MAKING AT SCHOOL: EXPERIENCES FROM THE DESIGN-BASED RESEARCH PROJECT

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This paper explores the transformative potential of Making in fostering self-guided, hands-on learning among students in grades 5 to 9. It presents the two-year initiative, "Making at School", wherein Zurich University of Teacher Education (PHZH) created and tested different Maker Education scenarios. A cohort of 13 educators received professional development, subsequently implementing the designed scenarios across approximately 60 classes, thereby engaging around 600 students. Applying the principles of design-based research, the training programs were iteratively enhanced, leveraging methods including teacher interviews, focus group discussions, and student questionnaires. Preliminary results indicate that while educators could introduce new concepts within their classrooms successfully, there emerged a need for additional support, particularly for advanced courses.

Keywords and Phrases: Maker Education, Teacher Development, Maker Tools, Design-Based Research, Embroidery Designer

1 INTRODUCTION

Maker Education is becoming increasingly important in education that is being initiated and developed in the educational community (Schön, Ebner and Kumar, 2020; Schad and Jones, 2020). Making - the process of tinkering, designing, and crafting with digital tools - creates opportunities to engage students, teachers, and pupils in problem-oriented approaches through creative project work in an open learning environment, bringing together disciplines such as computer science, natural sciences, art, and technical/textile design (Schön/Ebner 2020). In computer science, the focus is on process-oriented assessment and a fearless failure culture with open tasks for creative problem-solving in the sense of computational or design-based thinking (Schön, Ebner, and Kumar, 2014). As part of a digitalization strategy, Making enables learners to build a bridge between the digital and analog worlds.

With the introduction of the Swiss Curriculum 21 (lehrplan21.ch) in German-speaking Switzerland, a strong focus on general competences and future-oriented skills such as creativity has been observed in schools (Petko, Döbeli-Honegger, and Prasse, 2018). Here, Making offers children and young people the opportunity to engage in the production of creative designs or digital projects. However, Making is still in its early stages in schools and many teachers are not familiar with the concepts (Maurer and Ingold, 2019). The few existing tools and applications either assume that teachers have prior knowledge and understanding of Maker concepts, or they are limited to single, self-contained activities. Making, therefore mostly takes place in workshops or electives and is rarely recognized as a holistic teaching concept.

In this paper, we would like to share our first experiences from the “Making at School” project and provide insights into the five workshops designed for teachers.

2 THE “MAKING AT SCHOOL” PROJECT

The project "Making at School” (explore-making.ch) is a two-year research and development project of various Maker courses for school levels 5-9, supported by the Digitization Initiative of Zurich Universities (dizh.ch). The innovative aspect of this project is the interdisciplinary approach of the Maker activities by including natural sciences, robotics, art, and design. In the following, the five courses developed in the project are presented alongside the relevant literature.

2.1 Making Basics & Methods

The basic course consisted of two parts and was conducted in March and May 2022 (3.5 hours each). The aim for teachers was to build an understanding of Making and to become familiar with different Making tasks (Schön, Ebner, and Narr, 2021). Teachers were encouraged to learn about and try out methods such as design-thinking or documentation options (e.g., with BookCreator). To support teachers, an instrument was developed that structures the planning process while providing ideas for specifications, methods, and topics (Spieler et al., 2022). Between the two courses, the participants carried out their own teaching projects. The following 8 projects were carried out: masks were crafted for the school ball, materials were recycled and made into games or decorations, towers were built from different materials, and they used creativity against digital terror (e.g., surveillance) was designed in textile designs (see Figure 1).

