Programming as a New Creative Material in Art and Design Education

Stephanie Hoebeke, Ingri Strand and Peter Haakonsen

The purpose of this study was to look at whether programming should be introduced as a new material in Art and crafts education in Norway. Programming has here been linked to creative coding, where it is classified as a new creative material whose purpose is to create something expressive rather than functional. The empirical data was gathered through four semi-structured interviews. The participants were chosen through purposive sampling, based on their knowledge of programming in either art or in Art and crafts education. The result showed that pupils should be taught the particularities of each material, also when it comes to programming. Programming as a material was also described as relevant, accessible, and important for pupils' everyday lives. However, the fields' attitudes also show a resistance against ICT and teachers are more focused on developing pupils' skills in traditional material and craftsmanship and tactile experiences. Thus, it may be seen as a contradiction to introduce programming as a material, especially when creating digital expressions. At the same time, programming in Art and crafts have potential as a tool for in-depth learning and creative problem solving.

Keywords: Programming, Art, Creative coding, Art and crafts education.

Introduction

The rapid development of technology is something that affects most disciplines in one way or another. This has also been the case in art and design, where new fields have been created by new technology, such as game development, interactive media, multimedia and web development. Technology as a subject has long been discussed in school curriculum. Sanne et al. (2016) states that digital technology is such a central part of both technology and today's society that schools must describe and provide a clearer space for digital technology and programming. Discussions about programming in schools, also related to art subjects, have had an impact on curriculums. Programming is an explicit part of the Art and crafts subject in the Norwegian curriculum implemented in 2020-2021.

This paper is based on a study that aimed to find causal explanations to why programming should be implemented in the Norwegian subject of Arts and crafts. It builds upon data from four research interviews conducted in the autumn of 2018. The study showed that computational thinking and programming has much to offer to art and design education. Programming can teach pupils in-depth learning about key concepts in Art and crafts and the algorithmic components in the subject. Programming can also broaden the knowledge of and skills in different materials and provide the opportunity for the student to learn complex design concepts with interaction. The study also found that education should relate to the pupils' everyday life and that programming could give such an opportunity, that programming is a sought-after skill and that pupils should learn to critically create in a democratic way. In this article we will highlight and discuss the knowledge of different material and relating the Art and crafts subject to the pupil's everyday life.

Programming interpreted through art

Aaron D. Knochel og Ryan M. Patton, scientists in new media in art education, claim that pupils should work creatively with coding and electronics, in order to experience new materials within art as well as developing a critical attitude in creating with technology. They argue that 'Coding is not only a technical practice or a series of steps to implement mathematical algorithms, but rather a process of design informed through social, political, and cultural frameworks' (Knochel & Patton, 2015, s. 28). The same ideas are also represented in arguments about changing STEM to STEAM. Georgette Yakman (2008), a founder and researcher behind STEAM, defines STEAM: 'Science and Technology, interpreted through Engineering and the Arts, all based in a language of Mathematics' (Yakman, 2008, s. 18). This builds upon the idea that technology and programming should be seen in a context, such as art education.

Associate professor Jon Hoem teaches and researches new digital media at Western Norway University of Applied Sciences (HVL). He argues that programming is more than STEM (Hoem, 2017a; 2017b), it is also a craft and a means of expression, and refers to the term meaningware. While software and hardware can be difficult to place anywhere else than in the field of science, as soon as they are used for something, we must start talking about meaningware.

At the Art and crafts conference in 2017, Torgeir Waterhouse, director of Internet and new media in ICT-Norway, suggested Arts and Crafts as the most important subject when it comes to technology (Waterhouse, personal communication, 27. January 2017). This is because the subject provides expertise in the meeting between technology and people. Technological development also requires an understanding of e.g. design, communication, colour and visual communication, according to Waterhouse. Technology is often associated with design in the Norwegian primary school, but still programming, computational thinking and coding might get more attention in the science subjects, rather than in practical-aesthetic subjects. The question then becomes, which position should it have in art education?

