

# **ASKING WHY AS WELL AND HOW: STRENGTHENING THE TECHNICAL PROFICIENCY OF NEW DESIGNERS**

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## **ABSTRACT**

Significant challenges can be encountered when introducing technology to design students, especially those with limited science and technology backgrounds. Often students display a fear or unwillingness to participate in technology-based applications, without realising the synergetic potentials. These challenges also exist for design engineering researchers, educationalists and technologists. This paper presents a different view to educating new designers in relation to technology-based disciplines, specifically in Computer Aided Design (CAD) and Manufacture (CAM). The work focuses on moving beyond polarised 'how it works' attitudes to technology and considers wider implications of using technology and the impact for design practice. This view of teaching can develop student's awareness of the impacts of technologies as well as enhancing their knowledge of technological practices. This position has been taken from work which aimed to establish more engaging ways of educating designers on technological applications within design and problems solving. A framework for teaching engineering alongside key design knowledge is proposed, using a debates project to exemplify this. This project requires designers to examine good design principles with a variety of technologies, and develop a detailed knowledge and awareness of emerging technologies throughout debating and discursive sessions. The teaching methodology and practical assessment is particularly relevant to the expanding technological emphasis for designers and the need for students to have a wider perspective beyond a pragmatic technical view. This paper also highlights the knowledge and associated methodology for design pedagogy whilst building on current practices, to enhance the learning experience alongside the knowledge of technological issues.

*Keywords: Pedagogy, creativity, technology, industry realism*

## **1 INTRODUCTION**

It is important to recognise that in the process of teaching in its broadest context, the concepts of misperception and preconceptions need to be acknowledged concerning the understanding and teaching of technology. Essentially, there could be two basic reasons for the different forms of anxiety concerning people and technology; one is a lack of familiarity and we also suggest a second fear factor for some students concerning CAD/CAM and new design technologies.

The key driver in the teaching of technology, technical proficiency, problem solving and creativity could be described as common sense realism [1]. This is underpinned by detailed planning and an organised approach to designing [2]. However, in 2005 the UK government commissioned a number of papers to investigate the role creativity and its importance to the UK Economy. The Cox report, Lambert Review and the DTI paper entitled, 'Creativity Design and Business Performance' are some [3,4,5]. The overriding message in these is that creativity is important in business terms and in how it might be exploited for commercial reasons.

This research is centred on these issues. It argues that an innovative approach is needed to nurture students understand of technology in Design to both enhance their technical proficiency as designers and develop ability their design thinking, in being creative and resolving problems. A number of areas within psychology were considered, however, Poincare's process of discovery [6] would be the most appropriate method of nurturing creativity to engaged students with topics on technology, proficiency, creativity and the importance in industry.

## **2 IN THE CONTEXT OF EDUCATION**

Whilst the concepts and perception of CAD/CAM has been widely considered (both in design and academic cultures), it is also important to consider this work from an educational perspective. This paper argues that there needs to consider a different view when educating designers related to technological disciplines. Student learning is a fundamental consideration within all educational practice, irrespective of the subject or discipline being examined. Whilst this piece does not attempt to define this area, it will consider key principles to determine a standpoint relative specifically to technological education. It is therefore important to identify the student as central to this learning process.

Following this student-led principle, theoretical works commonly consider engagement to be centrally based on the learner, a view this paper follows is important in enhancing learners' engagement with technology and teaching practices; in this case the designer student. Haggis [7] argues that learner's engagement within learning is partly driven by the learner and the overall learning experience and that learning can be conceived from learners past experience and knowledge. When considering the student-centred approach, student engagement becomes a central concept, as an individual's involvement with the educationally relevant activities and conditions that are instrumental to their learning [8]. Meyers and Nulty [9] however, talk more simply about students having levels of, satisfaction, enjoyment, interest and engagement, whereas Kift and Nelson [10] refer to engagement and connectedness. However student engagement can be seen in many different contexts, and dependant on what students are engaged with. There is a different between institutional engagement and academic engagement [11]. Coates [8] affirms this showing that student engagement is a constructivist concept established within environments that encourages a range of educational activities that is likely to lead to high quality learning.

