



# Sheep With Five Feet\*

Struggling to teach, make, help, observe, and learn simultaneously in maker education

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## ABSTRACT

Makercosmos is a four-year maker education programme in Arnhem, the Netherlands, which comprises the development of series of maker education lessons and participatory action research about learning in maker education, among other activities. This study reports findings from the first pilot of this series, with a particular focus on how the research part was designed, developed, and delivered. Practice showed, that in our context asking teachers to teach and to carry out data collection for research simultaneously produced only meagre results when using a conventional notebook approach. Design principles are suggested to remodel the research approach.

## CCS CONCEPTS

• **Applied computing** → *Media arts; Collaborative learning*; • **Social and professional topics** → *K-12 education*.

## KEYWORDS

sound art, work in progress, participatory action research

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\*A sheep with five feet (or legs) is the literal translation of the Dutch expression “een schaap met vijf poten” which describes someone as a jack of all trades. The expression is regularly used in connection with vacancies when companies are looking for the perfect candidate – often in vain.

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## 1 INTRODUCTION

Makercosmos is a four-year maker education programme in Arnhem, The Netherlands, initiated by an alliance of primary school boards in Arnhem and the HAN University of Applied Sciences and facilitated through the Community Learning Centre in Arnhem. The purpose of the programme is to stimulate maker education at the schools involved and to learn from each other.

Within the programme, there are two lines of action – one, collectively designing, developing and delivering maker education, and two, establishing ways of effective collective learning about maker education.

Maker education is implemented through collective “make challenges” in which schools can participate, through establishing a dedicated makerspace which schools can make use of, through establishing a group of make coaches and qualifying teachers to develop their own maker education repertoire, and through dedicated series of maker education lessons.

Learning about maker education, the focus of this paper, is realised through a collective research programme that is evolving around the maker education activities and comprises three areas of study – developing a community of reflective practice in maker education at schools and libraries as set out in the “road map makerspaces” [5], teacher agency in the context of maker education, and curriculum development for maker education. Unlike in other studies done in Denmark [4] or California [2] that were able to muster extra research capacity, the aim of the Makercosmos programme is to integrate research as much as possible into teaching.

The two lines of action are intertwined, so the instances of designing, developing and delivering maker education are used as cases for learning about maker education. The current study reports on a work in progress on the development of studying a series of maker education lessons for kids aged ten to twelve years (i.e., in their last two years of their K-12 education). So, the study focuses on investigating learning in maker education. The lesson series to be studied was called “the art of making” and was developed in collaboration with the cultural centre Rozet in Arnhem that comprises the local library, the local heritage collections, and the arts education centre which offers internships for students from the ArtEZ University of the Arts in Arnhem.

## 2 PARTICIPATORY RESEARCH – AS DESIGNED

The series “the art of making” is supposed to be developed in three phases. The first and pilot phase took part in fall 2020 at two participating schools, with two slightly different projects. During the pilot phase, arts educators and a maker coaches designed, developed and delivered the lessons. The regular teachers supported them during delivery at the school, so they could get acquainted with the setting and the dynamics of maker education. In the second phase, the teachers would design, develop and deliver a programme themselves with the support of arts educators and maker coaches. In phase three, the teachers are supposed to have developed their maker education skills to a degree that they can design, develop and deliver their programmes mostly independently.

Following a participatory action research approach, Makercosmos aims at involving the art educators, the maker coaches and the teachers in research during their design, development and delivery of the lessons in all three phases of “the art of making”. There are two main research questions of maker education the research will eventually be addressing – how and what do students learn during the programme, and how does teachers’ resilience evolve in maker education. However, to properly be able to study these questions through participatory action research, a suitable research approach needs to be developed.

This study focused on the pilot phase at one of the schools. In this pilot, we wanted to experiment with how to best have teachers participate as researchers of their own condition in maker education. Of particular interest was what suitable tools were to collect evidence during the programme that could be used by the participants in a way that felt natural and that supported their main duties, namely delivering a maker education programme. The main data collection approach was guided by practices of the Reggio Emilia approach [3]. It was closely connected to students’ activities of documenting and discussing their design activities. However, as we knew from anecdotal experience from other projects and from own practice, and equally from what emerged from discussions with the arts educators and maker coaches in this study, the big question was how much “extra work” in terms of documenting, data gathering, reflecting etc. maker teachers could be asked to do in a situation when their main focus would have to be to immerse themselves in maker teaching – for many of them for the first time. So, the arts educators and maker coaches as first points of contact in the study were encouraged to go lightly on the requirements to document.

## 3 PARTICIPATORY RESEARCH – AS DEVELOPED

In the context of the lesson series “the art of making”, the teachers and art educators of one of the two participating schools decided to develop a series on sound machines, inspired by sound artists such as Jean Tinguely and Studio Zimoun. This group of teachers, maker coaches and aspiring arts teachers developed a series consisting of five steps in total seven lessons.

