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## Title

**'...we're not designing for a specific user at key stage 3'. Teachers' lack of planning of user-centred tasks in Design and Technology at key stage 3 in England and implication this has for pupils understanding of complex design tasks.**

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## Abstract

This paper discusses the importance of user-centred design by outlining its history, embodiment in national and international standards (for example, British Standards Institute, 2005) and its relevance in addressing the needs of an ageing population. It also outlines how a user-centred approach to design and technology has been part National Curriculum in England since 1989. Using data collected from two schools which includes, teacher interviews (n=4); pupil focus group interviews (12 pupils comprising 6 boys and 6 girls from two schools); a pupils survey (n=50) and departmental documents such as schemes of work, we found that many of the tasks teachers plan for students, do not provide them with the opportunities that allow for a user-centred approach. We discuss the implications of this and make some initial conclusions as part of our on-going research.

## Key words

User-centred design    Inclusive design    Design and Technology    Designing Our Tomorrow (EPSRC)

## User-Centred Design

### Introduction: Development of User Centred Design

Formal approaches to considering the needs of the user in the design process are nothing new and have evolved through the industrial age. As early as the 1890's Frederick W. Taylor developed methodical approaches to understanding how people worked to improve efficiency (Baumgart and Neuhauser, 2009). Designers such as Dreyfuss (1955) also promoted the importance of understanding people in design and he was responsible for designing a number of iconic everyday products such as telephones, a vacuum cleaner and an alarm clock based on anthropometric representations of ordinary people. Over this period, and going forward, the need for user-centred approaches has and continues to increase due to the ageing population. It is estimated that in the 100-year period from 1950 to 2050 the number of people globally over 60 will increase from just over 200 million to 2 billion (United Nations, 2001). Such a dramatic increase has a big impact on the structure of society.

*'The old-age support ratio is the number of persons aged 15 to 64 per person aged 65 years or over. It is an indicator of demographic ageing and of the degree of dependency of older persons on potential workers. The old-age support ratio fell from 12 persons aged 15 to 64 for every person aged 65 or over in 1950 to 9 in 2009 and is projected to fall to 4 persons of working age per person aged 65 or over in 2050. The level of the old-age support ratio has important implications for the solvency of social security systems (pensions and public health)' (United Nations, 2009:1)*

Inclusive Design is a user-centred approach with a particular focus on addressing the challenge of an ageing population (Coleman, 1994). It emphasizes the differences in peoples' abilities and desires and is neatly encapsulated in the expression coined by Becerra that it is '*normal to be different*' (Lange and Becerra, 2007: 1). It places the focus on diversity across the whole population as opposed to a narrower focus on disability (Newell and Gregor, 2002; Hosking *et al.*, 2010). User-centred approaches including Inclusive Design have now matured to the point where they have been embodied in national and international standards (see for example British Standards Institute, 2005; 2010).

The emphasis on the differences in people's abilities as well as their desires is important both to user-centred approaches and in the context of this paper. Since the year 2000, the I~design<sup>1</sup> research project in the UK (Cassim *et al.*, 2009) has focused on quantifying who can and cannot use products and why. Its research proposition is designers should '*...identify and evaluate the nature (kind of capability) and magnitude (the level of capability) of the capability demands imposed upon the user...it is necessary to be able to assess the features of the product to identify those that present difficulties to the user and, ideally why they present difficulty*' (Keates and Clarkson, 2004: 109). In order to make future products more inclusive, designers need to be better informed about what elements of a design may exclude and frustrate users. Various user research strategies (table 1) can help designers identify the nature and magnitude of the demands on end users' capabilities e.g. vision, hearing, dexterity and cognition.

