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Designing new, technology-based musical instruments in primary education

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Keywords

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Abstract

One of the ways in which pupils in Dutch primary education are being equipped with 21st Century Skills is through Design-based Learning. Building musical instruments could be an interesting entry point for Design-based Learning in music education. In this educational design research study, we explored how this approach could be applied to designing and building new, technology-based musical instruments. Workshops were developed on the principles of Design-based Learning and carried out in two cycles. Each cycle took place at a different primary school and was evaluated through observations, interviews with classroom teachers, and learner reports from pupils. The findings showed that the phases of Design-based Learning are helpful in structuring the pupils' learning process when designing and building new, technology-based musical instruments. Furthermore, a Design-based Learning approach in music education holds the possibility for the development of the 21st century skills of problem-solving, creative thinking, and cooperation. The findings also illuminated challenges. Workshop leaders not only need to have content knowledge of science, technology, and music, but also need to know how to guide a design process and how to approach problems that can arise during that process, such as design fixation.

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Introduction

The future of education and curriculum development are high on the agendas of Dutch educational organizations, educational support services, and politicians (Hotze, Bremmer, Heijnen, Beamer, Pijls & Roos, 2019; Nout, 2017). Now more than ever, it is being acknowledged that education plays an important role in preparing pupils to become citizens who can contribute to societal challenges, such as globalization, climate change, and migration (Groenendijk & Heijnen, 2018). In this context, the so-called 21st Century Skills – such as critical thinking, creativity, collaboration and media literacy – are receiving attention as pupils will need these skills to develop into critical citizens of our future society (Tanis, Dobber, Zwart, & Van Oers, 2014).

One of the ways in which pupils in Dutch primary education are being equipped with these 21st Century Skills is through 'Science & Technology', which is not a separate school subject, but an approach to teaching and learning through 'Inquiry and Design-based Learning'. This specific method of teaching and learning is based on how scientists and designers approach problems (Kraaij, 2015; TechniekPact, 2018). It allows pupils to explore and experiment, and to integrally acquire knowledge and skills (Van Keulen, 2010; Van Wessels, Kleinhans, Van Keulen & Baar, 2014). For instance, during Inguiry-based Learning pupils explore problems, set up small-scale research projects, carry out these projects, draw conclusions, and present their research outcomes. In the case of Design-based Learning, pupils sketch a design, realize the design, test it, and customize the design as part of a design cycle (Malmberg, Rohaan, Van Duijn & Klapwijk, 2019). This article will specifically focus on Design-based Learning.

Although the approach is meant to be applied to any school subject in primary education, in the Netherlands Design-based Learning is mostly applied in the domain of the natural sciences and mathematics. This domain resembles the international movement of 'Science, Technology, Engineering, and Mathematics' education, so-called STEM-education (Goldston & Downey, 2013). STEM-education originated in the late 1990s, and has known many variations. For example, it has included the R for robotics and the G for girls, and more recently, there has been a call to add the A for arts to create STEAM-education (Land, 2013). Bequette and Bequette (2012) note that examining how art, science, technology, and math can be integrated in artworks, and experiencing how the boundaries between these disciplines can be blurred, holds the possibility to develop thinking dispositions such as 21st

Century Skills that are valued not only within, but also beyond the arts. Introducing pupils to hybrid works of art can help them understand more about creative and artistic processes and design thinking (Bequette & Bequette, 2012; Guyotte, Sochacka, Costantino, Kellam, & Walther, 2015), and can confront pupils with materials that traditionally have not been used in the domain of the arts but have been part of the domain of science and technology (Grushka, Lawry, Clement, Hope, & Devine, 2016).

As STEAM-education has much to offer pupils, the question is how Design-based Learning can be applied within Dutch *arts* education, instead of solely within natural sciences and mathematics. Music education, for example, could be an interesting entry point for Design-based Learning. Although often overlooked as an activity in music education (Smith, 2018), building musical instruments offers pupils opportunities to sketch a design, build, test, and (re)adjust instruments, and – finally – to present them to a wider audience. Soltau (2014) notes that creating new, experimental musical instruments not only promotes artistry and innovation, but pupils can also develop their creativity. Moreover, *21st-century technologies* offer whole new possibilities to design and build instruments, expanding perspectives of what can be viewed as musical instruments.

