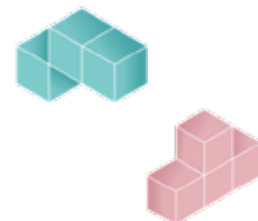


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TEACHING SIZE, AREA AND SCALE

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ABSTRACT

Gaining an understanding of scale, area and size is an important part of the subject of Art and crafts.

Although this skill should be practiced, perhaps even mastered, by pupils in primary education, it is regarded as difficult to teach, due to the skill being intangible and difficult to discuss. This paper seeks to aid in overcoming these difficulties, as it gathers initial findings from ongoing interviews with teachers on their strategies for teaching this important skill. Instead of highlighting one strategy as the best, we wish to showcase a broad range of appropriate approaches to this theme. Tensions between these approaches are also discovered and discussed to highlight the inherent properties of the different strategies.

INTRODUCTION

An understanding of matters of scale, area and size is an important skill, whether used in planning, redecorating or choosing private housing, or in participation in public planning and building processes. The importance of this is reflected in the new Norwegian curricula in Art and crafts, implemented in 2020–21, which aims to have pupils achieve competence in sketching and modelling architectural solutions for their local surroundings (Utdanningsdirektoratet, 2020). This requires an understanding of scale, a skill that may be viewed as difficult to grasp and to put into words. While Art and crafts is a subject filled with non-linguistic knowledge (Bloch, 1991), an understanding of size and a sense of space might be the most difficult skills to teach, as they are difficult to demonstrate or explain. In this paper, strategies used by Art and crafts-teachers to teach their pupils this skill is explored.

Although this skill is important in different aspects of adult life, it is not mastered by everyone. Observing the

interaction between an architect and two clients while planning a residential building, Nielsen (2000) found that the clients understood the architectural drawings only to a certain extent and had difficulties in imagining the spatial properties of the finished building. The same lack of understanding was also evident, for example, in the building of a centrally located hotel in Oslo, the Thon Hotel Opera, in 2000. The hotel was critiqued for being too high, creating a wall in front of the Opera building (Neubert, 2007). The politicians behind the decision did not fully understand the drawings, and it is unlikely that they would have consented to the plans if they had understood the implications (Lundgaard, 2000; Nielsen, 2004).

Educating children and youths to become engaged, critical and knowledgeable citizens is also necessary to ensure good democratic processes (Nielsen and Digranes, 2007). This belief is shared by the International Union of Architects (IUA), who is behind the UIA Architecture & Children Work Programme. This educational program aims to develop children into responsible citizens able to participate in democratic processes (International Union of Architects, undated). The foundation Archikidz, which has arranged architecture-workshops for children in the Netherlands, United Kingdom, Spain, Norway, Australia and Chile, is involved in a similar effort (Archikidz Rotterdam, undated). Their belief is that engaging children in urban planning “can help to create better communities and a more sustainable future” (Archikidz Australia, undated). Gaining an understanding of proportions, area and units of measurement, as well as the relationship between two-dimensional representations and three-dimensional objects, prepares children for participation in planning and building processes.

This exploratory paper addresses the following research question: *Which strategies are used by Art and crafts-teachers to enhance the pupils’ understanding of scale, area and size when working on architectural projects?*

The concept of teachers’ methodological freedom is strong in the Norwegian public school system. It is therefore important to mention that the goal of this paper is not to recommend one approach, but rather to showcase the broad range of approaches that may enhance pupils’ understanding of scale, area and size.

METHOD

Data was gathered through qualitative interviews with teachers in Art and crafts in lower secondary school. Informants were chosen through purposive sampling (Bryman, 2016). Searches in a non-academic journal and a research base of educational content in Art and crafts, along with inquiries within the authors' professional network, led to the identification of teachers with a strong background in teaching architectural projects. A request to participate in a research interview, as well as one reminder, was sent to ten teachers. Seven teachers responded positively. Currently, research interviews have been conducted with five teachers, and a sixth is scheduled.

All five interviewed informants were well educated and highly qualified to teach Art and crafts. They had between 3 and 20 years of teaching experience and taught at lower secondary levels in public schools. The interviews were semi-structured (Brinkmann and Kvale, 2015) and lasted between 50 and 70 minutes. Interviews were conducted in December 2020 and January 2021. As this is still a work in progress, the results presented here are preliminary and based upon initial analysis.

ARCHITECTURAL PROJECTS

The teachers were asked to describe one or more of their projects within the area of architecture in Art and crafts. In the following section, each teacher's project is portrayed. This offers a context to their teaching strategies, described in the next section.