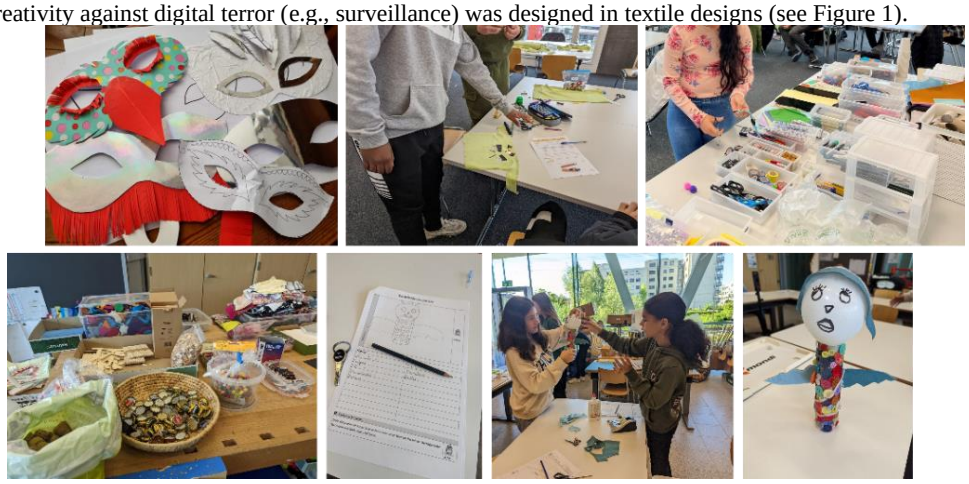

Figure 1: 1a: Masquerade. 1b-c. Textile creativity. 1d-g: Upcycling. (CC-BY-SA 4.0 “Making im Unterricht”)

2.2 Making & Digital Fabrication

"Rapid tooling" machines such as 3D printers, CNC machines, or laser cutters are very common in Makerspaces. Laser cutters and 3D printers in particular offer the potential to realize creative and innovative projects in form of "digital fabrication" (Iversen et al., 2015; Iivari et al., 2016). A specific course followed in August 2022: "Lasercutter 1x1". During the course, the online tool "vectr.com" was used. An introduction to the laser cutter was given and the possibilities of using different materials such as glass, wood, or acrylic were discussed. The implementation in the classroom, as well as challenges and opportunities, were addressed.

A 3D printing course was introduced in March 2023. This time the participants used “TinkerCad”. It started analogously with different shapes from which an animal or building was to be built. In addition, examples were shown, and own ideas were implemented. This time 6 teachers did projects with their class using the laser cutter. For example, key rings and other shapes, or Christmas tree decorations with the "word of the class" and fruits were cut into pieces, scanned, and cut out to create lights (see Figure 2). Classroom projects with the 3D printer are still ongoing.

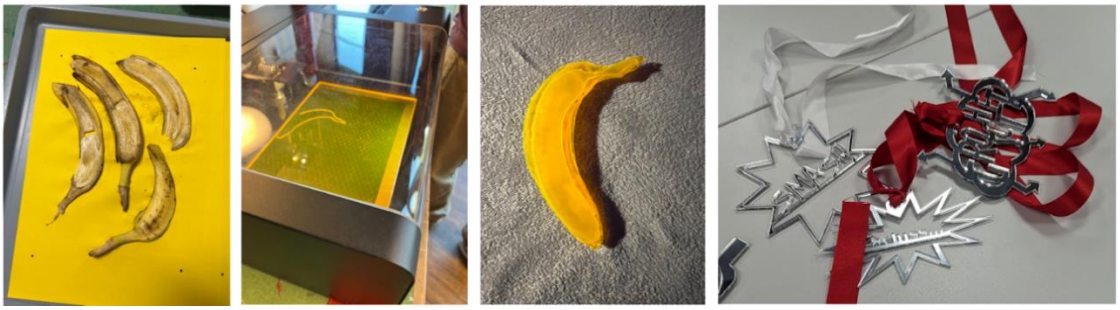

Figure 2: 2a-c: Cut out fruits. 2d.: Christmas tree ornaments. (CC-BY-SA 4.0 “Making im Unterricht”)

2.3 Making & Digital Pattern Creation

The concept of digital patterns implemented with an embroidery machine is not new. The Vienna-based project TurtleStitch (Wolz, Auschauer and Mayr-Stalder, 2019) already presented this idea in 2015, and the Maker movement has also become aware of these possibilities. With the development of various physical computer products, digital fashion can also become wearable and interactive (Kafai et al., 2021). For example, embroidered fabrics can be equipped with conductive threads or LED lights, turning them into “e-textiles” or "smart wearables".