Currently, the Dutch cultural organization SoundLAB already is expanding pupils' notion of musical instruments by bringing them into contact with experimental, technology-based musical instruments (Diepenbroek, 2015). SoundLAB organizes workshops for primary education pupils who learn to improvise and compose music on these newly developed, experimental instruments. In the ongoing development of instruments, the designers of SoundLAB use different technologies, such as electro-acoustics, and analogue and digital synthesis, sometimes in combination with sensors and mini computers/micro-controllers, such as arduinos. Although the use of these technologies is not exclusive to professionals (Challis, 2009), so far, SoundLAB has not offered building technology-based musical instruments as an activity in primary education. However, SoundLAB is interested in shifting the process of designing and building, technology-based instruments to pupils in primary education, to give them ownership of the instruments and to develop their creative skills.

In this research, we wondered whether we could pair the pupils' development of 21st Century Skills through Design-based Learning with the development of technology-based musical instruments under guidance of experienced workshop leaders of the cultural organization SoundLAB. Therefore, this research study asked the following questions: "*How*

can Design-based Learning be applied to designing and building new, technology-based musical instruments in primary education for the purpose of making music?", "Which 21st Century Skills do pupils develop through designing and building newly developed musical instruments", and "*What are the challenges of a Design-based Learning approach to designing and building newly developed musical instruments, according to the pupils and classroom teachers*?"

Methodology

Educational design research

This research study was set up as an educational design research study. Nieveen (2009, p. 89) defines this type of research as the "systematic study of analysing, designing and evaluating educational interventions in order to solve complex educational problems for which no ready-made solutions are available". Our problem concerned the question how Design-based learning could be integrated in music lessons. Therefore, in this research study, educational workshops concerning designing and building new, technology-based musical instruments were developed based on the principles of Design-based Learning, carried out in primary education and evaluated in a systematic way. In general, educational design research consists of the four research phases: 'identification', 'design', 'testing', and 'evaluation' (Heijnen, 2018). Each of these phases will be discussed separately in this article.

Research phase one: Identification

The first phase focuses on the identification of an educational problem in need of being solved. In this research study, the problem of how Design-based Learning could be applied in music lessons, as a means to developing 21st Century Skills, was central. Furthermore, the theoretical background of Design-based Learning and its design cycle have been explored, as well as different technologies that could be used to build musical instruments in primary education (e.g. arduinos, conductive touch boards, Little Bits, Patchblocks, and Makey Makey). We decided to work with Conductive Touch Boards (CTB), an easy-to-use microcontroller for building digital devices, such as musical instruments, offering the ability to turn almost any material or surface into a sensor (see figure 1).

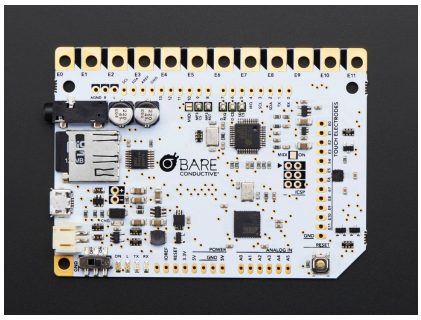

Figure 1: A conductive touch board.

Research phase two: Design

The second phase is concerned with the development of solutions for the educational problem in the form of an educational intervention. In this research study, the educational intervention was designed for "Arts Orientation", a compulsory subject area in Dutch primary education. Both cultural organizations, generalist teachers and specialist arts teacher (including music teachers) are allowed to teach lessons within this subject area. Its overall goal is to familiarize pupils with artistic and cultural aspects of their living environment and to learn to express themselves through artistic means such as dance, theatre, visual arts, but also music, which was the focus of our study.

