Creative, Engaging, and Playful Making-Activities with Smartphones and Embroidery Machines

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ABSTRACT

Smartphones have become the predominant way many students interact online, and mobile apps offer an ideal way to engage this audience. The Catrobat apps are used in this area, particularly for creating apps and thus teaching basic programming skills. During the "Code'n'Stitch" project, the apps have been extended with the creation of patterns, geometric, and artistic textile designs, as well as the programming of traditional embroidery machines. In this way, students not only learn programming, but they can also show the results of their code in a tangible way, embroidered on their shirts or bags. To take the idea of "Making" further, a combination with a sewing machine is possible: Fabrics can first be embroidered with programmed designs and then sewn into "cherry pit pillows". This idea was successfully integrated for the "Maker Days for Kids" event at Graz University of Technology in 2019 and 2020.

CCS CONCEPTS

• **Applied computing → Interactive learning environments**;
• **Social and professional topics → Gender**.

KEYWORDS

creative coding, programming, mobile programming, gender, digital designs

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1 INTRODUCTION

The focus of the European education system is more than ever on the education and training of teachers and students in the acquisition of computer literacy skills [2]. Students should not only be able to use computers in a meaningful way but also develop critical thinking and problem-solving skills, particularly Computational Thinking (CT) skills such as algorithmic and abstract thinking [12]. Critical and creative thinking was identified by the OECD as essential skills for 2030 in preparing students to face the present and future challenges of digitalization [3]. Making can create new opportunities to introduce students to such new concepts in a playful and experimental way [1, 6]. However, Making is not about merely reproducing projects, but about enabling constructionist learning. In this way, individual ideas are implemented and innovatively realized, for example, in the form of projects. Therefore, another critical aspect is creating safe and open learning environments in schools and considering that students have different prior knowledge in programming and computer science, or have different approaches in tinkering [8].

2 BACKGROUND

The Austrian FEMtech project "Code'n'Stitch"[1] (2018-2020) was a two-year funding program of the Austrian Federal Ministry of Transport, Innovation and Technology to promote equal opportunities for women in research and technology and to increase awareness and visibility. As part of this project, several programming and embroidery workshops at schools were conducted from September 2019 to March 2020 in grades 6 to 8 (ages 13-15). During this project, we explored how to effectively support non-Computer Science teachers in such coding activities with suitable teaching materials while navigating the difficulties in transferring designs initially drawn on paper to programmed artefacts. The main methods used during the exploratory workshops included on-site observation notes, questionnaires, interviews with focus groups, and analysis of the students' designs [9]. Figure 1 shows impressions of school workshops. Furthermore, during the "Maker Days for Kids" events in 2019 and 2020 at Graz University of Technology, the Catrobat apps were used for the purpose of introducing students to the basics of programming while creating a gaming app and for creating patterns [8].

The underlying FOSS (Free and Open Source Software) Catrobat project[2] was initialized in 2010 at Graz University of Technology in Austria at the Institute for Software Technology. One of our Catrobat apps is Pocket Code, a learning and programming environment to introduce young people to the world of programming in a fun and innovative way [7].

3 WORKSHOP DESCRIPTION

The idea of a constructionist learning environment can be summarized as learning through direct experience, hands-on activities, tinkering, and creative inventions [4]. In this workshop, we will

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[1] See instructions and tutorials: https://catrob.at/codeNstitch
[2] Catrobat project: https://catrobat.org

Figure 1: Program creative designs and patterns on smartphones. CC BY-SA 4.0 Catroat Association

try to combine many of these factors. Even though it will be conducted online, we will focus on creating an interactive learning environment, showing applicable project ideas for school purposes, and providing opportunities for Maker Education. Our workshop is well aligned with the theme of Making, as it shows possible combinations with other subjects such as mathematics or crafts. Thus, the workshop is not only interesting for computer science teachers, but for everyone who likes the idea of creating open and creative learning environments in combination with handicrafts, fabrics and programming. We also welcome participation from researchers and teachers who have little to no knowledge in programming and want to work in an interdisciplinary way. This may include teachers and researchers from various subjects and backgrounds in learning science or pedagogy in general.

3.1 Intended Goals

The objectives of the workshop are:

- to explore simple ways to learn the absolute basics of programming to create digital patterns.
- to provide a connection to mathematics through shapes: circles, geometric figures, polygons, stars, and ohter patterns.
- to look at the design workflow for creating personalized patterns in school classes.
- to experience new ways of doing interdisciplinary projects in open maker settings.
- to create a small, personalized pattern.

