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Designing in elementary/primary classrooms

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Abstract
There is a lack of evidence about how teachers in primary/elementary schools are translating curriculum requirements for teaching design, within technology frameworks, in their classrooms and how ‘school situated design’ relates to ‘workplace design’. This paper explores the relationships between designerly thinking and behaviours situated in classrooms and in the workplace, beliefs about how designing is learned in schools and in the ‘real world’, and children’s and adults understanding of design. These are best illustrated by extracts from interviews with teachers, children and designers and evidence of designing in classrooms and in the workplace. Similarities and differences between evidence from ‘school situated design’ and ‘workplace design’ and from the United Kingdom and Canada are discussed.

Introduction
This paper explores the relationships between designerly thinking and behaviours situated in classrooms and in the workplace, beliefs about how designing is learned in schools and in the ‘real world’, and children’s and adults understanding of design.

Rationale/Research questions
There is a lack of evidence about how teachers in primary/elementary schools are translating curriculum requirements into teaching design and how curriculum requirements and ‘school situated design’ relate to ‘workplace design’. Research is needed to explore a range of topics and the researchers selected a number for investigation.

Based in Canada and the UK, the researchers co-operated through exchange visits to explore the following research questions:
1. How do primary/elementary teachers conceptualise and teach designing?
2. How do children in primary/elementary classrooms learn how to design?
3. What are the relationships between designerly thinking and behaviours situated in classrooms and the workplace?
4. What are the similarities and differences between approaches to design education at the primary/elementary school level in the contexts of England and Canada?

Methods
The exploratory and complex nature of the present inquiry was best suited to the qualitative research approach of case studies within three groups, teachers, their students and designers, employing multiple data collection methods and triangulation of data (e.g. Bogdan and Biklen, 1998; Stake, 1994; Yin, 1994). This detailed study of a few cases is intended to provide data to form research questions for a larger study.

Data sources and analysis
Data were collected through interviews, classroom observations and dialogue, photographs, and design documents. Interviews were conducted with four teachers, eight of their students and four practising designers, half of each group from each country. The interviews were tape recorded and transcribed for text analysis. The two primary/elementary schoolteachers in the UK taught students aged four to five and eight to nine, and in Canada the teachers taught students aged six to seven and eleven to twelve. The interviews explored the teachers’ personal knowledge of designing, their understanding of how children learn to design, and their curriculum and pedagogical subject knowledge in design. Observations of, and interviews and dialogue with, eight children taught by the teachers were carried out to document students’ understanding about episodes of designing in classrooms. One girl and one boy who were articulate and interested in design related to technology were selected from each class. Materials developed by the children, such as reports and portfolios, and photographs of children’s
artefacts, both finished and under development, were collected. The two designers in the UK were a mechanical engineer and an architect and in Canada, fashion designers and a graphic designer. The interviews probed their beliefs about designing and how designing is learned. Materials from their portfolios were also collected.

The transcribed textual data were first analysed by group, that is teachers, their students and designers, according to country and placed into categories that responded to the research questions. The photographs were used to depict what teachers, their students and designers described in interviews. The children’s developed materials were used to support the teacher and student interviews, dialogue and observations. These multiple data sources permitted triangulation of data within the different groups. Following the completion of this analysis by country, the data from the two countries were combined keeping the same categories and analysed. The data from the multiple groups allowed for triangulation of data from different perspectives, as well as comparison and contrasts within and across groups and countries.

Findings

Voices from ‘Workplace Design’: The Designers

Design is typically carried out to meet a perceived need. Need varies greatly in context from creative endeavours to specific technical endeavours, and the technological process can be interpreted as creation, invention, modification or response to specific criteria. There are also many fields of ‘workplace design’ where design in ‘real world’ contexts occurs. In this study a mechanical engineer and an architect from the UK and fashion designers and a graphic designer from Canada represent ‘workplace design’ in four different design fields.