The educational intervention we developed consisted of a series of four workshops of 45 minutes each, and was designed by a team of three researchers with music educational backgrounds, an experienced workshop leader and two workshop assistants from the cultural organization SoundLAB. The workshops were based on the different steps of Design-based Learning as shown in figure 2: (1) Pupils explore and address a problem; (2) Pupils come up with ideas to solve the problem; (3) Pupils elaborate on and select an idea; (4) Pupils make a prototype of the idea; (5) Pupils test and optimize the design; and (6) Pupils present the design.

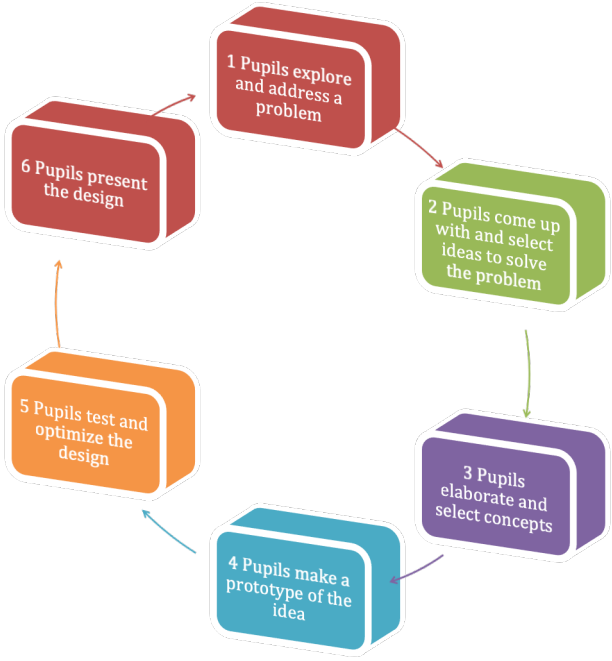

Figure 2: Design cycle (Malmberg, Rohaan, Van Duijn, & Klapwijk, 2019, p. 164).

The educational intervention was set up in the following way: In the first workshop, a soundless film fragment of a LEGO® film was introduced and the following question was asked: "Can you improvise sounds/music on self-built, technology-based musical instruments to accompany this film fragment?" To inspire pupils, the workshop leader showed, among others, sound installations by Tinguely, a Theremin, and a water organ. Then, the pupils were introduced to the CTB and how it works. After that, they formed groups of four and were asked to come up with preliminary ideas for new, technology-based musical instruments. Lastly, pupils were asked to bring materials that could be used to build musical instruments.

In workshop two, the groups of pupils came up with and selected ideas for musical instruments. During the workshop, groups of three pupils were formed and each pupil within the group would be assigned a different role: the designer who was responsible for the design of the instrument, the sound technician who recorded the sounds, and the electro-technician who built the instrument with CTBs. Each group was invited to make sketches of instruments and to record sounds that could be edited and imported into the CTB. A small recording studio was furnished, consisting of a computer, two studio microphones, two field recorders, and six headphones. In the third workshop, pupils chose their final design and built their instruments. They tested and optimized their designs. In workshop four, the groups presented their musical

instruments to each other. Furthermore, the groups were asked to improvise sounds/music to accompany the soundless film fragment.

Research phases three and four: Testing and evaluating

During these phases, the researchers test and evaluate the educational intervention in practice. In this research study, the four workshops were tested and evaluated in two cycles at two different schools. The participants who tested the workshops, the research methods used to collect the data concerning the experience with the educational intervention, and the data analysis and findings of the evaluation will be described in the following paragraphs.

Participants

The first test phase of the series of four workshops was conducted at a primary school in Amsterdam, and the second at a primary school in Koog aan de Zaan, both in the Netherlands. Both schools were chosen for their mixed population.

During the *first* test phase, four upper grade classes of primary education participated in the workshops: grades 5/6 (ten boys, seven girls), on average 9,5 years old; grade 6, (twelve boys, four girls), on average 10 years old; grade 7, (thirteen boys, eight girls), on average 11 years old; and grade 8, (six boys, eight girls), on average 12 years old.