Strategy	Definition
Self-observation	'the designer using the product themselves' (page 117)
User observation	'involves an observer watching users interact with a product' (page 118)
User interviews	Involves 'an interviewer asking an interviewee (the user) about the experience of using the product' (page 86)
User trials	'assessing products in their true context of use provides additional information not available from assessments performed in artificial usability laboratories' (page 120)
Simulation	'involves the assessor wearing physical simulators to mimic the effects of functional impairments' (page 121)

Table 1. An overview of strategies used to assess the utility and usability of products (Keates and Clarkson, 2004:117-123)

### User-Centred Design in Education

Given the history of user-centred approaches, it is perhaps not that surprising that '*the user, purpose and function of a product*' have been emphasised in all versions of the D&T National Curriculum in England since 1999 (Benson, 2009: 22). In the 1999 version of the National Curriculum (revised slightly in 2004) 'The Importance of Design and Technology' (DfEE, 1999:13) statement stipulated that pupils '*must look for needs, wants and opportunities and respond to them by developing a range of ideas and making products and systems. They combine practical skills with an understanding of aesthetic, social and environmental issues, function and industrial practices*' (DfEE, 1999:13). Furthermore, it stated that *pupils should be taught to 'consider aesthetics and other issues that influence their planning [for example, the needs and values of intended users, function, hygiene, safety, reliability, cost]'* (DfEE, 1999:20) and be able to '*identify and use criteria to judge the quality of other people's products. Including the extent to which they meet a clear need, their fitness for purpose...*' (DfEE, 1999 21). 'The Importance statement' in the latest version of the D&T National Curriculum stipulates that pupils should '*combine practical and technological skills with creative thinking to design and make products and systems that meet human needs*' and pupils should be able to '*identify needs and opportunities*' (DCSF/QCA<sup>2</sup>, 2007: 51). Indeed, one of the key concepts that underpins D&T, namely 'Cultural Understanding', states pupils need to understand 'how products evolve according to users' and designers' needs' as well as 'exploring how products contribute to lifestyle and consumer choices' (DCSF/QCA, 2007:52). Another key concept, '*Critical evaluation*' requires pupils to analyse '*existing products and solutions to inform designing and making*' as well as '*evaluating the needs of users and the context in which products are used to inform designing and making*' (DCSF/QCA, 2007: 53). Finally, the original National Curriculum had an Attainment Target for pupils that was entitled '*Identifying needs and opportunities*' (DES,1989). Policymakers then, clearly want (and have done for some time) pupils to be able to consider users' needs when designing and making their own products at Key Stage 3 (11-14 years).

To our knowledge, there have been no previous investigations on Inclusive Design in school, the focus of this research project, while some do discuss the role of tasks with respect to a "client or user" (for example see

<sup>1</sup> i~design is a major academic research programme that has helped to define, develop and disseminate inclusive design.

<sup>2</sup>

At the time these documents were produced, The Qualifications and Curriculum Authority was sponsored by the Department for Children, Schools and Families (DCSF) which maintained and developed the National Curriculum and associated assessments, tests and examinations as well as regulating examination bodies and examinations to ensure they are fit for purpose.

Kimbell, 1994). This paper explores to what degree user-centred approaches to design are taught in two English schools in the subject Design and Technology (D&T) at Key Stage 3 (KS3). We asked teachers a number of questions that probed how they planned and taught user-centred approaches to pupils as part of their D&T entitlement at key stage 3 (11-14 years). This forms part of an Engineering and Physical Sciences Council (EPSRC) funded research project called Designing Our Tomorrow (DOT) which has the aim of developing resources for D&T teachers for teaching Inclusive Design initially at KS3.

## **Methodology**

This paper concerns the pre-intervention stage of the formal pilot phase, which took place during the UK Autumn 2010 secondary school term. Sampling, in the choice of pilot schools, was purposeful. The two secondary schools involved were drawn from separate geographic regions within England, one being a rural and the other urban, with pupils from a range of socio-economic backgrounds. Members of the team had previously developed research and/or professional relationships with key teachers and thus hoped that members of staff would engage with both the research element as well as the teaching and learning resources. The overriding aim of the pilot was to enable further iterative development of the DOT resources, based on their use and drawing on the data that would be gathered.

Prior to the pilot phase, a pre- and post-intervention questionnaire was developed, trialled on two separate occasions in two different schools (to the pilot schools used in this study). At the start of the pilot, before any teaching of it, the questionnaire was administered during lesson time in the DOT pilot classes. Of School A's class of 31 pupils, 27 sat the questionnaire. All of School B's class of 23 pupils sat the questionnaire. Pupils were asked to base their answer-choices on their last D&T project. The questionnaire had 28 items over 3 sections and used a range of tick-box options. For each item in the first section, an option for not having done something in the pupils' last project, such as using finger restrictors, was included, plus a Likert (Likert, 1932) 4-point scale (1 being 'strongly agree'; 2 being 'agree'; 3 being 'disagree' and 4 being 'strongly disagree'). The second section used the same 4-point scale and the third section used yes/no choices. For each section no "neutral" answer-choices were available. Pupils were asked about what happened in lessons and their thoughts on this, incorporating what they enjoyed doing, what they found helpful for their learning, as well as a number of questions probing user-centred approaches and pupils' experiences of it in D&T.