Whilst many researchers have easily defined engagement, in differing contexts, the indication of engagement is harder to identify. Whilst this paper is concerned with some engagement phenomena it is not looking specifically the potential to become engaged with technology through the learning process. In this sense engagement will be context dependent to some degree, and as Coates [8] suggests, engagement picks up a whole range of issues such as intrinsic involvement with study, a measure of educational outcomes, involvement in key processes, quality considerations on student learning, educationally meaningful interactions with institutions, and quality indicators in higher education.

The focus within learners needs and fears relates heavily within educating technology practices, and a more positive learning experience can be developed; an ideal which has been heavily discussed within more wide reaching pedagogic research [12,13,14,15,16]. Novak & Gowin [17] provide a generalised description of learning as the acquisition and construction of new knowledge. However Saljo's [18] research offers a more detailed deconstruction of the process of learning in highlighting the levels of understanding learners' experience, which can have specific relevance in context to CAD in design education. He states that learners develop understanding within five levels, starting at a basic level, learning as an acquisition of knowledge and developing to more complex levels of learning to make sense of meaning and different interpretations and understandings of reality.

This research showed that the initial three points were unemotional and pragmatic levels where learners developed to a point of knowing. However points four & five resembled more personal aspects of learning, internal to the learner, which Ramsden [19] argued to enhance learning and the learning experience. These can be crucial when considering learning CAD technologies, as they develop the learners' level of context and independent awareness.

From this, it is suggested that to educate learners you consider not simply what information needs to be conveyed, but the wider picture of why this needs to be conveyed. This paper argues that technological educational practices should consider this approach in terms of moving from teaching 'how to' information, and also discussing the 'why' aspects as well by introducing the students to a practical issues of CAD in design practice.

## **3 DEBATES AS A TOOL IN DESIGN EDUCATION**

Debates as a tool for teaching was seen to enhance students' critical awareness as well as boosting their knowledge and skills. This approach has been developed and refined over the past 6 years. It introduces product design students to key areas of design thinking and hones their skills and

knowledge necessary for university and subsequently in industry. This model has become influential in enhancing students' critical awareness in an interactive way in Product design teaching.

This year, the debates project was developed to specifically to introduce the new technologies used throughout design education, such as CAD/CAM techniques, and tackle students' apprehension of using these in their studies. Debating gave students a chance to fully explore the potential of these technologies and critical analyse how these fit into design practice rather than simply teach students the methods of using these technologies in a 'how to' approach.

### **3.1 The brief**

The topics under debate were assigned to two areas:

1. This house believes that Computer Aided Design & Manufacture should replace hands-on craft;
2. This house believes that technology is having a negative impact on social interactions and promoting laziness.

Students were assigned groups to examine these areas and work on for or against opinions related to these topics for a 6 week period prior to Christmas 2012. Each group needed to develop the argument and present this an open forum as part of a conventional debate. They needed to be able to defend their opinions with evidence and be prepared to argue with their opposition throughout a 30 minute session. At the end of which the student cohort voted on the topic to decide which was the most persuasive.

Alongside the debates forum, each group produced a detailed research portfolio that validated their claims and showed the extent they had investigated this area. This provided a detailed view of the research conducted and furthered the academic rigor of this assignment.

### **3.2 The research methodology**

Other research in this area has shown the overall value of debating as a teaching method [20]. This research goes beyond this and aims consider the extent that debating can enhance students understanding of CAD/CAM in product design, tackling specific issues students may have with this topic. This investigation considers the following themes; the extent that students develop their critical awareness of CAD in Design, whether students develop more confident in using CAD, the impact debating had on students overall learning.

Research was conducted with 160 students at level one as a way of introducing the subject area, and challenging their pre-conceptions early on in their studies. The session was run with students across a range of courses; from BSc Product Design, BA Product Design and BA Furniture and Product Design. This mix of disciplines provided a range of different emphasis to Design, from engineering and industrial focus to more artist and creative areas in furniture. This became the grounded foundations to their thinking on design and technology with the aspiration that they would take these ideas on and develop them over the subsequent years of study.

