The contribution of product analysis to fixation in students’ design and technology work

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Citation: NICHOLL, B. and MCLELLAN, R., 2007. The contribution of product analysis to fixation in students’ design and technology work. IN: Norman, E.W.L. and Spendlove, D. (eds.). The Design and Technology Association International Research Conference 2007, University of Wolverhampton, Telford Campus, 4,5,6 July. Wellesbourne : The Design and Technology Association, pp. 71-76.

Additional Information:

• This is a conference paper

Metadata Record: https://dspace.lboro.ac.uk/2134/3315

Publisher: © DATA

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Abstract
Design and technology (D&T) educators have pointed to a ‘crisis’ in creativity within the subject. Creative cognition literature suggests lack of creativity in design work is at least partly the result of ‘fixation’ (difficulty in generating novel ideas due to imagination being ‘structured’ by pre-existing knowledge). This paper applies these ideas in the context of current practice in D&T to shed light on how students generate design ideas and how a particular teaching approach, product analysis, influences these processes. Data are reported from the six schools involved in the preliminary phase of a Gatsby-funded ongoing research and intervention project. A number of methods including interviews with D&T teachers (N=14) and focus groups of students (N=126), lesson observations (N=10) and an analysis of documents and student work were utilised to address the question: ‘How does the use of product analysis contribute to fixation in secondary school students’ design work?’ Product analysis was found to be frequently used by teachers at different points in design and make projects, particularly during initial research work prior to the generation of design ideas and as a starting point for the generation of ideas during an idea generation lesson. Example of these different uses of product analysis are outlined, however the impact each has on students’ generation of design ideas was similar: current practice leads to fixation as thinking is constrained down a particular path. Implications for practice are noted.

Key words
creativity, product analysis, fixation, generating ideas, creative cognition, 11-16 years

Introduction
Although creativity has been conceptualised in different ways by competing theoretical traditions (see Sternberg et al., 2005 for an overview) there appears a general consensus that creativity is an, ‘imaginative activity fashioned so as to produce outcomes that are both original and of value’ (Robinson, 1999: 29). Given that the D&T National Curriculum Programmes of Study stipulate that students should ‘generate design proposals’ enabling them to ‘think and intervene creatively’ (DfEE and QCA, 1999: 15), D&T educators should be ideally placed to foster creativity. D&T inspection reports however, note the lack of design opportunities provided, particularly in the 11-14 age range (Office for Standards in Education, 2001/2) and research has indicated that design work lacks creativity with design ideas often being based on images found in popular culture (Nicholl, 2002, 2004; Nicholl and McLellan, 2007), leading to the suggestion that creativity is in ‘crisis’ within the subject (Barlex, 2003; Kimbell, 2000a, 2000b).

An understanding of how students generate ideas and how teaching approaches influence these processes is needed, to enable practitioners to use currently available creative strategies (for instance the Key Stage 3 National Strategy, 2004) more effectively. Surprisingly little rigorous D&T-based research has examined these processes (although see Howard-Jones, 2002; Howard-Jones and Murray, 2003; Nicholl and McLellan, 2007). Application of findings from the emerging field of creative cognition (Finke et al., 1992; Smith et al., 1995), which investigates creative thinking, would appear to provide a way forward.

Creative cognition
Thinking which leads to creative ideas involves ‘conceptual expansion’: people ‘extend the boundaries of a conceptual domain by mentally crafting novel instances of the concept’ (Ward et al., 2002: 199). Thinking is constrained by pre-existing knowledge such that imagination, rather than being free-roaming, is ‘structured’ (Ward, 1994, 1995; Ward et al., 2002; Ward and Sifonis, 1997; Ward et al., 1997). People are likely to retrieve the most ‘representative’ instance of an object or concept from memory to base a new idea on, even when asked to come up with novel ideas that bear no resemblance to existing ideas. This default tendency has been termed thinking along the ‘path-of-least-resistance’ (Ward, 1994, 1995) and can lead to a state labelled ‘fixation’: ‘a blind, and sometimes counterproductive, adherence to a limited set of ideas in the design process’ (Jansson and Smith, 1991: 4). These findings suggest that most people find it difficult to come up with creative ideas (i.e. instances of conceptual expansion) because they will tend to come up ideas that are similar to existing ideas, ideas that have ‘structural connectedness’ (Finke, 1995), as these are based on established ideas or principles (Finke, 1995; Weisberg, 1999), and will therefore be similar to those of other people doing the same task.