A semi-structured interview schedule was developed and deployed in both schools. The class teachers and their Heads of Department were interviewed prior to the teaching of the DOT unit. Pupils' views were ascertained in 4 small focus groups (a group comprising 3 girls and another of 3 boys per school), with discussion following the same topics in each. The teachers were asked to select a representative sample of pupils, in terms of their academic abilities (results from pupils' work on the intervention will be reported in due course). For all interviews, and focus groups, audio recordings were made and transcribed. Members of the DOT team span Design, Engineering and Education backgrounds. Interviews and focus groups were conducted by a pair of DOT members, which always included the Education specialist.

Departmental documentation was also collected to help triangulate findings (Denzin, 1989). This comprised mainly a selection of each school's scheme of work<sup>3</sup> which was analysed for pre-existing user-centred strategies and teaching and learning activities.

This paper draws on the questionnaire data, which was input into SPSS (statistical software package), and the interview and focus group data, which was analysed using Nvivo (qualitative coding software package). Coding combined inductive and deductive analysis, with codes being derived from the qualitative data itself and drawing upon earlier secondary school D&T research (see Nicholl and McLellan, 2007;2008; Nicholl, McLellan and Kotob, 2008; McLellan and Nicholl, 2008; 2011). Check-coding was undertaken by two researchers to aid definitional clarity and as a reliability check (Miles and Huberman 1994: 64).

## **Data Analysis**

<sup>3</sup> 'A scheme of work is the overall planned provision of design and technology in a key stage. It is made up of units of work and shows the order in which they may be taught across the key stage' (QCA, 2000: 5). Furthermore, plans for a unit (or design and make project) 'are medium-term plans, usually designed for a term or less. They set out specific objectives that reflect the programme of study, as well as possible teaching activities and learning outcomes. (QCA, 2000: 5)

We asked teachers a number of questions about their planning of pupils' projects specifically at KS 3. We asked teachers whether they planned tasks that provided pupils with opportunities to consider the user when solving problems in D&T. In both schools, teachers said they didn't explicitly design tasks from the users' perspective as these excerpts reveal:-

I'm just trying to think if there are any... Not... There are no projects within Key Stage 3 curriculum at the moment that specifically looks at a user to start the project... actually in terms of projects that we do at Key Stage 3 there's not... they don't even sort of think about that. (Teacher A2).

Not really. Not in Key Stage 3 at the moment, no. (Teacher B4).

I suppose that... Because we're not designing specifically for a user at Key Stage 3 they're not getting that... they're not having that experience, because they're designing from a different perspective, I suppose, than actually having to truly understand the problem. (Teacher A4<sup>4</sup>).

Yeah I think we do that, but not hugely perhaps ...I am trying to think if in Year sort of 7 and 8 whether we do that very much or not at all...., and a bit in Year 9. But for example in Year 8 I don't know if I really tackle that or not. (Teacher B2).

We asked teachers whether they got pupils to design for themselves or for people other than themselves. Again, some teachers responses suggest that there is little evidence of teachers planning projects whereby pupils could design for other people or markets other than themselves as these excerpts reveals:-

I don't think any of them [projects] really get them to design for other people. Not specifically. I think even though some of the projects might sort of say that that's... wants to be the desired outcome. (Teacher A2).

...we would never want them to design for themselves... Or, if they were designing for themselves, we would want them to define that as a target market and we would want them to research around, so it's not merely themselves, it might be a teenage group. (Teacher A4).

Interestingly, the teacher in the first excerpt above states that the schemes of work does not '*specifically*' focus on the user, but some projects implicitly suggest that this is the '*desired outcome*'. The other teacher from the same school declared that '*we would never want them to design for themselves*' although admitted this was not explicitly written into departmental schemes of work at KS3, as it was up to the individual teacher to plan the user aspect of the project as this excerpt reveals:-

...naturally do it with most units, but not necessarily have written it into documentation [scheme of work]..., but it would be part of the research phase if a teacher had chosen to go in those particular directions. (Teacher A4).

