Ed.). *Aesthetics and the embodied mind: beyond art theory and the cartesian mind-body dichotomy* (pp. 23-38). Springer, Dordrecht.
- Jones, S. H., Adams, T. E., & Ellis, C. (Eds.), (2016). *Handbook of autoethnography* (pp. 57-83). Routledge.

- Kallioniemi, K., & Kärki, K. (2009). The Kalevala, Popular Music, and National Culture. *Popular Music*, 13(2), 12.
- Kanye West. (2018, 12 december). *StreetLights* [Video]. YouTube. https://www.youtube.com/watch?v=TUfuDKKGQxU&ab_channel=KanyeWest-KanyeWestOfficieelartiestenkanaal
- Keith, D. R. (2007). *Understanding Music Improvisations: A Comparison of Methods of Meaning-Making*. 42.
- Kiran, S. D. S. (2020). *Learner-Centered Approach: Engaging Students in Learning Activities*. 1, 13.
- Kirschner, S., & Tomasello, M. (2010). Joint music making promotes prosocial behavior in 4-year-old children. *Evolution and Human Behavior*, 31(5), 354–364. <https://doi.org/10.1016/j.evolhumbehav.2010.04.004>
- Kitts, H. (2015). Being, knowing, teaching: possibilities for post-Cartesian inquiry in mass compulsory education in the United States. *Interdisciplinary Humanities*, 32(2), 79–92.
- Lapadat, J. C. (2017). Ethics in autoethnography and collaborative autoethnography. *Qualitative Inquiry*, 23(8), 589–603. <https://doi.org/10.1177/1077800417704462>
- Leavy, P. (2015). *Method meets art: arts-based research practice* (2nd ed.). The Guilford Press.
- Levinson, J. (2004). Music as narrative and music as drama. *Mind and Language*, 19(4), 428–441. <https://doi.org/10.1111/j.0268-1064.2004.00267.x>
- Lum, C. H. (2008). Beyond music lessons: subject teachers' use of music in the classroom. *Research Studies in Music Education*, 30(2), 139-158. <https://doi.org/10.1177/1321103X08097504>
- MacDonald, A., Wise, K., Tregloan, K., Fountain, W., Wallis, L., & Holmstrom, N. (2020). Designing STEAM education: Fostering relationality through design-led disruption. *International Journal of Art & Design Education*, 39(1), 227–241. <https://doi.org/10.1111/jade.12258>
- Marazzi, A. (2019). Aural anthropology, a way of listening. *Visual Anthropology*, 32(2), 193–204. <https://doi.org/10.1080/08949468.2019.1603037>
- Margulis, E. H., Wong, P. C. M., Simchy-Gross, R., & McAuley, J. D. (2019). What the music said: Narrative listening across cultures. *Palgrave Communications*, 5(1), 146. <https://doi.org/10.1057/s41599-019-0363-1>
- McKay, S. W. (2005). “People should come to work”: Un-becoming cartesian subjects and objects in art education. *Journal of Social Theory in Art Education*, 25(1), 306-323.

- Meadows, T., & Wimpenny, K. (2016). Meaning-making processes in music therapy clinical improvisation: An artsinformed qualitative research synthesis. *Nordic Journal of Music Therapy*, 25(sup1), 1–156. <https://doi.org/10.1080/08098131.2016.11783620>
- Mohd Hawari, A. D., & Mohd Noor, A. I. (2020). Project based learning pedagogical design in STEAM art education. *Asian Journal of University Education*, 16(3), 102. <https://doi.org/10.24191/ajue.v16i3.11072>
- Moreira, S. V., Justi, F. R. dos R., & Moreira, M. (2018). Can musical intervention improve memory in Alzheimer's patients? Evidence from a systematic review. *Dementia & Neuropsychologia*, 12(2), 133–142. <https://doi.org/10.1590/1980-57642018dn12-020005>
- Moreno, S., Marques, C., Santos, A., Santos, M., Castro, S. L., & Besson, M. (2009). Musical training influences linguistic abilities in 8-year-old children: More evidence for brain plasticity. *Cerebral cortex*, 19(3), 712–723.
- Nakamura, K. (2013). Making sense of sensory ethnography: The sensual and the multisensory. *American Anthropologist*, 115(1), 132–135. <https://doi.org/10.1111/j.1548-1433.2012.01544.x>
- NENA. (2021, 24 april). *NENA | 99 luftballons [Offizielles Musikvideo] (1983)* [Video]. YouTube. https://www.youtube.com/watch?v=Fpu5a0Bl8eY&ab_channel=NENA
- One-dimensional motion | AP®/College Physics 1 | Science*. (n.d.). Khan Academy. Retrieved June 14, 2021, from <https://www.khanacademy.org/science/ap-physics-1/ap-one-dimensional-motion>
- Over meer muziek in de klas. (z.d.). Meer muziek in de klas. <https://www.meermuziekindeklas.nl/nl/over/#wat-doen-wij>
- Patel, A. D. (2010). *Music, biological evolution, and the brain*. 37.
- Patti, C. J. (2010). Musical artifacts of my fathers death: Autoethnography, music, and aesthetic representation. In Bartleet, B. L., & Ellis, C. (eds.). *Music autoethnographies: making autoethnography sing: making music persona* (pp. 57-72). Australian Academic Press.
- Pellegrino, A. M. (2013). Employing music in the history classroom: Four models. *The Social Studies*, 104(5), 217–226. <https://doi.org/10.1080/00377996.2012.755458>
- Peter Gabriel (2013, September 12). *Peter Gabriel - Biko* [Video]. YouTube. https://www.youtube.com/watch?v=luVpsM3YAgw&ab_channel=PeterGabriel.
- Real World Records. (2014, 10 augustus). *Afro Celt Sound System - Release (feat. Sinéad O'Connor) [Official Video]* [Video]. YouTube. https://www.youtube.com/watch?v=7LhI-kAKJzs8&ab_channel=RealWorldRecords