During the *second* test phase, two upper grade classes of primary education participated in the workshops: grade 6/7, (fifteen boys, eight girls), average age 11,5 years; and grade 8, (seven boys, eleven girls) average age 12 years.

Both series of workshops were led by a workshop leader from SoundLAB with a background in music technology, supported by a SoundLAB assistant. The workshop leader's role was to supervise the workshop through deepening the design process of the pupils by offering new options for action. The assistant mainly focused on helping pupils record sounds for the instruments. All classroom teachers (five female and one male) of the participating grades took part in the research study by assisting the workshop leader and filling out a questionnaire about the workshop. All participants actively consented in taking part in the study.

Research methods

Both series of workshops were evaluated through multiple methods. First of all, structured observations were used to evaluate the pupils' and teachers' experiences with Design-based Learning. The observation form was based on the design cycle as shown in figure 2. For every phase of the design cycle, there were three key questions: 1) What happens/ can be seen in the groups of pupils? 2) What seems successful in the teaching and pupils' learning process within each phase of the design cycle? And 3) What seems challenging in the teaching and pupils' learning process within each phase of the design cycle? Two researchers executed the observations.

Secondly, at the end of the last workshop of both workshop series, all the pupils filled out a so-called learner report: an open self-evaluation method allowing learners to describe what they learned or how they experienced the workshops (De Groot, 1980). In the learner report, pupils could write down what they enjoyed or did not enjoy about the workshops, and they were asked how they experienced the different phases of Design-based Learning and what they had learned during the workshops.

Thirdly, at the end of the last session of each workshop series, the classroom teachers were asked to fill out an open ended questionnaire, such as whether or not they were acquainted with Design-based Learning, with science and technology, or music activities; which challenges they perceived with regard to a Design-based-Learning approach to designing, building, and performing with newly developed musical instruments; and what the added value of Design-based Learning could be for their own teaching.

Data analysis

Regarding the observations, these were analyzed through a thematic-analysis approach (Braun & Clarke, 2006). Within the process of coding, the following themes were chosen for the analysis: 1) activities/actions performed by pupils (e.g. cooperation, problem solving, creativity); 2) successful aspects during the different phases of the pupils' design cycle; 3) challenging aspects during the different phases of the pupils' design cycle.

A thematic analysis was also applied to the learner reports and the questionnaires of the classroom teachers. First of all, the following themes were chosen for the analysis of the learner reports: 1) appreciation of the activities in the different phases of the design cycle; 2) the cooperation with other pupils; 3) perceived learning outcomes.

Lastly, for the open ended questionnaire the following themes were chosen for the analysis: 1) prior experiences with Design-based Learning, science and technology, or music activities; 2) perceived challenges with regard to a Design-based Learning approach; and 3) the added value of a Design-based Learning approach.

All research methods were analyzed by two researchers on the basis of the predescribed themes. After the process of coding, they discussed their analysis to achieve interpretive convergence.

Findings

First test and evaluation cycle

Overall, the observations made clear that the pupils advanced through the different phases of the design cycle to build a musical instrument in a motivated way. However, the observations also revealed some challenges that surfaced during the four workshops. For instance, during the first and second workshops it became clear that the problem *"Can you improvise sounds/music on self-built, technology-based musical instruments to accompany the film fragment?",* did not appear to be meaningful enough to the pupils. Although the workshop leader showed the soundless film fragment of the LEGO® film several times, the pupils seemed to forget it and, hence, did not seem to relate the sounds they were looking for to that particular film fragment.

Furthermore, observations during the second and third workshop showed pupils actively working together in the process of building a musical instrument and recording sounds. Yet, some pupils started building instruments without designing them first through sketches, texts, or simple 3D models. These pupils immediately ran towards the table with materials and tools, and started building an instrument through the process of trial and error. To prevent this a next time, pupils in the other classes were explicitly asked to make sketches of their designs first. Although more pupils started sketching a design, it became apparent that the process of divergent thinking, in which multiple ideas and sketches can be generated, required more attention.