1 The Subject Leadership in Creativity in Design and Technology project. The preliminary phase spanned nine months (January to September 2005). For further details refer to the project website www.educ.cam.ac.uk/slcdt/index.html.
Nicholl & McLellan (2007) argue that the stereotypical design ideas based on popular culture typically seen in secondary D&T classrooms are the outcome of fixated thinking. Because imagination is structured and operates along the path-of-least-resistance, students will draw on sources of knowledge that are most accessible to them, which for teenagers, relate to the culture they are, and want to be, part of. As the default tendency is to retrieve ‘fairly specific, basic level exemplars’ as a starting point (Ward et al., 2004: 2), common shapes and images such as love hearts and footballs form the basis for design ideas. Hence, stereotypical design ideas are the outcome of the operation of subconscious, automatic and normative cognitive processes that have lead to fixation.

Nicholl & McLellan (2007), therefore, provide one explanation of why students’ design ideas lack creativity2. Because default tendencies in cognitive processing can be overridden (Ward, 1995), Nicholl & McLellan (2007) also suggest that the teacher has an important role to play. This paper, therefore, starts to investigate the role teachers play when students generate design ideas and focuses on the effects that one specific teaching strategy, product analysis, has on the generation of ideas.

The role of product analysis in D&T

Analysing existing products for weaknesses is a standard strategy used by designers in industry, illustrated for instance in the television series ‘Better by Design’, (Channel 4, 2000). This approach is also expected to be employed in the D&T classroom, as the National Curriculum Programmes of Study specifies that students should be taught to ‘identify and use criteria to judge the quality of other people’s products’ (DfEE and QCA, 1999: 21) under ‘Evaluating Processes and Products’ and that ‘they develop their understanding of designing and making by investigating products’ (DfEE and QCA, 1999: 20).

The Key Stage 3 strategy states ‘the expectation is that knowledge, skills and understanding will be taught through: product analysis’ (KS3 National Strategy, 2004: 21). ‘Pupils use their understanding of the characteristics of familiar products when developing and communicating their own ideas’ (KS3 National Strategy, 2004: 21) and so should be taught to ‘use existing, familiar products and systems to inform their design thinking’ (KS3 National Strategy, 2004: 29).

Analysing and investigating existing and familiar products would appear to be a major strategy used to inform design and in the generation of new, improved ideas, in particular, in D&T. Indeed, in this research many instances of the use of this strategy were recorded in the school context. This is why this paper focuses on product analysis, as a starting point for analysing the impact of teacher practice on the idea generation process.

The study

The research question that is addressed in this paper is: How does the use of product analysis contribute to fixation in secondary school students’ design work?

The six participating schools were chosen to represent a heterogeneous sample in terms of socio-economic circumstances, ethnicity and performance in public examinations.

Semi-structured interviews were conducted with D&T teachers (N=14) and students (N=126). Teachers were interviewed individually and students in same-sex, same cohort groups. The two main areas probed were the research students undertook (what/when/who decides etc.) and the idea generation process (how/when/how many ideas expected/contribution of research etc.). Interviewees’ views on creativity were also sought. All interviews were taped and transcribed. In addition various documents were gathered (e.g. schemes of work, student project booklets, Ofsted reports). Samples of student work were also collected.

To substantiate and triangulate findings (Denzin, 1989) idea generation/development lessons (N=10) were observed. One researcher constructed a narrative of the lesson (Ely et al., 1991). The other researcher focused on teacher-student interaction, as this was a key area of interest. These notes were written up and discussed so that the approach could be refined in later observations. The dialogue in lessons was also tape-recorded and significant events were transcribed.