The mechanical engineer’s project was to design an interactive for children in a museum. The purpose of the interactive was to offer a visual/mechanical explanation of the phenomena of the distinctive ‘diddly dum’ sound railway carriages make as they cross the joints in British railway tracks. The architect’s project was to design a one-off dwelling for a wealthy client in the British Virgin Islands. Initial conversations between the client and the designer were focused on life-style and practical requirements for the dwelling. The fashion designers’ projects were to design new lines for their employer. One designer of children’s clothing owned a small company with 12 employees. A second fashion designer was part owner of a medium sized manufacturing business of women’s sportswear employing 30 to 35. A third designer was employed by a manufacturer of women’s clothing with about 1300 employees. The graphic designer’s project was to design a logo for a new housing development.

All designers indicated that a critical part of their work was to thoroughly understand the design project at hand; its need, the problem(s), the criteria, the constraints. In order to do this it was important to first investigate the situation. In all cases this meant meeting with other people. All designers gathered information from these meetings and then conducted investigations to more fully understand the design project. These meetings and investigations varied for each design field. When several fashion designers described design and how they conceived their ideas, there were variations even within this one design field. The process of generating and communicating initial design ideas also varied. The mechanical engineer generated initial design ideas alone.

“Often I’ll do the thinking away from the problem and bring the solution in the form of a sketch to the team and the group interact with the sketch.”

The architect took notes during initial meetings, compiled a brief, began to sketch, and then had additional meetings with the client. There were differences between the four fashion designers in how they conceived their ideas but they all needed to know their clients’ requirements. While there were differences in how a designer gathered information and generated and communicated ideas to others, these were consistently two significant patterns in their design process. The graphic designer began with a ‘word picture to organise my thoughts
and perhaps discover some theme or pattern’ then ‘concentrated on developing one idea at a time.’ He then further developed each idea. After exhausting possibilities for the idea, an entirely new idea was explored. All designers continued the process of researching, developing ideas and meeting with clients. Rowell et al (1996) also documented this iterative process.

Amongst the four designers, there were many concrete suggestions for learning about design. The mechanical engineer suggested that children should be encouraged to design in groups. He believed that children should be taught how to draw:

“I believe that training (in drawing) was seminal in forming an ability to turn an object around in my mind’s eye”

Drawing was the ‘universal language’ of engineering drawing. He believed they should be taught how to handle materials through problem solving_playing with construction kits; about the physical properties of material so that designs were based on sound principles of physics; and hand skills so that they understood the practicalities of turning design ideas into prototypes. The architect believed that children should be taught: to use drawing as a tool for generating and representing ideas; the aesthetic concepts of ‘proportion, balance and visual harmony’ but in relation to their immediate built and natural environment. He believed children should be educated in basic physical concepts such as ‘tension and compression of having a slab over the top of a wall’ and that this could be developed through model making and using construction kits in schools. All fashion designers talked about the need for students to develop a good sense of observation of the world around them, a desire to travel and the ability to be open-minded to life experiences and culture in order to be in touch with the world around. One of the designers talked about other skills and knowledge such as ‘good science, communication skills, the use of computers, textiles and fibres, statistics definitely, measurement.’ Beyond these more generic requirements, the designers emphasised technical knowledge and hand skill requirements specific to fashion design. The graphic designer talked about how he learned to design ‘by playing with elements.’ He thought that designing should be taught, ‘with a combination of both structure and freedom. Too much structure leads to boring and predictable results. Too much freedom tends to frustrate, as it is meaningless without boundaries...Playing is important for individual discovery. Structure helps us to organise common themes and becomes a tool for creative freedom.’ His greatest concern about how design is taught and learned was the attitude that educational institutions have toward design.

“It tends to be treated as an artsy frill rather than something that has a real impact on our lives.”