Another striking observation during the second and third workshop concerned the different social-cultural roles the pupils had to take on during the designing and building of

the instrument: the designer (responsible for the design of the instrument), the sound engineer (who records the sounds for the instrument), or the electro-technician (who builds the instrument with CTBs). Although these roles seemed to be clearly distinctive to the workshop leader, to the pupils they did not seem clear at all. The role of the sound engineer was the clearest, but pupils seemed to have a hard time to distinguish being an electro-technician and being a designer. These roles were seen as one by the pupils.

Observations in the final workshop made clear that pupils did spend time optimizing their musical instruments (see figure two), but lacked the concentration to improvise sounds/music to accompany the film fragment. Lastly, observations relating to the workshop leader showed that his instructions were too extensive: shorter instructions directing pupils to start working immediately seem important to increase task-oriented behavior of pupils.

Figure 2: Pupils optimizing their instruments

The learner reports made insightful that the pupils enjoyed building the musical instruments, as well as recording sounds. However, it was difficult for the pupils to focus on solving the presented problem of making an improvisation/composition – they mainly focused on building the new musical instruments. A pupil described: *"We made a pizza. If you touch it, it will make a sound. We can build it with tinfoil."* Regarding their cooperation, some pupils noted the confusion about the different roles. A pupil reported: *"I enjoyed the workshop, but I don't understand what we sound engineers should do. I would rather build an instrument."* Although most pupils noted they enjoyed the activities, they were unable to explain what they learned from the workshops: they described their musical instruments and the activities they performed, but seldom mentioned what they actually had learned. Or, as one pupil wrote down: "*We had a good time, but we didn't actually learn anything*".

The open-ended questionnaire showed the teachers hardly had any experience with Design-based Learning, science and technology, or music activities. With regard to Design-based Learning, one classroom teacher wrote down: *"In my daily practice, I let children search for information and let them do small experiments. However, I never ask them to solve problems by asking them to make a design. It's interesting to see that this is a possibility that offers pupils to learn in a whole different way than they usually do."*

The challenges the teachers reported concerning the workshops mainly focused on organizational aspects of the workshop, not as much on the content of the workshop. This could possibly be due to their lack in experience with Design-based Learning, science and technology, and musical activities. For instance, forming pupils into groups was mentioned as a challenge. A teacher explained: *"If I would give this workshop myself, I would only let pupils work together whom I know are able to do so. If you don't know the pupils you get to work with, my advice would be to ask the classroom teacher to make groups."* The duration of instruction moments was also mentioned by the teachers as challenging, or as teachers noted: *"Keep the instruction short and 'to-the-point'", or "Too much information will distract pupils from what you want to achieve. Be aware of a relatively short attention span of pupils."* Other teachers mentioned the lack of time during the workshops. For some classes 45 minutes matched the attention span of pupils and/ or time needed to finish the activity. Other classes had to rush to finish their work, which, according to the teachers, was frustrating for the pupils.

Other organizational problems mentioned by the teachers, concerned the space and the materials used during the workshops. For instance, the workshop leader had to move all the materials from classroom to classroom, but some teachers reported it would have been helpful if the workshops could have been given in the same classroom. This room could have been furnished as a so-called makerspace (Schaareman, 2018). Makerspaces are collaborative workspaces inside a school, library, or a public/private facility for making, learning, exploring, and sharing, using high-tech to no-tech tools (Clapp, Ross, Ryan, & Tishman, 2017). As one of the teachers described: *"It's a pity that the workshops could not be given in a special subject classroom. The workshops offer a rich content. A makerspace, as a rich learning environment, could reinforce the strength of the teaching approach, as well as the content of the workshop."*

Although the classroom teachers reported collecting and recording sounds was an interesting activity for pupils, they also noted the recording studio (consisting of a computer, two studio microphones, two field recorders, and six headphones) was rather advanced for this activity (see figure 3 for the sound studio). The classroom teachers appreciated the recording studio but raised the question whether it was realistic to use this kind of equipment in an educational project at primary schools. Teachers wondered whether there wasn't more simple and affordable equipment to be used for this purpose. A teacher asked: *"It's nice that SoundLAB brought in professional recording equipment but would it also be possible to collect sounds with mobile phones? Schools will never be able to afford such [professional] recording equipment."*