Interview transcripts, observation narratives, fieldnotes and memos were transferred to the QSR NVivo programme (Fraser, 2000). An initial set of descriptive codes (Miles and Huberman, 1994) was developed relating to the questions asked during the interviews, and additional ones were added that reflected important strands in the responses. Check-coding between the two authors was undertaken to ensure consistency (Miles and Huberman, 1994). Coded segments were examined for evidence of ‘fixation’ and related aspects of teacher practice were identified. In this paper data relating to product analysis is focused on specifically.
Product analysis in the classroom

Product analysis appeared to be used at three different points in design and make projects, however due to space restrictions only two of these are reported here: namely the use of product analysis during initial research work prior to the generation of design ideas; and as a starting point for the generation of ideas during an idea generation lesson.

Product analysis during initial research work

Students were typically given a design brief and asked to research existing products, usually by gathering images. The following extract from a lesson observation was typical. The class had already been introduced to the project, which was to design and make a widget.

Teacher tells the class ‘homework is to research into 4 things. The four things we talked about earlier. You must find out about at least two of these’. No further instructions are given in terms of what information is to be found or where to find it. But after a pause teacher adds ‘what is important is the pictures and not the writing’.

(School E, Y7 class lesson observation, February 2005)

These students were given very little guidance about what to look for whilst researching. The importance of images was stressed but no advice was proffered as to what would constitute a good or bad image or how many images would be desirable (for instance the different views). Although these students were referred to the school learning resource centre for this particular project, in general students did not appear to be directed to specific sources. The approach most students seemed to adopt for research is described by this Year 10 student:

‘If you’re doing a bedroom alarm, go and find pictures of bedroom alarms, go onto the internet, find out about bedroom alarms, write information down but in your own words… and then when you come back to school you just have to literally write it down… like on a new piece of paper’

Y10B(A)

This boy, like the majority of students interviewed sourced images from Google Images and printed off the first ones that appeared suitable. This approach does not necessarily yield appropriate images. Many students were observed trying to use small and/or poor quality images as sources of inspiration for their widget design, where key features of the product (for instance the lever mechanism) were not clearly visible. Some teachers were aware of these types of problem:

‘Oh we say they can go on the internet… give them ideas of the sort of places they can look on the internet, as I say there’s no point typing clocks because you get fifty million ways… they need to narrow it down to specifics’

(Teacher, School A)

However, even this teacher admitted they didn’t give highly specific advice as to what types of images to source, commenting ‘we haven’t done that but that’s something we’re working on at the moment’. This suggests that teachers have a greater role to play than they do currently in ensuring students are researching appropriate images.

Students were also given little advice as to how to use images in their design work. The following extract comes from a later lesson relating to the widget project (once the research homework had been completed). Students were about to start designing the mechanism for the widget.

‘It is difficult to think of ideas so get your research out’.

(Once students have retrieved their work and quiet has been restored) ‘I quite often see that students have some wonderful research and don’t use it. Your research is based on a thousand years of history so it should help you… You don’t have to design the whole thing. You can design bits’.

(School E, Y7 class lesson observation, February 2005)

This Year 7 class were then left to come up with design ideas and it was only some time into the lesson, when it became apparent that the class did not know what to do that the teacher led a whole class discussion focussing on parts of the structure they needed to design, in particular the lever. Such targeted support was not commonly seen which suggests teachers should be taking a more active role in teaching students to critically analyse products.

Product analysis as a starting point for generating ideas

Product analysis was used in a variety of ways to provide a starting point in idea generation sessions. One strategy was to bring in examples from a previous cohort’s work, and in all the cases observed or discussed, this was work from the same project:

3 Project anonymised for ethical reasons
4 Indicates school and year group. Schools were labelled A-F. Y7 is the first year of secondary schooling (students aged 11-12 years), Y8 the second year etc.
5 Indicates year group and sex of student. School is given in brackets. Year group and school labels as before. Boys are represented with a ‘B’ and girls with a ‘G’. This therefore is a Year 10 boy (aged 14 to 15 years) in school A.
'She [the teacher] showed us designs that other students had made like a couple of years ago to give us ideas.'

Y7G(D)

A variation on this was to draw students’ attention to work on display already. Again this always related to the same project:

'We put a lot of work on display and usually the work that is on display, we use it to start a project off with a group. It's usually used because it displays creativity in the first place.'

(Teacher, School B)

'He [the teacher] showed us some. There’s some in the display case and we looked at that.'