Findings were gathered from a questionnaire to all 160 students and in-depth interviews with a selection of students across the different cohorts. This provided a level of qualitative and quantitative results that were analysed through thematic coding.

### **3.3 Findings and discussions**

Overall this research showed that students developed their learning on CAD/CAM extensively throughout this project. This teaching methods help enhance students engagement, both in the topic and the process of learning, enabling students to develop their opinions on this area and develop different ways to learn. Specifically the debates enhanced their thinking and understanding from a holistic perspective; in examining the wider issues of the topic in relation to design alongside specific practical factors of how to use CAD/CAM in design. These notions were evident in three clear areas; critical awareness, student confidence and the professional context.

#### **3.3.1 Enhanced students' critical awareness of CAD**

Findings showed that students developed their learning beyond a 'how to' view of CAD and incorporated an understanding of why it may be useful in Design. In interviews, students commonly noted how CAD was more than just a tool to use and could be a means to enhance design practices:

*"Before I'd used CAD and knew a bit about what it could do and stuff, but now I can see how I could use when I do design...being able to try things out and do things a bit differently"* BA PD Student

*"I think it's helped me look at what I do when I design and not just do the same thing all the time, like always draw things or always make models. It [CAD] can help break up the way I design to visualise something or see the details more."* BSc PD Student

These findings were supported by the results in the questionnaires, with 91% of students rating the history and practices of CAD as *highly critical* to their understanding of CAD whereas the skills and techniques of using CAD was rated less, as *significant*. Students also took a critical standpoint on this topic, arguing where CAD fitted into Design, but could contrasted to the alternatives areas. Students often referred to areas in Design that were related to CAD and others that were also more suited to craft techniques, however there was often an underlying view that CAD could be itself a crafting technique:

*"We've initially thought CAD was great and that we should always use it in Design, but actually there was a lot to learn from craft skills, and hand-crafting stuff, things I didn't expect before"*

*"CAD is actually a craft skill in itself. We found, in our research, that lots of designers were actually using CAD based on the craft skill they'd learnt before"*

This research showed how students had developed their opinions specifically based on the research they had considered. This consisted of a large volume of research, from speaking to experts in the field, reviewing books, journals and cross-examining these with relevant academic literature. Whilst this view is interesting, in itself, what it shows overall is that students were reading and interpreting key research in this area and synthesising this to form their opinions. In effect they were developing their critical skills and forming academic arguments; key skills for university education.

In combining history, theory and practice to CAD/CAM students developed their critical understanding of the topic to be able to ascertain the what, how and why of the topic. Ultimately students' knowledge went beyond the practical 'how to' aspects and developing a more rounded view of the subject. This relates to the holistic approach to teaching and learning, as a T-shaped view of learning in design education [21,22].

### **3.3.2 Enhanced students' confidence to use CAD**

Alongside developing their critical awareness, students also discussed how this teaching enhanced their confidence on using CAD when designing. In the questionnaires, 92 % of students said that this project had made them more confident to using CAD in their design work and the subsequent 8% stated that they maintained a good level of confidence. These findings were extended in the interviews where students discussed that they were not only more confident but also have developed an understanding of what CAD could offer them and why:

*"Having done this [the debates] I feel so much more aware of what CAD is and how to use it in design."* BSc PD Student

*"I wasn't very confident about CAD stuff before, but now I know why its relevant and where I could use it, so do more of it now than I did before"* BA FPD Student

CAD was seen as both a tool to visual and prototype their designs and also part of the process of developing their ideas and practices for the designer. Students were using it as a means of enhancing their learning as well as presenting their work to others. This dual purpose shows how CAD had a dual value for students and how they would seek to use it as part of their overall education. Alongside what CAD offered, students also discussed what it offered them and why they might not to use:

*"CAD can be a stop you designing though ... you can end up designing based on what you know and the actual software"* BA FPD Student

*"Its sometimes good to do things by hand and physically interact with the materials and the shapes, you can lose that when you're working on the computer too much"* BA PD Student

For some, CAD was seen at times to be restrictive to Design, specifically when generating initial design ideas and conceptualising design thinking at the early stages of the design process. At such an early stage of their university education these students had adopted a critical standpoint on this area, how it impacted on their own design practice and also how they used the taught sessions overall in this area. Ultimately this shows how students were independent in their learning, a key skill for future university education. Students considered what they were being taught in sessions more deeply than just getting the facts and skills. However, they also appeared encouraged to go beyond the teaching sessions and learn for themselves outside the classroom.