Figure 3: The sound studio

Alterations of the workshops

Based on the observations, learner reports, and questionnaires of the first test and evaluation phase, a number of changes regarding the content and organization of the workshops were made. For instance, regarding the content of the workshops, we decided that a class with hardly any experience in science and technology should be presented with a less complex problem to solve, and the problem should be made more meaningful to the pupils. Therefore, for the second test phase, we designed a new problem: in the first workshop the soundscape *'Several Species of Small Furry Animals Gathered Together in a Cave'* by Pink Floyd would be presented and the pupils would be asked: "How can you build a new musical instrument with which to make a soundscape?"

Furthermore, the phase in Design-based Learning in which pupils come up with multiple ideas to solve the problem and make sketches, texts, or simple 3D models of an instrument prior to the actual building, would receive more attention: the pupils would

explicitly be asked to come up with several ideas before building an instrument. Also, the number of roles for the pupils was reduced from three to two: the sound technician and the designer, the electro-technician being merged with the latter. For the recording of the sounds, field recorders would be offered to the pupils, instead of studio equipment. We also decided that the last workshop would be turned into a session on Creative Music Making. The pupils would be introduced to all kinds of circle activities, improvisations, and sound experiments meant to inspire them to create a soundscape.

Regarding the organization, changes were made too. For example, the amount of time per workshop increased from 45 to 60 minutes per workshop. Furthermore, the workshops would be given in one classroom, so the workshop leader would not have to move the materials from one classroom to another. Lastly, specific attention would be given to the way the workshop leader gave instructions: these would be kept brief, allowing for increased time-on-task (Van Gog, 2013).

Second test and evaluation cycle

The second test phase took place at a primary school in Koog aan de Zaan, and the same research methods were applied to gain insight in the educational intervention. Observations showed that asking pupils how they could design instruments to compose a new soundscape, seemed to offer both the pupils and the workshop leader more freedom than having to compose a piece of music to match a specific film fragment.

Furthermore, observations made clear that the increased attention to coming up with ideas and making and selecting sketches did not necessarily lead to more creative designs, but in general did seem to lead to smoother design processes. For instance, pupils seemed to encounter fewer problems building their instruments because they had a clearer idea of what they wanted to build. Observations also showed that there seemed to be less confusion regarding the roles of the pupils, as there were only two roles left: the sound technician and the designer. The field recorders worked effectively for collecting sounds, and the creative-music-making activities inspired pupils to make a soundscape that had some form or structure instead of just random notes.

Finally, observations made insightful that the workshop leader had a better idea of the designing and building process as a whole, which seemed to contribute to a smoother process than in the first test phase. In this second cycle, he started structuring and deepening the ideas

pupils came up with through asking them questions, and he could suggest adding new elements to the design and building process. The brief instructions of the workshop leader seemed to lead to a more task-oriented behavior of pupils, too.

The learner reports showed that designing and building musical instruments for the purpose of making a soundscape was experienced as a meaningful activity, possibly because it gave them more freedom to use their creativity. For instance, pupils wrote down: "*We built a great piano-flute. If you touch the buttons, it makes cool sounds that sound like cars and motorbikes*", and "*I liked building a hat that looks like a time machine. Touching the buttons and wires produces awesome sounds*". The confusion noted during the first series of workshops was absent, and pupils reported positively on their collaborations. As a pupil noted: "*Working in a small group challenged me to do the best I could to bring in some smart ideas.*" Remarkably, similar to test phase one, most pupils reported they had enjoyed the activities, but were unable to describe *what* they had learned: "*I enjoyed building an instrument, but it's difficult to tell what we have learned*".

Concerning the open-ended questionnaire, no specific feedback was given by the teachers with regard to the content and organization of the workshops. However, as in test phase one, the answers of questionnaire did show that the teachers had little experience with Design-based Learning, science and technology, or musical activities.