Y7B(D)

Even when teachers did not draw attention to previous cohort’s work on display it was clear that students used this in their design ideas, particularly when they were struggling to come up with ideas:

'I got my ideas from that [pointing to display of previous group's work]. ’Cos I copied the base and then I added some bits to it.'

Y7B(E)

Another strategy used by teachers was to show students designs they had made themselves.

'We've looked at ones I've made and that sort of thing... more often than not to discuss. I mean I made one with them last year just to talk it through at the start.'

(Teacher School A)

Instead of bringing exemplars to the lesson, some teachers employed a teacher led discussion to distil the key features of an object and generate a few design ideas that were sketched on the board. This was seen in the widget lesson, described earlier, once it became apparent students were stuck. Students in interview also noted this was a fairly common approach:

'We share them [ideas] in class and we all say what we think and then we write them down [from the board] and you can choose or you can make your own up.'

Y9G(C)

Discussion

A number of issues are raised. Firstly, students are almost always asked to analyse examples of the same product that they are making. Secondly, students are often asked to source images of products, rather than to look at/bring in physical objects, with little guidance of where to look and what to source. Finally, students are given rather limited guidance on how to use product analysis to inform design work. These, it is argued here, can all lead to fixation in design ideas.

If students analyse the same product that they are making, this immediately limits thinking due to the way normative cognitive processes operate. When faced with a problem, for instance the need to generate design ideas, a cognitive plan (what needs to be done) is formulated to meet the goal (generation of design ideas) (Smith, 1995). The first step is the retrieval of existing concepts and knowledge from memory, which due to the operation of the path-of-least-resistance (Ward, 1994, 1995), retrieves all knowledge about the object being designed. For instance when designing a clock, the cognitive plan retrieves knowledge about clocks held in the clock ‘schema’ (Bartlett, 1932). Furthermore, as ‘fairly specific, basic level exemplars’ are retrieved as a default as the starting point for ideas and properties of these are ‘projected’ onto new ideas (Ward et al., 2004: 2), very stereotypical features of an object (for instance, in the case of a clock, typical features might include; has a round face, two hands, is two dimensional, hangs on the wall and has numerals) will be integrated into design ideas leading to the fixated outcomes commonly seen (Nicholl and McLellan, 2007).

Once a cognitive plan is activated this remains active until the goal is achieved. This ‘retrieval bias’ (Smith, 2003), means that the activated cognitive plan acts as a ‘blocker’ to other lines of thinking, hence it is difficult for students to pursue other lines of reasoning. The process is further reinforced by teachers drawing attention to that product because students tend to direct attention to what a teachers says (Neisser, 1976), and as attention is a limited resource (Lavie, 2000), this reduces available cognitive resources for other avenues of approach. The same applies when students are looking at their research; students are not able to engage in other potentially more creative modes of thinking.

The provision of examples therefore appears to reinforce default cognitive processes that are unlikely to result in creativity. There is even some evidence that providing examples can be detrimental to design work, as features that

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6 It might be argued that the clock brief does not constitute a problem however the sequence of thinking described will occur even if the brief is a real problem. Duncker (1945) found, for instance, that people focused on the characteristic properties of boxes when presented with a box containing tacks, leading them to fail to solve a problem that required the box to be ascribed a different use to normal.
have been pointed out as exhibiting poor design may actually be integrated into designs subconsciously (Jansson and Smith, 1991). If students are not given guidance in how to conduct a product analysis (for instance in terms of what images to source) or in how to use this in generating design ideas, in the absence of any other input again creative thinking will default down the path-of-least-resistance with the likelihood of producing fixated outcomes. Hence product analysis, as used currently for the starting point or development of design ideas would appear to be problematic.

Conclusion
Product analysis, as has been discussed above, potentially restricts thinking and can lead to fixation. This presents a dilemma for teachers who are expected to use this strategy. Beyond statutory requirements there are many good reasons for providing examples. For instance the modelling of desired outcomes aids learning (Bandura, 1986) and the recognition of students’ work by putting it on display is an important motivational strategy (Ames, 1992). All new ideas need to be based on some knowledge (Finke, 1995; Weisberg, 1999) so students need some source of inspiration as a starting point. Further research is therefore needed to explore alternative ways of utilising product analysis so that practitioners can avoid the potential problems that product analysis presents, in particular to avoid the fixation trap.

References
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