In the advanced course "Digital Patterns" the focus was again on the workflow: from one's own sketch to the embroidered fabric (Spieler et al., 2020). An important step in this process is abstraction (Angeli and Giannakos, 2020). This means simplifying the design step by step and transforming complex designs into the simplest possible programmable geometric shapes (e.g., circles, lines). Since most of the teachers had no programming experience, the introduction to the app Embroidery Designer was less a free experimentation and more a step-by-step programming. Three teachers have tested this way of Making in class. The students either created their own designs or made programmable patterns from the children's wire faces (see Figure 3).

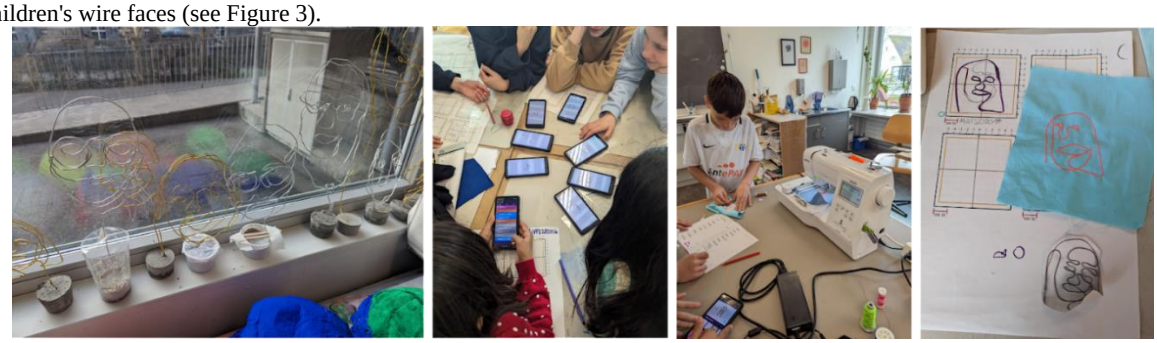

Figure 3: Digitized wire portraits. (CC-BY-SA 4.0 “Making im Unterricht”)

2.4 Making & Physical Computing

Physical computing projects overlap with other disciplines such as textile and engineering design, art, science, and technology (Grillenberger, 2023). Microcomputers, e.g. BBC micro:bits, are specifically designed for educational purposes to enable hands-on experimentation and exploration and to show how to connect the physical and virtual worlds (Hodges et al., 2020). This course was piloted with educators in March 2023. Participants received an introduction to micro:bit, sensors, and actuators and learned how to integrate them into their lessons. This time, teachers with a background in science subjects were explicitly targeted. In June 2023, projects (e.g., class mascots) will be carried out with two teachers.

3 DISCUSSION & CONCLUSION

This intensive two-year mentoring of teachers has led to a certain rethinking and increase in competence. In particular, the teachers from the area of technical/textile design became familiar with modern technical tools, programs, and programming and felt able to try them out independently with their classes. However, it also became clear that the teachers wished for more intensive support and guidance, especially with previously unknown tools.

For this reason, a room is currently being set up at PHZH as a Makerspace, which will be available to students, teachers, and classes. Many participating teachers would also like to set up a Makerspace at their school and face similar challenges. With the experience we are gaining in planning the Makerspace, we can provide teachers with targeted support for their projects and offer additional advice in Making.

ACKNOWLEDGMENTS

This work has been partially funded by Digitalization Initiative Zurich Universities (https://dizh.ch/2022/01/03/making-im-unterricht/).

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