

# **DIGITAL DRAWING DEMYSTIFIED: EXPLORING A CREATIVE ZONE OF PROXIMAL DEVELOPMENT**

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## **ABSTRACT**

In the process of work life, product designers are expected to master and use digital tools. This must therefore be integrated in teaching in a pedagogically appropriate manner. Research has shown that there are many students who do not use digital tools despite having been trained in digital programmes. According to Donald Schön, who has studied reflective practice among professionals, it represents a general challenge for interdisciplinary processes that the terminology used is so advanced that it reduces communication across groups. The purpose of this paper is to elaborate on Vygotsky's theoretical notion of a 'zone of proximal development' (ZPD), whereby learning is supported by doing things together. The research question in this study was therefore how to develop a creative zone of proximal development that bridges the gap between manual product design and digital tools. The methods used were based on learning in communities of practice where the teacher and student work together. By showing the working process, the goal of the teacher was to demystify the development process and demonstrate how various tools can be used in a way that was useful and that saved time. Some students worked with CNC milling, pairing 3D print in polymeric materials, 3D print in ceramics and additive manufacturing. The approach can help students in a playful and more informal approach to the process in which they can learn the creative dynamics between digital tools and the physical world.

*Keywords: Digital tools, illusion, design education, zone of proximal development, Vygotsky.*

## **1 INTRODUCTION: DIGITAL DRAWING AND DESIGN**

In work life, product designers are expected to master and use digital tools [1]. This must therefore be integrated in a pedagogically appropriate manner in teaching in product design education [2]. Although this is not new technology, there is a need for a variety of teaching methods that aim to demystify the process of developing and designing a product.

This study explores how to implement digital drawing programmes in a pedagogical way. Experience has shown that many students do not use digital tools despite having been trained in digital programmes, while other students actively apply digital tools in their design projects such as drawing, 3D printing and production [3]. The purpose of this paper is to elaborate on Vygotsky's theoretical notion of a 'zone of proximal development' (ZPD), whereby learning is supported by doing things together [4]. Vygotsky claimed that effective learning occurs when students have a starting point in their existing expertise but face challenges whose solutions require some effort. Through a learning approach, students make use of existing expertise so that they extend their thinking and behaviour beyond previous knowledge. They learn in this way to enter unfamiliar contexts to achieve solutions through learning in social contexts. They learn best with others, according to Vygotsky, and a teacher should facilitate the occurrence of such a development.

## **2 BACKGROUND: COMMUNICATION IN PROFESSIONAL LANGUAGE**

Communication is essential both in design education and design practice in relation to digital design in the design studio. In an interdisciplinary context, this challenge also applies at the educational level in the meeting between product design and advanced digital tools that are usually used outside the competence area of the product designer. There is therefore a need for teaching methods that facilitate

this connection in education and across disciplinary genres without the use of overly complicated terminologies according to Donald Schön [5]. He has studied reflective practices among professionals and it is generally a challenge for interdisciplinary processes that the terminology used is so advanced that it reduces communication across groups. The goal is to make the subject more transparent for students' learning strategies [6] as well as for cross disciplinary communication in work life. Being a professional product designer requires one to create prototypes as an illusion of finished products that can be understood by a customer, retailer, distributor or manufacturer [7]. The research question in this study was therefore how to develop a creative zone of proximal development that bridges the gap between manual product design and digital tools.

### **3 METHODS: COMMUNITIES OF PRACTICE IN A DESIGN STUDIO**

The students who participated in this study had received training in SolidWorks in the first year of their bachelor's study. Several of them avoided the use of the tool in their studies. In the fifth semester, there was a compulsory requirement to submit digital drawings and renderings. Some students thought it was challenging to start using the programme again. Earlier years' submissions had shown that many students lacked knowledge and skills in how to use the tool, and the teacher wanted to motivate the students to use the programme through their design process. The methods used were based on learning in communities of practice, where the teacher and student work together and in teams [8]. A participatory design was used in the process [9], and document analysis of the students' reports and reflection notes was conducted [10]. The basis for the empirical documentation was a 12-week course with 42 students. They had to make five submissions, sometimes individual tasks and sometimes group tasks. Finally, they had to submit the final exam and a reflection note as well as a designed product. The students were tasked to design and produce a physical three-dimensional product. In parallel with the student activities, the teacher solved the same task as a professional designer. The task was done during the fifth semester in a bachelor's study programme in product design education. In terms of background, they had all learned about computer-aided design (CAD) and SolidWorks during their initial two years of the bachelor's programme. The method was to stage a zone of proximal development in the design studio, both in terms of the task itself and by activating the teacher in the process while doing similar tasks as the students, although on a different design. By showing the working process, the goal of the teacher was to demystify the design development process and to demonstrate how various tools could be used in a way that was useful and saved time [11]. The method aimed to show in lectures and under supervision how the designer can alternate the use of analogue and digital tools throughout the design process.