Teacher1 collaborated with the software developer Ludenso, which gave him the opportunity to use their 3D-modelling app with an Augmented Reality (AR) application at a fairly early stage of development. The pupils designed a holiday home of 100 m². This was a large project spanning over most of a semester, about 15 weeks. It started with an open exploratory phase in which the pupils could use different techniques, such as sketching on grid paper, building with wooden blocks or using Minecraft or IKEA Home Planner. After this, they moved on to modelling in the Ludenso app. The finished buildings were viewed at a life-size scale on an empty soccer field, using the AR-application and Head-mounted Displays (HMDs). For the last part of the project, the pupils replicated their buildings at a scale of 1:50 using cardboard.

Teacher2 chose to describe different parts from several projects. In one project, the pupils worked on form experiments using the 3D-modelling software SketchUp to explore constellations of three blocks of different character. This was done as preparation for modelling a small cabin of 30 m². The pupils worked individually in SketchUp and afterwards in groups to collaborate on a floor plan and a cardboard model based on one of the group members' ideas. Another project focused on

remodelling their own school, analysing which needs the building did or did not meet and designing changes accordingly. This project also used SketchUp, along with sketching on existing floor plans and making drawings. A third project had a more sculptural focus: designing a model in cardboard to be drawn in perspective later.

Teacher3 used model figures as a starting point, asking the pupils to design houses suitable for a 1 cm or 2 cm tall figure. The pupils started with an exercise to understand how to make a three-dimensional shape, cutting out and gluing together a pre-drawn house, before moving on to their own design in cardboard.

Teacher4 gave her pupils the task of designing a studio for a chosen artist, such as a ceramist, painter or street-artist. Instead of giving them any limitations in area, the size of the studio was instead to be tailored to the artists' needs, while keeping in mind that a large studio would be expensive. The pupils started out with drawing their ideas in one-point perspective, before drawing a floor plan and building a cardboard model at a scale of 1:40.

Teacher5 prioritised exploration of form in her architectural project, in which the pupils designed a small cabin of 18 m². The pupils were randomly assigned a geometric shape as a starting point for their design. To further challenge them, Teacher5 gave them a "change card" that would force them to make a specific change to the design they had started to work on, such as moving, removing or doubling a shape. The project began with an open idea phase involving sketching on paper, iPads or in Minecraft before the pupils moved on to three-dimensional "paper sketches" or prototypes in thin paper. The prototypes were then disassembled and used as templates for the end product: cardboard models at a scale of 1:25.

The teachers had different approaches to the work on matters of scale in their architectural projects. While most of the teachers gave their pupils a certain scale to convert real-world measurements into, Teacher3 stood out with a more playful approach, as she gave the pupils the task of designing a house for a scaled figure. These figures were referred to throughout the project instead of talking about scale. Teacher1, Teacher2 and Teacher5 set limitations to the area the pupils could use, while deciding the appropriate area for the user was an important part of the task given by Teacher4. The area the pupils had to work with differed significantly, from Teacher1's large holiday home of 100 m² to Teacher5's small mini cabin of 18 m². Irrespective of this variation, all teachers said that their pupils complained about being given a small area. Although most of the teachers focused on the exterior of the building, some work on the interior and the creation of floor plans were part of the projects of Teacher1 and Teacher2, while Teacher4 focused solely on the interior.

STRATEGIES FOR TEACHING MATTERS OF SCALE

The initial analysis revealed six different strategies employed by the interviewed teachers, presented below.

MEASURING ITEMS OR AREA OF A ROOM

All teachers except Teacher3 mentioned measuring a certain area or items in a room as an important strategy when working on architecture-projects. Both Teacher2 and Teacher5 conducted exercises with the class where they measured the given area of their classroom. This area was marked with tape on the floor or pupils standing in the corners of the area. This provided them with an initial understanding of the area they had to work with. Teacher1 and Teacher2 also described talking about or measuring the floor-to-ceiling height of the classroom.

These four teachers also gave their pupils the task of measuring items in their surroundings, particularly the doors were mentioned. Teacher1 stated that he always kept a measuring tape in the classroom. Teacher2 and Teacher5 said that when they were asked about the size of an item, they told the pupils to take thorough measurements themselves. For Teacher4, measuring the furniture and equipment in their workshop, such as wood carving benches and sewing tables, prepared the pupils for their decisions on how large an area their artists would need.