- Reynolds, J. A., Thaiss, C., Katkin, W., & Thompson, R. J. (2012). Writing-to-Learn in Undergraduate Science Education: A Community-Based, Conceptually Driven Approach. *CBE—Life Sciences Education*, 11(1), 17–25. <https://doi.org/10.1187/cbe.11-08-0064>
- Roberts, A. (2017). photos/82wJ10pX1Fw [image]. Retrieved from <https://unsplash.com/photos/82wJ10pX1Fw>
- Romo, J. J. (2004). Experience and context in the making of a Chicano activist. *The High School Journal*, 95-111.
- Ronai, C. R. (1995). Multiple reflections of child sex abuse: An argument for a layered account. *Journal of contemporary ethnography*, 23(4), 395-426.
- Roodenburg, H. (Red.). (2014). *A Cultural History of the Senses in the Renaissance*. Bloomsbury Publishing Plc. <https://doi.org/10.5040/9781474233217>
- Russel, M. (2012). Now climb that tree [image]. Retrieved from <https://marquetteeducator.wordpress.com/2012/07/12/climbthattree/>
- Ruud, E. (1997). Music and the Quality of Life. *Norsk Tidsskrift for Musikterapi*, 6(2), 86–97. <https://doi.org/10.1080/08098139709477902>
- Sand-Jensen, K. (2007). How to write consistently boring scientific literature. *Oikos*, 116(5), 723-727.
- Schellenberg, E. G. (2004). Music Lessons Enhance IQ. *Psychological Science*, 15(8), 511–514. <https://doi.org/10.1111/j.0956-7976.2004.00711.x>
- Schilling, M. A., Vidal, P., Ployhart, R. E., & Marangoni, A. (2003). Learning by doing something else: Variation, relatedness, and the learning curve. *Management science*, 49(1), 39-56.
- Smith, B. (2013). STEM to STEAM: Developing New Frameworks for Art-Science Pedagogy.
- Snowdon, C. T., Zimmermann, E., & Altenmüller, E. (2015). Music evolution and neuroscience. In *Progress in Brain Research* (Vol. 217, pp. 17–34). Elsevier. <https://doi.org/10.1016/bs.pbr.2014.11.019>
- Tinari, F. D., & Khandke, K. (2000). From Rhythm and Blues to Broadway: Using Music to Teach Economics. *The Journal of Economic Education*, 31(3), 253–270. <https://doi.org/10.1080/00220480009596784>
- Tullis, J. A. (2016). Self and others: ethics in autoethnographic research. In Jones, S. H., Adams, T. E., & Ellis, C. (Eds.). *Handbook of autoethnography* (pp. 244-261). Routledge.
- Valtone, A., & Haanpää, M. (2018). The body in autoethnography. In Norrgrann, A., & Syrjälä, H. (Eds.), *Multifaceted autoethnography: Theoretical advancements, practical considerations, and field illustrations* (pp. 125-145). Nova

- van Boekel, M. A. J. S. (2006). Formation of flavour compounds in the Maillard reaction. *Biotechnology Advances*, 24(2), 230–233. <https://doi.org/10.1016/j.biotechadv.2005.11.004>
- van Waaijen, R. (2019). *De Positieve Effecten Van Kunstonderwijs Zijn Allang Bewezen*. Mocca. <https://mocca.amsterdam/smaakmakers-interview-rob-van-waaijen-directeur-stichting-jam/>
- Watson, V. W., & Beymer, A. (2019). Praisesongs of place: Youth envisioning space and place in a literacy and songwriting initiative. *Research in the Teaching of English*, 53(4), 297–319.
- Wayang Golek Performance (2013) [image]. Retrieved from <https://www.indonesiatravel-guides.com/wayang-golek-traditional-show-of-west-java.html/wayang-golek-performance>
- Weinkauf, D. (2009). I am a paleontologist [Recorded by They might be giants]. On *Here comes science* [MP3 file]. Burbank, California: Walt Disney records.
- Wienk, J. (2020). In Conversation With Four Handbooks: On the Current State of Arts Education in the 21st Century. *International Journal of Education & the Arts*, 21(31).
- Wikimedia Foundation. (2021). *A Horse with No Name*. Wikipedia. Retrieved from https://en.wikipedia.org/wiki/A_Horse_with_No_Name#:~:text=Writer%20Dewey%20Bunnell%20also%20says,a%20quiet%2C%20peaceful%20place%22.
- Wilinsion, S. (2021). Frozen glass [image]. Retrieved from <https://unsplash.com/s/photos/frozen-glass>
- Wilson, O. M. (2010). *Arts Education: Assessment and Access*. Nova Science Publishers, Inc.
- Zittoun, T., & Brinkmann, S. (2012). Learning as meaning making. *Encyclopedia of the Sciences of Learning*, 1809-1811.