Creative coding

Some projects have used creative activities to teach programming, with a goal to create physical objects with integrated technology and programming, or animations and video games based on programming. Research shows that students often have a positive experience of a creative framework and that it is a good way to promote and teach programming (Adams, 2007; Burke & Kafai, 2010; Giannakos, Jaccheri & Proto 2013; Knobelsdorf & Romeike, 2008; Lau, Nagai, Chan & Cheung, 2009;). Such an approach can nevertheless be said to be using the subject as a framework for learning programming, and not learning programming on the subject's premise

There are branches within today's art institution where programming has become part of the development of artwork. Creative coding is a term that is often used in the context of art. There are also several articles describing how creative coding has been used in art-related teaching, or why it should be part of art education (Greenberg, Kumar & Xu, 2012; Knochel & Patton, 2015; Peppler & Kafai, 2009). When talking about creative coding, programming is often referred to as a new material whose purpose is to create something expressive rather than functional (Artut, 2017; Knochel & Patton, 2015; Maeda, 2000; Reas & Fry, 2006;)

The development in art and art education

The development of art after the modern period is strongly linked to the development of the latest technology, according to Selcuk Artut (2017), artist in new media. He questions whether current art education should have technology as part of the education. Artut concludes that programming should be implemented as a new material for creating art in teaching. Kylie Peppler, associate professor of computer science and education, and Yasmin B. Kafai, researcher on programming in design-related topics and one of the early developers of the programming language Scratch, believes that art education at the elementary school has not followed the evolution of contemporary art practice. They write:

> (...) multimedia design, particularly that which uses Adobe Photoshop and Hyperstudio software, have been taken as the main artistic expressions of digital media in primary and secondary educational settings, whereas professional artists are using advanced programming to manipulate and create digital expressions. If there is any movement in education, it has not paralleled the developments in professional art. (Peppler & Kafai, 2009, p. 1).

The field's attitudes also show a resistance against ICT and that teachers are more focused on developing pupils' skills in traditional materials, craftsmanship and tactile experiences (Strand & Nielsen, 2018).

Method

Four semi-structured interviews (Brinkmann & Kvale, 2015) were conducted in October-December 2018. One via e-mail and GoogleDocs, where the informant got the questions on e-mail and replied through GoogleDocs, where he also got follow-up questions. The other three interviews were conducted in person, recorded and later transcribed. For the purpose of this paper, transcriptions have been translated from Norwegian to English by the main author. All interviews were based on an interview guide, but some of the questions were customized each informant's expertise. The questions dealt with whether programming should be implemented in primary school and, if so, whether it has a place in arts and crafts. Questions were also asked about why the informants thought or did not think that programming should become part of the subject and what role it should play.

Semi-structured interviews were chosen because of the opportunity to ask open-ended questions, to which the informants could choose the direction of their answer, as well as the possibility to ask follow-up questions (Brinkmann & Kvale, 2015). Possible consequences of interviewing one informant via text-media were that the answers were less detailed and nuanced, but at the same time they might have gotten more precise, as he got time to think and reflect on the questions.

The participants were chosen through purposive sampling (Bryman, 2016) based on their knowledge of programming in either art or in Art and crafts education. There are two reasons why the informants were not anonymized. First, the informants' knowledge and position will have a bearing on the credibility of the study and the answers. Secondly, at the time of the study there were few people in Norway with knowledge about programming, primary school and Arts and crafts, and on this basis, it could be difficult to anonymize. With the consent of each informant, as well as an approval from the Norwegian Centre For Research Data, table 1 presents their names, profession, experiences and education at the time the interviews were conducted.