RELATING TO FAMILIAR ROOMS OR PLACES

Another common theme was talking about rooms or places familiar to the pupils. Instead of measuring the area the pupils were assigned, Teacher1 and Teacher4 would measure the area of the classroom and then discuss how much larger or smaller their buildings or rooms should be. Teacher4 told them to keep in mind that the workshops were designed to fit twenty pupils, while they were only designing a studio for one, in an effort to avoid studios that were too large.

During the lockdown in the spring of 2020, when the pupils worked from home, Teacher5 also gave them the task of measuring their own bedrooms. Teacher4 said that her pupils often chose to take measurements of their bedrooms, as they got curious about area while working on the project.

Teacher2 explained that while working with a floor plan of their school, the pupils got an understanding of the scale of the floor plan through talking about the gymnasium. Imagining the size of this familiar room, the scale of the rest of the floor plan made sense to them. "So the fact that they can relate to, that they have been to the places they are talking about or that they have experienced it physically, these exact sizes, I think that is of great importance," Teacher2 said.

USING FIGURES AT SCALE

Teacher3 was the teacher who most actively used figures at scale, but this strategy was also mentioned by most of the other teachers, apart from Teacher4.

As a starting point, Teacher3 gave her pupils the task of designing a house to fit a 1 cm figure, sometimes 2 cm. All of the heights of the model were calculated to fit the figure, while the other measurements were set to be proportionate to the heights. The figures were used actively throughout the project to gauge whether the pupils were on the right track with the scale of their models.

Teacher5 gave her pupils the task of using metal wire to make a model of themselves at a scale of 1:25, the same scale as the model. This also introduced them to the proportions of the human body. These figures would later be used while working with the models. When asked whether the scale of the model seemed correct, she would reply "Just bring yourself out—can you get through this door?"

In a similar fashion, Teacher1 brought a scaled figure around when his pupils were working on their physical models to check whether they had gotten the scale correct. Both Teacher1 and Teacher2 also mentioned that the software they had used, Ludenso and SketchUp, had figures in the modelling area for scaling purposes. They were both unsure if their pupils had actually used them, but as Teacher1 said, "... he is standing there, so if it is a complete disaster, then you at least understand that you have started all wrong."

CALCULATING MEASUREMENTS TO SCALE

All teachers except Teacher3 gave the pupils a set scale to work with. For Teacher3, avoiding this seemed a conscious decision, as she was determined to keep the subject of Art and crafts a practical subject. Her experience was that working with calculations discouraged the pupils and caused them to not have fun anymore, while her approach instead gave the pupils a more implicit understanding of scale. Teacher2 said that while working on the sculptural model at scale, she had only briefly discussed the concept of scale. The pupils did not work a lot with scale themselves, but this choice was mainly due to time constraints.

Teacher1's project was interdisciplinary in that it involved mathematics: pupils made calculations and created a spreadsheet for converting life-size measurements to scale. Teacher3, Teacher4 and Teacher5 expressed that organisational conditions made it difficult to collaborate with mathematics teachers, but that they had a dialogue about their work on models at scale. To overcome this challenge, Teacher5 chose to work with practical mathematics in her Art and crafts lessons, at the start of the project. The pupils worked in groups, discussing previous experiences with scale, e.g.

using maps and solving practical tasks, such as figuring out how to convert real life measurements to a scale of 1:25. Both Teacher4 and Teacher5 talked about their projects as an approach to understanding mathematics, as they had experienced pupils struggling with mathematics finally gaining an understanding of it when working with materials and solving practical problems

PERSPECTIVE DRAWING

Perspective drawing was also a theme that emerged in most of the interviews. The teachers had different views on its usefulness in working on matters of scale, area and size. Teacher1, who had let his pupils use their methods of choice in the idea phase, said that the pupils who had drawn their house in perspective seemed to have less of a general sense of the size and scale of their structure, especially compared to the pupils who had worked with a floor plan in IKEA Room Sketcher. Teacher4, on the other hand, viewed perspective drawing as an important part of the preparation phase. Her pupils started by drawing their studio in one-point perspective, before moving on to make the floor plan and model at scale. Here, the perspective drawing was used to gain a feeling for the space in their room and as a basis for discussions on whether the room should be made smaller or larger in the next stages.

In general, Teacher4 viewed perspective drawing as a basic skill in Art and crafts, useful both for achieving more realism in visual arts and for visualising ideas while working on crafts or product design. Teacher2 expressed that she wished to continue teaching perspective even though it is not specifically mentioned in the new curricula. "I think it is a very important part of understanding the transfer from 3D to 2D," she said. Teacher3 also expressed her desire to continue teaching perspective drawing, although now with a larger focus on the creative angle than the mathematical.