### **3.3.3 Put CAD in context to Design and designing**

The final area where Debates aided students' learning was to contextualise CAD within the design practice and the process of design. Students were encouraged to do both primary and secondary research in the design profession. Most groups adopted this approach and did empirical research with designers in industry to examine their use of CAD alongside craft-based skills; what practitioners did and why they. Students then underpinned their primary results with secondary literature and theory to ascertain where CAD fitting into to design practice. This process was highly valued by students as a means of understanding the topic and its relation to the industry:

*"It was really good to interview the designers...they showed us what they did and why. Then we found the stuff we'd read about made sense more and we brought that it to really make the point on the day"*  
BA FPD Student

*"I got loads from watching interview with designers online and speaking to real designers but also when I read some of the design books on this – it helped me understand the industry more"* BA PD Student

The process of researching a topic in detail, developing a critical standpoint and arguing this in an open forum, enabled students were able to develop valid opinions on the topics and demonstrated a level of academic rigor in their work. However students were also exhibiting a theory-practice process, developing their ideas from both theory and practice-based learning. This format of learning enhances students' critical awareness and can be seen as an advance learning skill for those in their first year of study.

As these findings illustrate, students valued this in helping them develop their understanding in a real context. Whilst this contextualisation is good, in introducing a professional context to first year students, it also expanded students' understanding of CAD overall. CAD was seen as both a tool for them to use alongside other communication techniques; such as drawing, modelling and photographic studies. However it was also seen as part of their overall skill set as a designer, and what they could offer in their future career.

This also influenced how students developed their understanding in other teaching sessions; specifically the taught skills-based workshops and design projects sessions. In debating this topic, CAD became real and understandable to students, reflected significantly in the questionnaire findings with 97% of students stating they were more aware of how CAD was part of the design process and in the design industry.

In effect, students were joining up what they were learning in other workshops, lectures and practical sessions; on hand drawing and CAD work, to understand where this fits and why it may be relevant to designers' overall practice. Students again exhibited a T-shape model of learning which is a deeper knowledge that Crisp [21] argues is inherent to what higher education should be extolling. This echoes the view Van Dijk [22] promotes of graduates who can work across disciplines, collaborating and sharing knowledge.

## **4 FURTHER WORK AND CONCLUSIONS**

This work demonstrates the role CAD/CAM technology can play within learning environments. Discussions have suggested that teaching can go beyond practical skills-based learning and consider how this can offer valuable contributions for designers as part of design practice and design thinking. However, to take this leap from skills to teaching, design students have to be encourage to be consider CAD/CAM critically, as part of their designerly thinking. Students should be encourage to critically analyse and debate these topics, to research and examine not only what these are but also why they relevant to Design, and when they might not be.

This project provided students with several opportunities to examine and identify technological developments combining both the how and the why perspectives. It allowed them to engage within a wider design context consider new ways to integrate the technology within design in the public domain. As the theoretical education research showed, opportunities to progress on the levels of learning can be encouraged when shown in context and made relevant to the learner and thus engagement in the subject, as well as the discipline has greater potential.

Interestingly design students grasp the opportunity to work as a team on this and how easily they learn CAD/CAM alongside this activity. Effectively they developed their view of this technology; as a tool but also in how it can enable students to develop their craftsmanship and creativity in design practice. Whilst some students did not feel confident about CAD/CAM initially, taking it out of the traditional

skills-based activity meant that they were less focused on conforming and could consider the topic widely and question what it entails for them and their future practice.

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