Table 1: Information about the participant in the study (2019)

Participants' name	Description of background, in relation to programming and Art and craft
Anette Seip	Teacher in Art and crafts and the elective subjects Programming and Work-related training, with a Master's degree in Design, art and crafts. She has worked as a teacher since 2013 and is also an initiator of the school's Makerspace.
Roger Antonsen	Associate professor at the Department of Informatics, University of Oslo and guest lecturer at UC Berkeley, California. He has written the book "Logical Methods" as well as the writer of a recurring column about mathematics and pattern in the Norwegian national newspaper Aftenposten. He has worked on several projects concerning mathematics, informatics, philosophy and art, such as the YouTube-series "Magiske mønstre" [Magical Patterns]. As an artist he creates art based on mathematical structures through programming. His art has e.g. been shown at Catharine Clark Gallery in San Francisco in 2019.
Liv Klakegg Dahlin	Head of studies and lecturer at the Department of Art, Design and Drama, Oslo Metropolitan University. On behalf of the Directorate of Education, she has led the work on developing core elements in the Art and crafts subject and is now leading the work on the new curriculum reform in Art and crafts. She has also written several books on technology and design, as well as digital media in school.
Jon Øyvind Hoem	Associate professor at the Department of Arts Education, Western Norway University of Applied Sciences. He has a ph.d. in ICT and learning and does research on robot-assisted teaching, spherical media, exploration of interactive installation art and the use of mobile technology. Hoem has also written about programming and Art and crafts on the Western Norway University of Applied Sciences' blog.

The study was conducted from the perspective of critical realism (Bhaskar, 2008). Within this paradigm, there are no specific guidelines for analyzing empirical data, nor was programming in Art and crafts a much-explored field. On this basis, a grounded approach was chosen instead of sorting the empirical data into an existing framework (Bygstad & Munkvold, 2011). The analysis started by marking interesting and relevant sentences from the transcribed interview in Microsoft Word. These sentences were accordingly sorted in different categories, where the answers had something in common. The categories may have been influenced by the interview guide and reflections made on the basis of the theory. The six categories that emerged from the analysis were: a) programming could actualize arts and crafts, b) it can create awareness about the technology students use every day, c) to gain experience with a design process where technology is part of the product, d) gain an understanding of the uniqueness of different materials, e) get competence in interdisciplinarity and f) that combining programming with art and design can contribute to a positive development for programming. In the analysis, possible limiting factors that may make implementing programming in Arts and crafts difficult were also found. These were that the field has a different focus and a lack of competence, that it can contribute to more electronic littering, that equipment and competence will cost a lot and that something else must be taken out of the subject, but as mentioned in the introduction, this is not the focus of the paper and will not be presented to a greater extent. In this paper, categories b) and d) will be presented and discussed.

Results

As mentioned above, the analysis showed several categories. We will present the findings that programming can lead to a greater understanding of what a material is in arts and crafts, but also that the subject must relate to the students' everyday life and that programming can provide such a platform

The uniqueness of programming as a material

In this category, data were collected which indicated that programming could be seen as a separate material. In the subject of Art and crafts, material knowledge and understanding is valued, and it is important to facilitate that pupils gain insight into different materials. The informants still had different views on what they saw as programming's uniqueness linked to the subject. In the interview, Roger Antonsen links programming both to the fact that programming can be a distinctive tool for exploring patterns and forms, but also that it is a unique way of expressing oneself. When Antonsen talks about programming as a tool or material for expressing oneself, he talks about speed and number of operations, as well as parameterization and finding constants. He is interested in each tool's unique nature, and that is something the pupils should learn. He also emphasizes that it is when the computer can help us do something more, it becomes interesting to use a computer and possibly programming. Antonsen also adds another dimension to the distinctiveness of programming, namely generative mechanisms and procedural processes. Jon Øyvind Hoem focuses less on the peculiarities of programming but emphasizes that it is a good tool for making audio-visual expressions. Audio-visual expressions, as we understand it, can be e.g. games and animation. Both Hoem and Antonsen say that if something can be solved without programming, there is no point in using programming.

Programming makes it possible to create objects with integrated technology and give pupils the opportunity to work on tasks where they need to think about form and function. When the informants talk about function, they mention, among other things, interaction, mobility, sensors or other technological functions. This is mainly where the focus of Hoem, Liv Klakegg Dahlin and Anette Seip lies when they talk about what pupils should do with programming. Although they give examples on working within visual representations, they mainly talk about physical products with programmed parts. Here, emphasis is placed on physical artefacts with which it is possible to interact or physical objects that have mobility. When it comes to interaction, sensors are cited as an example, and both Dahlin and Seip link it to e-textiles.