Throughout the series, the students were supposed to work in groups of three to four. According to the lesson plan (see also table 1), the series started with a lesson introducing the students

to sound by exploring sounds made with items they found in the classroom, presenting the steps of the series, and teaching how to control a servo motor with the micro:bit. The second lesson consisted of an introduction to sound artists and an activity in which students were asked to build basic machines that generated sound using the micro:bit and servo motors. For the technical details, one-page instruction sheets were used. The following lesson was used to generate ideas for sound machines, of which the students had to choose one and to describe it in more detail in the next lesson – the story of their idea, the techniques and materials they planned to use, their individual roles and contributions to the group, and the support they needed. In lessons five and six, the groups built and improved their sound machines, analysing the obstacles they encountered and how they dealt with them. The final lessons consisted of presentations of all the groups and a final, collective sound machine concert. For the use of the teachers, the whole series was described in a twelve-page lesson programme booklet, accompanied by an eight-page booklet with a collection of sound artists’ work for inspiration.<sup>1</sup>

Part of the lesson programme was also a four-page worksheet, called the “observatory”, for the student groups to document their progress. The worksheet provided space for jotting down ideas and observations, and there were several 3-point Likert scales the students were supposed to review the important learning rubrics per step, such as “techniques used”, “collaboration”, “inventors’ mentality” or “use of feedback” (see table 1).

Teachers attended an introductory afternoon where they were introduced to “the art of making” and given the opportunity to build their own sound machines. They were also given a short introduction into research on maker education – what the research questions were, what methods were available, and what documenting meant. As a starting point in developing the action research programme, we decided to ask teachers to take notes on their experiences with maker education – particularly when delivering the programme. To that end, they were given a notebook and were encouraged to document the developments in the lessons, dividing their notes into observations and reflections, and to answer four questions after each lesson: What happened? What did I feel? What are the insights? What are follow-up steps? (see figure 1).



**Figure 1: Minimal instructions to teachers for observations (left) and reflection (right). @ Peter Troxler, based on photograph © 2012, by Gratuit via [http://www.freeimageslive.co.uk/free\\_stock\\_image/blank-notebook-jpg](http://www.freeimageslive.co.uk/free_stock_image/blank-notebook-jpg), licensed under cc-by 3.0 unported.**

<sup>1</sup>The materials (in Dutch) are available from the Makercosmos website at <https://makercosmos.org/makersmissies/makersmissie-geluidsmachines/>

**Table 1: Sound machines lesson plan**

Step	Lesson	Issues for review
Explore	Introduction to sounds and to the micro:bit, use of the “observatory” <sup>a</sup> Sound artists; making sounds with micro:bit and servo motors	Techniques used Studying art
Flow of ideas	Developing multiple ideas for sound machines	Inspiration from art ... from technology Diverse ideas Collaboration
The plan	Selecting an idea and detailing is (basic story, techniques and materials needed, roles and contributions, help needed)	Use of art in the plan Level of detail in description
Make and test	Building a first prototype of the sound machine  Completing and improving the prototype	Inventor’s mentality Collaboration Use of feedback
Take the stage	Presenting the sound machines, sound machine concert	Presenting and sharing Creativity

<sup>a</sup>The “observatory” was a four-page worksheet that was supposed to guide the students through the process of building a sound machine and help them plan, document and reflect upon their work.

#### 4 PARTICIPATORY RESEARCH – AS DELIVERED (FINDINGS)

The series of lessons was delivered to six groups of students between September and November 2020. The lessons were given by two arts educators, each group was supported by their regular teacher. So, in total, eight educators were involved in the pilot. Briefly, we were hoping the teachers would be the sheep with five legs who simultaneously could teach, make, help, observe, and learn about maker education. However, of all eight participants, only one did actually keep a diary. Noting this situation, one of the arts educators took the initiative to ask colleagues for feedback after the lessons in their joint WhatsApp group – about strengths, points for improvement, and what students learnt. Also, the arts educator encouraged colleagues to share photos in the group. On 5 occasions, 4 different teachers posted verbal feedback, resulting in 5 strengths items, 5 points for improvement, and 9 items of what students learnt. There were 22 photos – of which 5 of pages in a notebook and 1 of a schedule – and 7 short video clips shared in the group.

This was certainly not the rich set of impressions and data points we had hoped to collect and to work with. So, when we held an online review session with the arts educators, the maker coaches and the teachers at the end of this first phase, we also addressed this approach to documentation and reflection. The teachers explained their experience with the notebooks, particularly that they were too busy helping students and getting surprised by what happened, so they forgot to document their observations. Yet they welcomed the WhatsApp approach. Also, the questions asked in the reminders were deemed clear; and while the answers were few, they were succinct and to the point.