We thought this was interesting and decided to ask teachers to talk about any projects that specifically addressed users' needs and/or users' desires in order to probe whether they implicitly covered this in their teaching. This revealed some interesting insights about the nature of tasks undertaken at KS3. First, some teachers described tasks that focussed on markets as this participant reveals:-

They don't necessarily address a real life problem, they're probably more adapted to needs and market driven needs. So for example, a Year 8 task to do the chocolate box, it's aiming at a specific market, and addressing that field, rather than a problem as such. (Teacher B2).

I am trying to think about Food whether... I mean I did like a smoothies project with them about er... a healthy drink for kind of working, commuting, you know on the trains and that. (Teacher B2).

In analysing the schools' schemes of work, it is evident that the projects described above do focus on users' desires or likes as opposed to their needs. For example, year 8 pupils (13 years) had to make the smoothie drinks in food technology. This required pupils to research the lifestyles of commuters aged around 25 years in order to identify what they might desire or want as this excerpt reveals:-

I had got some video clips just of programmes on the TV of the kind of age, and the kind of people, that it would be like. So we talked about what clothes they would wear, what music they would listen to, just to try and get them in the mindset of what those people would want. (Teacher B2).

In another example, a year 7 (12 years old) textiles project, pupils are given a standard wallet design to construct and are then required to 'embellish their product...they have designed for themselves...with hand held decorative sewing and stitching techniques' using a predetermined theme to design something a potential user might like (School A Documentation). Another year 7 project is described by the teacher as 'consisting of a pine frame and plywood lid of which there's some form of design, if you can call it that' (Teacher A1). Projects focussing on the acquisition of practical knowledge and skills, whereby pupils construct the same product, using materials prepared in advance, and where pupils have limited opportunities to embellish or decorate a surface, sometimes to a given or chosen theme, which might be framed around a potential market are common projects planned by the teachers. The implications of focusing on desires and likes only, will be discussed later in this paper.

Consequently, teachers planned few, if any tasks that provided opportunities for pupils to design for users' needs as part of the statutory curriculum entitlement discussed previously. Again, this was confirmed during the teacher interviews when they were asked whether they used any of the 'user' strategies outlined in Table 1. Analysis of schemes of work and related items in the questionnaire we asked all pupils confirms that these strategies were not used in any projects at KS3 across the two schools. This data is summarised in appendix 1. The implications of this will be discussed later.

Several teachers did however, describe examples of projects they had taught outside of the statutory curriculum which did focus on users' needs [as opposed to their likes or desires] as these excerpts reveal:

We had a kid last year... who wanted to make like a... an arm for people who had half their arm blown off... And it was like a kitchen gadget, it moved... It did all these things and we made a model of it. We made a lovely model out of papier-mâché but I have no idea how that would work, but the kids were so enthused in it, because it was his own idea. Completely his own. And he stood up in front of the Dragons<sup>5</sup> with this massive papier-mâché arm talking about it, and I think he actually won. (Teacher B2).

We had a day actually, which was called, 'Design for the Disadvantaged'. And my group was erm arthritic fingers and limbs, they were designing... it was for the elderly, it was like garden tools and people with only a couple of fingers, and how they would strap... how you'd strap something around, whilst still having the pressure to push into the earth, to use a... erm... We did that. We did... There was one on electronics, there was visually impaired, and we blacked out goggles, and said to the kids, 'Right, you've got an hour around school where you're visually impaired'. (Teacher B4).

These last two excerpts are interesting as they describe projects based on users' needs that were undertaken outside of 'normal' D&T lessons. For example, the 'design for the disadvantaged' was undertaken when the school timetable was suspended for a day in the summer term of the previous year, where year 9 pupils (14 years) could choose to undertake this task for the day. The assistive arm described above was done by a year 7 boy who was part of a selective group of pupils who were acknowledged as 'gifted and talented'<sup>6</sup> and this work was undertaken during his lunchtimes and after school as this excerpt reveals:

We have got some kids in – gifted and talented year 7s at lunch times doing the *Dragons' Den* Club. And they all come up with products... I was trying to get them to think of a specific target market... (Teacher B2).