3.2 Format and Outline

In this interactive session, we will present the learning apps Pocket Code and Embroider Designer to introduce programming in a fun and innovative way. The learning tools offer many opportunities to express creativity and to code personalized apps such as games, music videos, animations, or digital designs with different coding blocks, extensions, and figures. The apps have been used in many different school subjects, for example, arts, physics, or computer science [11].

Programmes are easily created without the need for previous knowledge by utilizing simple graphical blocks, like in the well-known programming environment Scratch [5]. In contrast, our apps do not require a laptop or PC, but only a smartphone. In addition, the apps access many sensors such as inclination, GPS, or compass direction and have further extensions, for example, for Lego NXT/EV3 robots, drones, Arduino, or embroidery machines.

We plan a 90-minute workshop with the following components:

3.3 The Design Workflow

The individual steps of the Design Workflow are described below:

(1) select a design
(2) simplify the design
(3) draw it (optional)
(4) code it
(5) export embroidery file
(6) stitch the design with an embroidery machine

For the first step, students should be given enough time to research their ideas on the Internet and come up with possible designs. Teachers can inform students about geometric shapes, formulas, different types of embroidery (running stitch, triple stitch, zigzag stitch, etc.) and different textiles. For the second step, it is important to think about “programmable designs". Patterns such as hearts, simple composite designs of squares and circles, drawings that consist of straight lines, and drawings that have few curves were rated as “good” for programming, see Figure 2 and Figure 3.

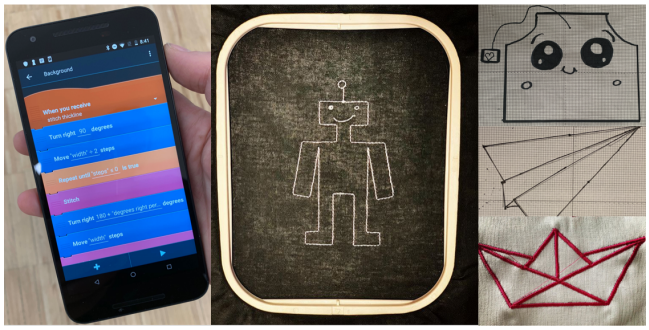

Figure 2: a. Programming bricks in Pocket Code for stitching a star. b. Simple patterns consisting of lines. CC BY-SA 4.0 Catroat Association

Figure 3: Geometric patterns. CC BY-SA 4.0 Catroat Association

Example of a Design Workflow: A student wants to program a bicycle. While researching the Internet, the image in Figure 4a is found. The next step is to consider what geometric patterns to use. A simplified bicycle consists of three circles connected by straight lines, see Figure 4b and Figure 4c. This preliminary planning is helpful for later programming. Figure 4d shows the finished pattern on fabric.

Additionally, emphasis is placed on a gender-appropriate guidelines and concepts [10]. On the one hand, the aim is to show young women new ways of using technology, in a fun and sustainable way. On the other hand, young men can also be inspired by this digital design process and the possibility of new challenges in textile handwork lessons.

Table 1: Detailed schedule of the workshop

Time	Activity
5’	Short introduction of the organizers and the project.
15’	Basic introduction to the Catrobat Apps and programming.
10’	Presentation of the design workflow: selecting a pattern, simplifying the design, programming, stitching.
10’	Multidisciplinary teaching: mathematics, handicrafts, computer science.
40’	Live-demonstration of the embroidery machine and hands-on programming session.
5’	Presenting results of classroom projects and the “Maker Days for Kids” event.
5’	Outlook and Closing.

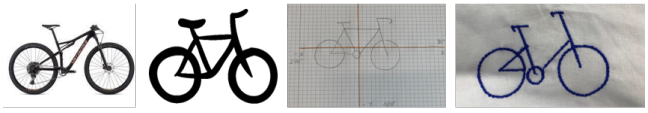

Figure 4: a. Bicycle from internet search b./c. Simplified bicycle d. Embroidered pattern on fabric. CC BY-SA 4.0 Catroat Association

3.4 Requirements and Resources

For this activity, participants should have a smartphone or tablet and should download either the app Embroidery Designer for Android devices (https://catrob.at/ED) or the app Pocket Code for iOS devices (https://catrob.at/PCios). We suggest holding this workshop with a maximum of 15 to 20 participants.