Updating Arts and crafts education and relating it to students' everyday lives

Based on three of the informants' opinions, programming has an opportunity to make Art and crafts more current, link the subject to the everyday life of the students and that outsiders may see the relevance of the subject to a greater extent. Both Hoem and Dahlin emphasize that the pupils must meet technology in school that they will later meet in working life. They are also aware that Art and Crafts may focus too much on tradition, with Hoem adding that it might decrease the subject's value in society later. Hoem and Seip mention that programming might capture the attention of more students and relate the teaching to the students' everyday lives. Seip says:

> You can catch an entire class who may either get bored in the subject, or feel that they are not getting enough challenges, or do not like the traditional techniques. [Pupils] feel more met at their level because we are working on something that is related to what they are doing. If we create a computer game, they will automatically think 'Oh! I do this at home, the teacher understands me, she is not just an old person.

Hoem says he is not concerned about which materials the pupils should use in art and design education, as long as they are able to create something based on their own ideas and needs. It may seem as if Hoem thinks it is important to teach pupils processes and techniques in how to create, instead of focusing on

which materials or tools they use. Hoem believes it may be desirable to relate the tools and materials to pupils' everyday lives. Here he also points out that much is changing around the pupils, saying 'children and young people create with digital tools and Art and Crafts must seize this'.

Discussion

Art and crafts is a subject that emphasizes knowledge and skills in various materials and tools. As Antonsen states in his interview, programming can be seen as a material to create with. As mentioned before, programming in Art and crafts can be understood as a material whose purpose is to create something expressive rather than functional (Artut, 2017; Knochel & Patton, 2015; Maeda, 2000; Reas & Fry, 2006). Antonsen illustrates that it is important that pupils get to know the particularities of each material. Having pupils develop knowledge and skills in different materials can help them make decisions about which materials are most appropriate to use for different tasks. In the interviews, Antonsen emphasizes the creation of expressions that require many operations and speed, but also the creation of expressions with embedded structures, such as patterns. Hoem aims instead at programming well suited to create audio-visual expressions. One idea that the informants have in common, especially Hoem and Seip, is to provide pupils with craftsmanship from materials that are relevant, accessible and important to their lives. In this context, the informants mention that programming and technology can be examples of such materials. Knochel and Patton (2015) also elucidate this by saying '(...) we believe students would derive deeper understanding across disciplines and mediums by learning to code as part of their artistic practice' (Knochel & Patton, 2015, p. 26). In a world that increasingly incorporates technology and is guided by algorithms, pupils must also become aware of this. On the other hand, the study also showed that implementing programming in Art and crafts education, especially within digital products, can present problems. Teachers in the Art and crafts subject have tended to focus on traditional materials where the pupils get tactile experiences (Ottestad, et al., 2014; Olsen, 2014; Strand & Nielsen, 2018). For that reason, it may be necessary with a different introduction to programming in arts education. One of the strengths of programming may be, as Seip says, that practical tasks can get a technological twist. With this approach, the idea that the subject should be tactile will still be taken care of.

Programming in Art and crafts may also include using programming in physical products. Hoem, Seip and Dahlin illustrate that an understanding of design, aesthetic sense, and product development are important when programming and that technology are integral parts of a physical product. We think programming can offer a greater focus on technological interaction within physical products. This is an important element of programming, using sensors that capture interaction such as position, orientation, movement, touch, light and sound. This also means that pupils must reflect on how the user or participant interacts with the product or with the artwork. This is already an important part of design, but one can still argue that technology opens up a new aspect to this, where the algorithms help determine the interaction. Programming can also contribute to an increased focus on interaction when it comes to art. An important factor for modern art and art practice is to look at the meeting between a work of art and a viewer as a participation. Aesthetic theory includes that one should become active viewers and co-creators, but also that the artwork should lead to active and physical participation (Bishop, 2006). Based on our reflections, programming and technology can be a tool to achieve this in art and design education. Children and youths will face a more complex world, so they must gain knowledge of working within a complex design process where technological interaction is part of the design or art concept.

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