## Discussion

The analysis of the data above raises some interesting issues and these will be discussed in turn. Perhaps the most surprising finding was the lack of opportunities across the whole of KS 3 for pupils to design based on people's needs, wants or desires. There was some evidence that teachers planned opportunities for pupils to experience designing based on users' desires or likes, as in the embellishment of the wallet example discussed previously. There was little, if any evidence of teachers planning based on users' needs, whereby pupils were given opportunities via appropriate strategies (outlined in Table 1) to '...assess the features of a product to those that present difficulties to the user' (Keats and Clarkson, 2004:109). Where teachers did plan opportunities for pupils to design based on users' needs, this was done outside of normal D&T lessons, that is, not part of the statutory entitlement for all pupils. Furthermore, these two examples seem to focus narrowly on disability and not on *'diversity across the whole population'* as discussed earlier. This lack of opportunity for designing for people's needs is a little surprising given that user-centred design has featured prominently not only in the latest version of the National Curriculum discussed previously, but in all versions over the past 20 years.

We are not necessarily advocating that all tasks should have a user-centred dimension. Much of what the two schools participating in this study do in terms of projects can be described as progressive and good practice. We are not advocating 'throwing out the baby with the bath water'. What we are highlighting, however, is that the distinct lack of opportunities for pupils to experience tasks that allow them to solve design problems based on users' needs at KS3 ought to be redressed. The status quo is limiting, as pupils never have the opportunities to develop their understanding of solving complex [D&T] tasks (Doyle, 1983) at KS3. Indeed, current and previous versions of the National Curriculum have acknowledged '...the breadth of the subject on which teachers should draw when teaching the key concepts and key processes...should include an understanding of...users' needs and the problems arising from them' (QCA, 2004: 55) and pupils should have opportunities to 'engage in design and make assignments in different and progressively more complex contexts, including for purposes and uses beyond the classroom' (QCA, 2004: 57), something the 1999 version also stipulated. In other words, the breadth of study at KS3 could, indeed should, allow some opportunities for pupils to solve problems based on people's needs as part of their statutory entitlement. This, we argue, is currently not happening in the two schools in this study. Of course, teachers' lack of planning tasks based on users' needs warrants further investigation and this is part of our on-going research. Our initial analysis of the data suggests, however, that the reasons are varied and complex and this will be reported in due course.

## Conclusions

The initial conclusions from this work are:

1. User-centred approaches have matured over the last 100 years and have been part of the National Curriculum entitlement for over 20 years.

2. In the schools analysed there is a clear lack of opportunities to learn and practise user-centred design.
3. Where elements of a user-centred approach are included they tend to focus on the desires or wants of the user and do not address the users' functional needs.
4. Where capability variation has been considered it tends to focus on disability and not the general diversity across the population.

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## Appendix 1

Strategy	definition	Teachers’ interview responses about their use of these strategies at KS3	Pupils responses to items asking whether they used these strategies in their last project Number=50 pupils	Whether these strategies are explicit in schools’ scheme of work
Self-observation	‘the designer using the product themselves’ (page 117)	‘Not really, no. We don't do...’ (Teacher B2)	No=82.0% Yes=14.3% Void=3.7%	No
User observation	‘involves an observer watching users interact with a product’ (page 118)	‘No. I don't think I do’. (Teacher B2) ‘No. I can't think really...’ (Teacher A2) “plays a significant part our KS4 and it probably should be a fundamental part of our schemes of work	No=68.2% Yes=28.15% Void =3.7%	No

		in key stage 3'(Teacher A1)		
User interviews	Involves 'an interviewer asking an interviewee (the user) about the experience of using the product' (page 86)			No
User trials	'assessing products in their true context of use provides additional information not available from assessments performed in artificial usability laboratories' (page 120)	'No, I suppose we don't'. (Teacher A2)		No
simulation	'involves the assessor wearing physical simulators to mimic the effects of functional impairments' (page 121)	'Not really, no. I can't think. Not... not at Key Stage 3'. (Teacher B2). 'No' (Teacher A4) 'Not really, no....not at KS 3'. (Teacher A2)	No=92% Yes=4.3% Void=3.7%	No