‘School situated design’: the teachers and their students
In the UK the teacher interviewed described designing as ‘thinking of something you need or want’ or ‘improving something you’ve already got’. Ideas in designing were driven by ‘aesthetics’ and ‘how things work’. Her task as an educator of four to five year olds was to introduce children to the grammar and vocabulary of designing. Much of what she did was materials based and hands-on. She did not require the children to ‘draw’ their design ideas, since their ability to represent 3D objects in 2D was limited, but she introduced them to strategies for organising their thinking. The task for the children was to make puppets. She resourced their ideas by showing them different types of real hand puppets and some in video extracts. The children planned their own finger puppets on a worksheet. Chosen materials were laid onto the worksheets with words to describe them but the children were mostly unwilling to discuss their plans at this stage. Their design choices were dictated by the aesthetic appeal of specific pieces of material rather than their fitness for the function. Many of the puppets fell to pieces when the children played with them. The young children found it difficult to talk about designing. They said that their ideas were ‘inside my head’ and that the puppets were ‘good’. They found it impossible to speculate how they would make a better puppet next time.

The teacher of the eight to nine year olds had a strong belief that children should be
encouraged to design for 'real life needs'. The task set for these children was to design a 'rainproof' 'holder' which would 'leave their hands free' to carry their picnic lunch for a walk alongside the local canal. The children were asked to sketch a design for homework, and in some cases parents became involved in the problem solving. The children's decisions were based on the 'look' of the holder rather than its function. When asked about the stimuli for their design ideas they gave idiosyncratic replies - "I had a fish and I just thought I'd do one like a fish." To translate their ideas into outcomes many compromises had to be made as the resource store in school had limited materials. Two parent helpers worked alongside groups of children using a sewing machine. The children acknowledged that without adult help they would have floundered. The evaluations were the most exciting part of this task. Lunches were packed into the holders and they were rigorously tested along the canal side. Only a few passed these tests! In general, despite the efforts of their teacher to get them to record their designing on paper the children claimed that left to their own devices "I'd probably just get on with it". When asked how real designers worked, they acknowledged "they'd probably still draw something out, but they'd be measuring and doing it properly".

Many of the ideas were in the students' heads. She indicated that students who were comfortable with drawing 'will either add more detail, draw different views and add dimensions. Students uncomfortable with drawing will add measurements and want to start immediately in on their projects.' She did not think that all children designed in the same way, whether in the same grade or in different grades. Students generated their ideas 'from examples of other students' work or other products, talking about the designs and functions of the products, past experiences and books.' The teacher did identify some differences between younger and older students' approach to design. "Younger students tend to really put a lot of detail into their initial designs." She also saw differences in how different age groups used 3-dimensional modelling to design. Her observations supports Jones' (1997a) findings that young children have difficulty with modelling and that the process of modelling may confuse young children.

The overall instructional strategy that was used in the design centre was to set timeframes for: brainstorming on the large sheets of paper; regroup as a class; listen to each student's idea; offer one or two comments; begin to design a product through drawing; regroup as a class for students to write in their logbooks; continue the designing; make the model or the prototype. The teacher interpreted her role as 'interacting, communicating, acting as a resource.' The teacher had resources in the classroom to assist both students in their research and her for her role in teaching technology. A computer program was used for students to learn independently technical knowledge and concepts, as were a variety of books that covered both design process and technical aspects of technology. The main concerns that this teacher had about teaching and learning design in the elementary school was 'the personal expertise needed to teach the students the basics and the process.'

This teacher's class of six to seven year olds had studied technology for two years. The boy remembered previous design activities that related to movies.
"I like to design parts of movies. I think of a part and use something like a cherry tomato box to make a part of the movie and make it stand up."

The girl remembered crafts like ‘a butterfly with wings from a clothes-pin.’ The project that these students and their classmates were working on at the design centre during this study related to their classroom work on insects. The boy described designing as ‘using a pattern to make something’ and ‘making things.’ The girl described designing as ‘drawing’. Their definitions appeared to be based on their experiences in their own design exercises. Their understanding of design activities was also based on their classroom experiences. The boy, thought that designers ‘drew, use materials or machines and make it’, and similarly the girl saw designers as ‘drawing on a piece of paper and making it 3-D...making things’. The boy identified sculpting and house building as designerly activities and the girl 2-dimensional maps, art and knitting.