Final alterations

Based on the outcomes of the observations, learner reports, and questionnaires, final adjustments were made to optimize the workshops for future projects in primary education.

First of all, the learner reports from the first and second series of workshops showed pupils had a hard time explicating what they had learned. Therefore, in the new series of workshops, the previous implicit goals, such as "pupils become aware of the design cycle" will be made explicit, e.g. by clearly mentioning the phases of the design cycle during the workshops. In this way, pupils might become more conscious that they are learning a way of approaching a problem, next to learning about technology and music.

Secondly, more attention will be given to the role of the workshop leaders of SoundLAB. During the second series of workshops, the workshop leader started structuring and deepening the ideas of the pupils, suggesting them to add new elements to their design.

Such teaching activities seemed to facilitate a smoother design process. Therefore, the new design of the series of workshops will incorporate guidelines for a workshop leader on how to supervise pupils during each phase of the design cycle.

Conclusion and discussion

The data of the study showed Design-based Learning could be a useful approach to structure the pupils' learning process in primary music education when designing and building new, technology-based musical instruments. Under the guidance of a workshop leader, pupils were able to move through the different phases of the design cycle and to develop their own musical instruments within the time frame of four workshops. Moreover, the use of accessible technology and simple field recorders provided pupils with the agency to make their own choices regarding their musical instruments (Van Oers, 2018). As such, these workshops seem a promising way for a form of STEAM-education in which music is central.

A Design-based Learning approach in music education also seems to hold the possibility for the development of 21st Century Skills, including problem-solving, creative thinking, and cooperation. For instance, during the design cycle pupils not only discussed hypothetical solutions for a problem, but they also had to *produce* a concrete solution on the intersection of science, technology, and music. This way of hands-on problem-solving – through producing and assessing, generating and judging products – can stimulate pupils to make/think in and about the world, whilst working in an interdisciplinary environment and incorporating different tools and technologies (Quigley & Herro, 2016). With regard to creative thinking, the open-ended problem and the use of accessible technology fostered a space for pupils to use their imagination and to build a whole array of different musical instruments. Thus, what traditionally can be viewed as a musical instrument, could now be expanded by pupils through the creation of their new instrument (Soltau, 2014). Lastly, the different roles (the designer and sound engineer) in the groups of pupils complemented each other, which allowed pupils to practice their cooperation skills through attuning to each other, discussing, and deciding on design and sound choices.

The data, however, also illuminated challenges regarding the implementation of Design-based Learning as a way of designing and building technology-based musical instruments. Firstly, in order to make the approach successful, a workshop leader needs to

have content knowledge of science, technology, and music, but also needs to know how to teach the design cycle of Design-based Learning. For instance, the data exemplified that some pupils suffer from design fixation: they were unable to consider multiple solutions to a problem and got stuck on one idea that was not necessarily interesting. As divergent thinking is an important skill in the first phase of the design cycle (Malmberg, Rohaan, Van Duijn & Klapwijk, 2019), a workshop leader needs to have the skills to help pupils move beyond this fixation, e.g. by asking pupils to think up new ideas that are the opposite of their current idea (Sawyer, 2018). These skills need specific attention before these kinds of workshops are given.

Secondly, to make real use of the musical instruments, the making of music or soundscapes should receive more attention. Although adding the creative-music-making activities during the workshops helped pupils to make their own music or soundscape, a possibility would be to add a second design cycle after the instruments are built to make a composition or soundscape.

Thirdly, to allow for the pupils' experiences with the design cycle to become applicable to other subjects or to real-world problems, they need to have an understanding of the design cycle's different phases. In our study, the design cycle was more of a tool for the workshop leader than for the pupils: they followed his instructions in the design process and little time was spent on reflecting on the different design cycle phases. Thus, the pupils neither became conscious of these phases, nor could they make explicit what they had learned during the design process itself. Making the phases explicit for the pupils and adding reflection to the different phases might solve this problem (Puente, Van Eijck, & Jochems, 2013). Classroom teachers will also gain more explicit insight into the process of Design-based Learning, possibly lowering the barrier to apply this approach in and beyond music education.

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