4 ORGANIZERS’ BIOS AND CONTACTS

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Bernadette Spieler holds the position of a Professor of Computing Skills in Education at Zurich University of Teacher Education in Zurich, Switzerland. To strengthen Computer Science education, this professorship is situated at two centers: 1) “Media Education and Computer Science" to develop new concepts for teacher education and training in Computer Science and 2) “Education and digital Transformation", researching the effects of digitization on schools and education. In 2020, she was at the Institute for Mathematics and Applied Informatics at the University of Hildesheim, Germany as a visiting professor in Computer Science Didactics. She had previously worked at Graz University of Technology, Austria, Department of Software Technology as a postdoctoral researcher. At TU Graz, she is still part of the product owner board of the Catrobat project. Her work focused on how to engage teenagers in playful computer science activities, with the dedication to enhance the experiences of girls in particular

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Vesna Krnjic is a postdoc research assistant at Graz University of Technology and Product Owner member of the Catrobat Project. Her research focuses on the aspect of human-computer interaction, especially with regard to usability, security, and protection of private data for adults and teenagers.

5 CALL FOR PARTICIPATION

The target audience for this workshop is secondary school teachers and educators from different subjects and anyone interested in the possibilities of creating digital fabrication for Maker Spaces or creative open learning settings. Participants will experiment with coding concepts to create different shapes and patterns. This highly creative process could also be used as a cross-curricular approach in schools; for example, this could be utilized in craft or mathematics classes. The Catrobat apps Embroidery Designer for Android devices (https://catrob.at/ED) or the Pocket Code app for iOS devices (https://catrob.at/PCios) are used to create these designs. These apps allow users to easily program patterns directly on their mobile devices. Through the “Lego”-style visual programming language, users can assemble code bricks into different shapes and designs that can later be stitched using traditional embroidery machines. Through this process, our apps focus on teaching computer skills, developing computational thinking, and promoting creativity.

REFERENCES

[1] Edward P. Clapp, Jessica Ross, Jennifer O. Ryan, and Shari Tishman. 2016. Maker-Centered Learning: Empowering Young People to Shape Their Worlds. *Jossey-Bass, San Franzisco* (2016).

[2] Committee on European Computing Education (CECE). 2017. Informatics Education in Europe: Are We All In The Same Boat? . Report by The Committee on European Computing Education. Jointly established by Informatics Europe & ACM Europe, https://www.informatics-europe.org/component/phocadownload/category/10-reports.html?download=60:cece-report. Last accessed 16 February 2021.

[3] OECD. 2019. OECD Future of Education and Skills 2030 - Conceptual learning framework. https://www.oecd.org/education/2030-project/teaching-and-learning/learning/skills/Skills_for_2030_concept_note.pdf, Last accessed 22 March 2021.

[4] Seymour Papert. 1985. Mindstorms: Children, Computers, and Powerful Ideas. *Basic Books, Inc* (1985).

[5] Mitch Resnick, John Melony, Andres Monroy-Hernandez, Natalie Rusk, Evelyn Eastmond, Karen Brennan, Amon Miller, Eric Rosenbaum, Jay Silver, Brian Silverman, and Yasmin Kafai. 2009. Scratch: programming for all. *In Commun. ACM* 52, 11 (2009), 60–67.

[6] Sandra Schön, Martin Ebner, and Swapna Kumar. 2014. The Maker Movement. Implications of new digital gadgets, fabrication tools and spaces for creative learning and teaching. *eLearning Papers* 39 (2014), 14–25.

[7] Wolfgang Slany, Kirshan Luhana, Matthias Müller, Christian Schindler, and Bernadette Spieler. 2018. Rock Bottom, the World, the Sky: Catrobat, an Extremely Large-scale and Long-term Visual Coding Project Relying Purely on Smartphones. *In Proceedings of Constructionism* (2018).

[8] Bernadette Spieler, Maria Grandl, and Vesna Krnjic. 2020. The hAPPy-Lab: A Gender-Conscious Way To Learn Coding Basics in an Open Makerspace Setting. *International Conference on Informatics in School: Situation, Evaluation, Problems,* (2020), 1–12.

[9] Bernadette Spieler, Vesna Krnjic, Wolfgang Slany, Karin Horneck, and Ute Neudorfer. 2020. Design, Code, Stitch, Wear, and Show It! Mobile Visual Pattern Design in School Contexts. *Frontiers in Education (FIE)* (2020).

[10] Bernadette Spieler, Libora Oates-Induchova, and Wolfgang Slany. 2020. Female Teenagers in Computer Science Education: Understanding Stereotypes, Negative Impacts, and Positive Motivation. *Journal of Women and Minorities in Science and Engineering* 26, 5 (2020), 473–510.

[11] Bernadette Spieler, Christian Schindler, Wolfgang Slany, Olena Mashinska, Maria Eugenia Beltran, Helana Boulton, and David Brown. 2017. Evaluation of Game Templates to support Programming Activities in Schools. *In Proceedings of the 11th European Conference on Games Based Learning* (2017), 600–609.

[12] Jannette Wing. 2006. Computational Thinking. *Commun. ACM* 49, 3 (2006), 33–35.