The eleven to twelve year olds were completing a mask project. The students worked in groups or alone. These students easily expressed their understanding of design. The female student indicated that design was:

"when you write or sketch a structure and then you follow your design or sketch and then you build your structure."

However, she could not think of a designer and the activities they would do until the end of the interview. The male student said:

"I think designing means ... ideas and putting them all together to make something ... The people who design cars and aviation things and stuff ... they sketch out a lot of stuff on paper and design."

The mask project had two parts: the mask itself made of papier mâché and an electronic control panel to control a signalling system that was then attached to the inside of the mask. The ideas stage of the mask part was very exploratory in nature. When the girl described how she communicated her ideas to others, the initial sketch and how it had evolved, she explained, “everything we were going to put on was (sic) here” pointing to a sketch on paper. This initial idea evolved throughout the technological process. This replicated results in a study examining how secondary school students designed for ‘real life’ contexts (Hill and Smith, 1998; Hill, 1998). Although a drawing was required for the mask making, a 3-dimensional model was not. The girl’s sketch of the mask was detailed, on a large piece of paper, and annotated with written notes. The boy worked with a partner instead of a group. The sketch was very small even though it was on a large piece of paper. There was little detail to the sketch and there were no written notes. He did not seem comfortable in talking about how he came up with the idea for the mask and the sketching, and described it all as ‘brainstorming’. However, he was anxious to talk about the construction of the mask and the second part of the mask project, the control panel. When dialogue about the control panel began in the interview the boy was very articulate and used correct terminology. Although the girl seemed less enthusiastic about this part of the project she was also very articulate.

When these older students talked about what they found easy about designing at school the girl indicated that “the papier mâché did not take that long but the electronics (sic) is taking a little bit longer” and that there was lots of testing. The girl indicated that “mostly the sketching and the ideas” were easy but that “putting it all together is really hard.” The boy on the other hand found that, “once you get to know it, it is not that hard ... it stays in your mind and it is easy and it is fun.”

Both students explained that the teacher was both helper and teacher and confirmed that she used the teaching strategies identified earlier. Besides the teacher, students learned about designing from family members. While they both enjoyed studying design and technology, only the boy thought he would like to be a real designer to design “vehicles ... like racing cars.” The girl was wary when asked if she would like to be a real designer.

"Not really. It is kind of complicated to make a bigger version of what we are doing now. Like making elevators and buildings. I do not think I could do that.”
Conclusions

While there are similarities in ‘workplace design’ - from ideation to finished product - within and across different design fields, there are also substantial differences that cannot be ignored once design is put into the context of a design field. However, descriptions of ‘workplace design’, textual and visual, indicated that design development exemplifies an iterative processes of decision making from concepts to prototype outcomes, to evaluations and to final product and that this was consistent within and across design fields in both countries.

Children in ‘school situated design’ situations did not design in similar ways either, within or across age groups. The teachers seemed to acknowledge this, particularly in Canada, and yet curriculum and didactic materials aimed at ‘school situated design’, particularly in the UK, persist in an emphasis on ‘drawing skills’, ‘modelling skills’, ‘design process skills’ (see Anning, 1997) that are generic in nature. This research brings into question the utility of a generic approach alone, without translation into a context and a close examination of skills required for different design fields. This research also suggests that patterns in a design process vary across age groups due to developmental differences that affect both interests and abilities (see Anning et al, 1996).

Exploration of ideas and resources in design field contexts was seen as important to designers, teachers and the students and there seemed to be time allotted for this exploration in ‘school situated design’ in classrooms. The girls and boys demonstrated different interests in, attitudes towards and perceptions of technology. Choice and independence seemed to be appreciated by the children in Canada. In both countries the teaching of technological skills and concepts and teacher assistance, while sorting out ideas and building the artefact, were appreciated as supportive by children. Designers consistently talked about how they worked in a team, but the schools did not foster team working.

Further research is needed to examine how teachers can manage classrooms that emulate features of contextualised ‘workplace design’; while acknowledging differences in design practice for different purposes and the requirements of children of different ages with different interests.

References