While this study focuses on the research approach rather than the actual content of the lessons and the teaching setting, there is one salient parallel between the students’ and the teachers’ work. As we’ve seen, teachers did not make use of their notebooks to observe and reflect. Also, Teachers reported that students did hardly make

use of the “observatory”. They indicated that there was not sufficient time in the lessons to focus on the observatory. Teachers suggested this was the case because students regularly needed to finish their making assignments. Also, they thought that the observatory felt like a “mood killer” (sic!) as it would have diverted the students from the hands-on making activities to more traditional cognitive tasks.

#### 5 LESSONS LEARNT AND NEXT STEPS

The most interesting result of this pilot was not that what we designed and developed as research tool – the diary for observations and reflections and the guiding questions – was asking too much from teachers. Keeping notes in a booklet appeared to be something that not many teachers were regularly doing. Rather, the main outcome of this pilot is that moving the research part to the WhatsApp group – with actionable, timely reminders – actually prompted at least some teachers to respond. It’s also interesting to note that the reminders yielded more photos than verbal responses.

So, when we reviewed the first phase of the project together with the teachers, the arts educators and maker coaches, we also discussed the redesign of the research approach and collected a few ideas or design principles to explore – such as

- keeping the WhatsApp group as a research medium while reducing the numbers of things to observe to a minimum (e.g. one question per lesson),
- matching the observations with the content of the lessons,
- experimenting with gamifying the research (e.g. by putting the questions on cards and distribute them to the teachers),
- integrating the research more into teachers’ practice – for instance as a platform to show their pride or by adding a “tipster” to the group who could help teachers.

Regarding the overall design of the lessons, the teachers suggested that adding explicit reflection moments in the classroom could have a positive effect on the use of observatory – and on

research note taking. Other aspects to take into consideration are the spacial context of the lessons, and the role of arts educators and teachers in the classroom [1].

Obviously, using a digital communication tool to collect research notes feels like an unobtrusive and low hurdle solution. However, this approach brings a number of ethical caveats, particularly when using photos and videos. Since students will inevitably appear in such media, their informed consent to participate in the study is needed. Cultural sensitivities regarding taking pictures must be catered for. While WhatsApp provides end-to-end encryption, sharing research data through WhatsApp might bring some extra complications regarding the general data protection regulation (GDPR) in Europe and similar regulations elsewhere as communication metadata (not content) is monitored.

The next step in the development of “the art of making” is the design and development of the second phase in which teachers will deliver the making lessons themselves. Still, the ambition is to combine research with teaching. To this end, teachers will be involved not only in designing the lessons for the next phase of the programme, but also in devising ways to document and study classroom activities. Based on the experiences in the pilot, the above design suggestions will be used. Specifically, we will hold a co-creation session with the teachers, the arts educators and maker coaches to work on that next phase, and specifically on redesigning the research approach.

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## REFERENCES

- [1] Wolmet Barendregt, Peter Börjesson, Eva Eriksson, Olof Torgersson, Tilde Bekker, and Helle Marie Skovbjerg. 2018. Modelling the roles of designers and teaching staff when doing participatory design with children in special education. In *Proceedings of the 15th Participatory Design Conference: Full Papers - Volume 1 (PDC '18)*. Association for Computing Machinery, New York, NY, USA, 1–11. <https://doi.org/10.1145/3210586.3210589>
- [2] Fabio Campos, Tatiana Soster, and Paulo Blikstein. 2019. Sorry, I Was in Teacher Mode Today: Pivotal Tensions and Contradictory Discourses in Real-World Implementations of School Makerspaces. In *Proceedings of FabLearn 2019 (FL2019)*. Association for Computing Machinery, New York, NY, USA, 96–103. <https://doi.org/10.1145/3311890.3311903>
- [3] George Forman and Brenda Fyfe. 2011. Negotiated Learning through Design, Documentation, and Discourse. In *The hundred languages of children : The Reggio emilia experience in transformation*. ABC-CLIO, LLC, Westport, 247–271.
- [4] Mikkel Hjorth, Rachel Charlotte Smith, Daria Loi, Ole Sejer Iversen, and Kasper Skov Christensen. 2016. Educating the Reflective Educator: Design Processes and Digital Fabrication for the Classroom. In *Proceedings of the 6th Annual Conference on Creativity and Fabrication in Education (FabLearn)*. Association for Computing Machinery, New York, NY, USA, 26–33. <https://doi.org/10.1145/3003397.3003401> tex.ids= HjorthEducatingReflectiveEducator2016.
- [5] Peter Troxler, Eva Visser, and Maarten Hennekes. 2018. *Roadmap makerplaatsen. Van knutselen 2.0 naar leren met 21ste eeuwse vaardigheden*. Kenniscentrum Creating 010, Rotterdam. <https://www.narcis.nl/publication/RecordID/oai%3A05df5728-c833-46cd-88de-799e67abe0e9>