### **4 FINDINGS: TEACHER AND STUDENT PROCESS ALIGNED**

#### **4.1 The task**

The teacher developed a height- and depth-adjustable sofa table with a simple mechanical solution that made it possible to demonstrate the application of digital signs in a simple and illustrative way (Figure 1). The teacher emphasised that the tools were initially used as they were valuable for idea development at a personal level. Some of the students did not use the 3D application because they were afraid of making mistakes. The goal was to lower the threshold so that students could use the programme without being afraid of doing something wrong regardless of the level they were at. By removing the fear of drawing the wrong way, the teacher assumed that the students would be more motivated to use the programme at the beginning and, eventually, in a more sophisticated way as time elapsed [4]. By showing that the programme could be used to draw simple two-dimensional drawings that were later replaced with more accurate construction drawings, the teacher aimed to show that the drawing programme could be a useful tool, even though the first drawings would not be used later in the process. Examples of how sketches in SolidWorks were used to find critical goals and feasible solutions were demonstrated as well as how the sketches were used for making physical models, without which the drawings had to be properly constructed. The goal was to lower the threshold so that students could use the programme.

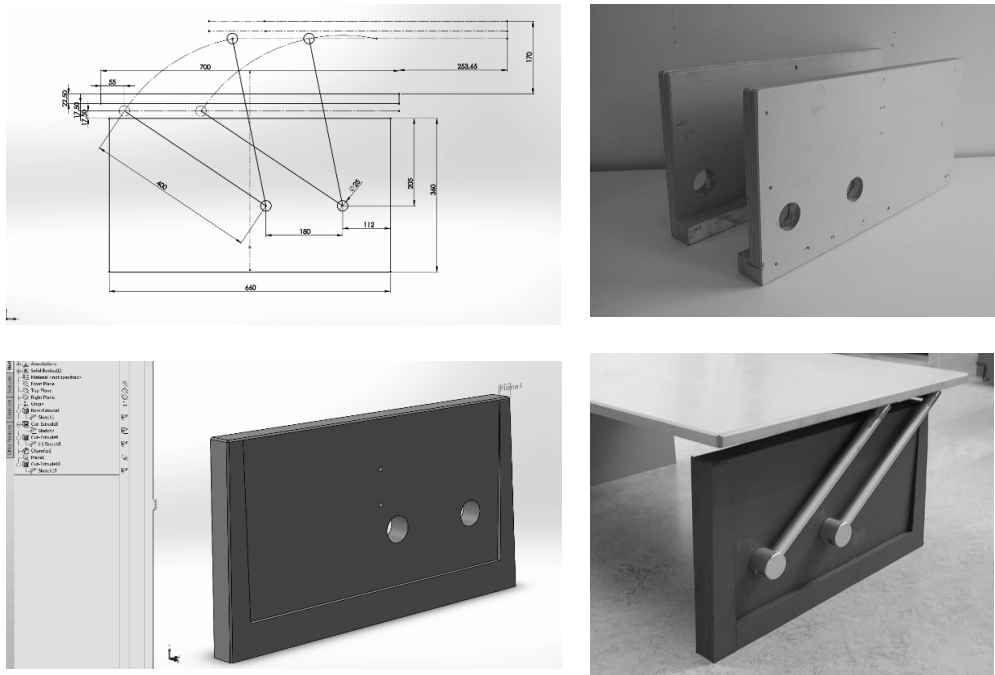


Figure 1. Teacher examples/work, from left to right: Top line: Digital Sketch; Sketch Model plywood 1: 1; Bottom line: Digital drawing; Test model In MDF and steel

#### 4.2 Student projects and their reflection notes on the process

The digital drawing competence level of the students was variable; some had not used the programme since the training in their first class, while others had very good skills in digital tools. Some students worked with water cutting, milling, pairing 3D print in polymeric materials, 3D print in ceramics and additive manufacturing. At the end of the course, the students submitted their reflection paper outlining professional and personal development through the subject [12]. There was an open reflection without special questions regarding the teaching method [13].

A female student wrote in her reflection paper: ‘For me, it was totally new to use SolidWorks in the work process. When we learnt the programme in the first year, we were told that there could not be any blue lines and we could not draw on them. Since I did not pass the test we had two years ago, I have not touched the programme since. It has been fantastic to now learn that not everything needs to be fully defined. Using SolidWorks, sketching and model building simultaneously has been fantastic, and it is definitely something I would use later’.