USING DIGITAL TOOLS VS. WORKING WITH MATERIALS

There were also differences in the teachers' approaches towards digital versus more traditional work. Teacher1 and Teacher2 had projects where the pupils worked with 3D-modelling, in Ludenso or SketchUp, as a large part of the project. This meant that the pupils used life-sized measurements instead of converting measurements to a scale.

Teacher1's pupils got the freedom to choose methods in the idea and planning phase, leading some of them to draw digitally or work in Minecraft or IKEA Room Sketcher. In Teacher5's project, the pupils ended the project by making a poster where they edited an image of the model into a picture of the assigned plot of land using the app Snapchat. Some of her pupils also used Minecraft in the idea phase. All teachers let their pupils use digital tools in the inspiration-and-information-gathering phase. Teacher4 and Teacher5 expressed that

they would like to work digitally more, and Teacher5 had previously used SketchUp several times. The implementation of iPads at their schools hindered this.

Teacher3 used digital tools the least of this group and expressed that her priority was letting the pupils feel the joy of working with materials. She also asked the pupils to build a paper model based on a template she handed out during her introduction to the project to make them understand how to work three-dimensionally from the very start. Although positive about the digital sphere, Teacher1 and Teacher5 also emphasised working with materials from an early stage of the project. Among the techniques Teacher1 mentioned from the idea phase was building with wooden blocks. Teacher5 had chosen to leave out two-dimensional sketching in favour of making three-dimensional sketches or prototypes, as she had learned from experience that this improved pupils' understanding of their final cardboard models.

DISCUSSION

In the interviews, it was apparent that an understanding of matters of scale, area and size was something many of the teachers viewed as challenging to teach, although some felt that they had found an approach that worked well. Both Teacher1 and Teacher2 described this skill as something fleeting and difficult to grasp.

The three most prominent strategies involved converting an abstract number to something more tangible, whether it was showing the pupils how large their given area or familiar rooms were, measuring items or using figures they could relate to in the correct scale. Without such a physical component, several of the teachers suggested that it would be too difficult for the pupils to understand the sizes they were talking about. As Teacher1 said, "It's just a number somehow. There is a difference between numbers and a physical understanding."

This group of teachers did not exhibit any opposition to digital work, something one may come across among Art and crafts teachers (Strand and Nielsen, 2018). Instead, most of them perceived it as useful to work digitally with architectural projects. However, working with materials could give the pupils' work a tangibility that digital work does not possess. Teacher1 pointed out that when working digitally, you can't really see the difference between five and fifty meters, as it changes when zooming in or out. The intangibility of the digital sphere may be viewed as contradictory to the strategy of connecting numbers to something physical, which may explain why all of the teachers also included some physical elements in their projects.

The teachers differed the most in their approach to working with calculations and other mathematical activities within the project. While some worked in an interdisciplinary way or gave the pupils practical mathematical tasks, one teacher avoided calculations

and instead adopted a more playful approach to working with scale through the use of scaled figures. Despite this, most of the teachers talked about this project as an approach to gaining an understanding of scale that benefits the pupils' competency in mathematics, as the projects offered physical experiences with scale. Here, the calculations were used in practical tasks instead of working with abstract calculations, which some pupils would regard as more pointless. This connection to mathematics is lacking in solely digital projects, as life-sized measurements are used in 3D-modelling. In addition, digital works are often experienced as abstract images on a screen. An exception to this is Teacher1's project, where the pupils viewed their buildings in three dimensions and at life scale using AR with HMDs. This experience marked the end of their work on the models and was therefore not used to adjust their buildings. Teacher1 described the pupils as very engaged and enthusiastic but was unsure whether viewing their buildings or encountering new technology was the cause of their enthusiasm.

The teachers also had some conflicting views on the usefulness of perspective drawing as part of such a project. While Teacher4 used it actively to give the pupils an understanding of room sizes, Teacher1 observed that it did not give them a good overview of their building. It is important to note that they used it in different ways, in part explaining these different outcomes.

The preliminary findings of this research should be further developed by connecting the strategies of the teachers to key ongoing discussions on the understanding of scale, theories from the architectural and design fields, as well as other studies on how an understanding of scale, area and size may be enhanced. In further research by the authors, the use of Virtual Reality in connection to 3D-modelling will be explored as a strategy to hone these skills.

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