A male student wrote: ‘By designing and constructing sketches, CAD and technical drawings with digital tools, I have increased my knowledge, and more importantly, I have become more familiar with using digital tools. A useful way to work was to first digitally test functionality and solutions and then later combine the digital sketches with practical and experimental work in the workshop’ (figure 2).



Figure 2. Digital drawing, rendering and model by student

Another female student wrote: ‘In most other topics, I have not had the need to use SolidWorks in the way that I’ve been working. In this course, I have learned to use SolidWorks as a tool and have thus also seen more benefits of using it’ (Figure 3).

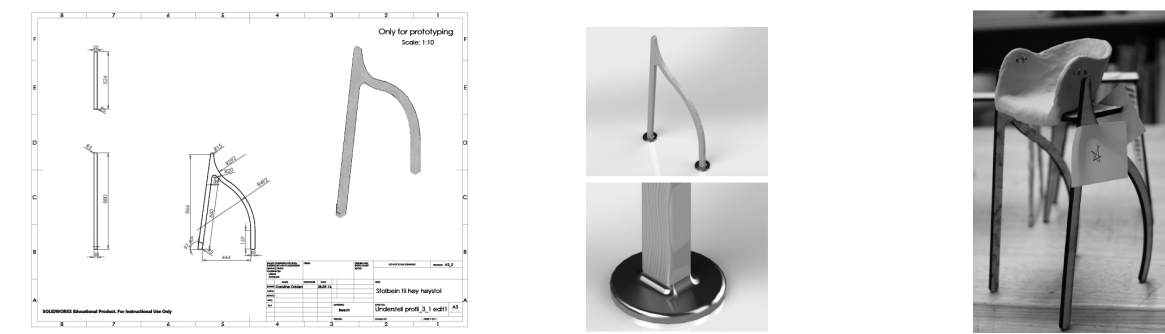


Figure 3. Digital drawing, rendering and sketch model by student

These reflection notes were selected because they show a variety of learning outcomes from the course. They show that more students have learned that SolidWorks is not as complex and daunting as they first thought or perhaps as they first learned. The students used their sketches/drawings to make quick models from simple materials. Most students achieved satisfactory digital drawings and final prototypes for the exam submission, which was a minimum requirement. The reflection notes demonstrated that these students learned how to use the CAD programme in a more sketchy and unpretentious manner, which possibly motivated them to delve deeper into the programme. This educational method, inspired by Vygotsky’s zone of proximal development, shows another way of teaching in digital applications by going step by step instead of aiming for the perfect finish. The students’ drawings using SolidWorks were used as a part, an assembly, a drawing and a rendering. The students experienced that they could use the programme in unusual ways. They had learned to use it in full application terms from the beginning; now, they were learning that it did not matter if you did the design process completely on the programme’s terms, but that you can lower the difficulty for its own use and for different stages of the design process. They can use the programme as a sketch tool and not be overly bothered about the final drawings. They learned to think that they did not have to care about the application’s requirements and that each individual can use it in their own useful way. This is an early stage, and eventually, they will need to make new drawings after making the first models. They can use a 3D programme to draw 2D sketches, and they understand that they can use the drawing programme without anxiety that something will go wrong. This attitude creates good educational end results in terms of improved motivation and learning pleasure. The exploded drawing portrays another way of using the programme (Figure 4).



Figure 4: Student works, digital drawing and final prototype

## 5 DISCUSSION: DEMYSTIFYING DIGITAL DRAWINGS

Although this is not new technology, there is a need for a variety of teaching methods to demystify, to some extent, the process of developing and designing a product [11]. The reflection notes showed that the method had a positive effect on some of the students, and the final exam submissions confirmed that most students had acquired a satisfactory level of competence in relation to the use of the digital drawing programme and making the final prototype. Notwithstanding, the study showed little by way of the effect of the method on those students who had already mastered the drawing programmes. It is a feature of the professional industry that the language in the design discipline is made more complicated than is necessary [5]. Complicated words and instruction manuals are constructed and widely used; and in this way, the design processes and the design subject are unnecessarily mystified. For students, the method should be further developed. For future studies, it may be interesting to go deeper into what effects the method has among all students in the class. This would entail conducting a thorough collection of information in the form of in-depth interviews through the course and afterwards [4]. It may also be interesting to do research on how to motivate all students to use their digital drawings in digital production such as 3D printing, laser cutting and CNC milling [14, 15].

In conclusion, the design teaching approach inspired from Vygotsky's zone of proximal development (ZPD) demonstrated a pedagogical attitude that can, to a large extent, empower product design students towards a playful and more informal approach to the process in which they learn that the creative dynamics between digital tools and the physical world, the perfect and imperfect, and that this may be a rewarding approach to develop new and innovative products [16].

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