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Young children’s learning strategies in design and technology

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Abstract
The value of understanding the procedural knowledge that young children bring with them to the Design and Technology task is addressed in this paper. The research so far provides an investigation into young children’s learning strategies and goes some way towards identifying emergent, developing and changing strategies during key stage one. It challenges the conventional Technology problem solving models and strategy cycles and poses questions concerning optimal times of capability. In doing so it attempts to gain greater insight into children’s motivation for their actions and through their perceptions of the classroom culture, raises broader issues regarding early years education.

Introduction
The aim of the study was to trial methodology that would serve to identify, classify and describe the strategies young children bring with them to design and technology education and to trace this strategy development through the reception class. It was also to try to describe the properties of these strategies and the relationship between them, and to begin to explore the social context in which this development may take place, seeking key concepts or themes underlying children’s motivation. It was hoped to use the findings as a starting point from which to consider further in-depth research into young children’s strategies and their relationship to technology education.

The word ‘strategy’ is much used and abused in education. The notion of ‘strategy’ may suggest many different procedures. It can mean an approach or a tactic, a plan, a grand design or a simple process. It was decided to seek the conscious or unconscious procedures that young children use in order to control or work upon their environment. The word strategy was tentatively defined as a control process.

Background
The importance of problem solving strategies has always been paramount in technology education but until recently very little research seems to have been done into young children’s problem solving strategies in design and technology. However the design and technology problem solving process is now beginning to be questioned and the marked absence of empirical research concerning what pupils can do in the classroom has been highlighted in work by Hennessy, McCormick and Murphy [1993]. This study concerning children in the early secondary age range reveals the complexity of how pupils undertake design and make tasks and the need for teachers to explicitly teach techniques which will assist pupils problem solving strategies. It supports the most comprehensive pre-national curriculum classroom study on general learning strategies in older pupils [Nisbet and Shucksmith, 1986]. This study concentrated on developing procedures in reading, writing and mathematics but also began to explore more general strategies such as planning ahead, monitoring performance, checking and self-testing. It was suggested that children may possess learning strategies but not use these rationally or productively when faced with a task in the classroom until they are supported by an adult.

Work is now beginning to be done on the strategies exhibited by children under 11 years old in designing and making. Close observation of primary children engaged in design and technology in the classroom has been done by Rob Johnsey [1993], in his case study of two girls in a Y4 class undertaking a one hour project. In attempting to identify the
relationship between their behaviour and simplified models of designing he also exposed the complexity of their strategic action. Rogers and Clare [1994] have focussed on the use of a Process Diary to aid children’s reflection but this is one of the few research projects to include 5 year olds or children beginning their formal education. However Joy Cullen in Australia has traced individual preschoolers’ general learning strategies to their first months in school and linked this to teacher management styles. In this country important work has been done by Yvonne Outterside [1993]. She has observed the emergence of design ability in a two and a half year old child and traced the growth of perceiving, imaging and modelling towards school age. She concludes that it is evident that children enter formal schooling with a wealth of knowledge and experience relating to design which should be utilised and built upon by the teacher.

The present study was framed to acknowledge the problem solving skills and strategies that young children bring with them to the design and technology task in the reception class, and to trace these strategies through the Infant school. It was hoped that this work would help to support teachers at key stage one by providing a clearer conception of what young children can do when they arrive at school and what they might be expected to achieve in the first months.

The study
The aim of the study was to trial methodology to identify and describe strategies by trying to find effective ways of observing and recording children using them during design and technology tasks. However the results of the first data collection in the classroom before Christmas encouraged a further study of the same children at the end of the school year in order to verify findings. It then became evident that during the intervening months the children’s strategies had not only developed but new control processes had emerged and others appeared to decline. Additional objectives for the study ensued concerning the relationship of children’s motivation and maturity to the development of these strategies together with a perceived need to look closer at the nature of the task, the school context and the interaction between the teacher and children.

Data collection
The sample consisted of eighteen reception class children organised in three groups according to age and experience in school. When the study began all the children were aged between five and five and a half years old. The three groups tackled identical design and technology tasks twice during the year and naturalistic observation was used as a means of data collection. The teachers help and intervention was kept to a minimum during the problem solving activity. It was felt necessary to capture the children’s actions in as natural and unconstrained a context as possible giving the children maximum control over their learning. The complete lesson with teacher’s introduction and children’s verbal responses to the task were audio-taped and data was collected concerning the children’s actions and social interactions with peers. This was done so that the focus was equally on verbalised strategies and the observable but inaudible task adequate problem solving behaviour. It was then possible to sort, classify and code both children’s utterances and actions together in context.

The need to trace the development of the initial findings concerning strategy identification, classification and age association in a similar context led to further data collection with the same groups of children six months later. The youngest reception class group were now the same age as the oldest group in the first task. This was interesting in terms of strategy identification as it may be expected that they would now exhibit similar strategies. While the oldest group of children had ‘gone up’ so were now the youngest group in a year one class.

Data analysis
Qualitative data analysis was used to attempt to gain insight into children’s motivation for their actions. It was hoped not only to identify and describe children’s strategies but to form some ideas about why they used them. Systemic Networks were used to try to identify and classify strategies and represent them in a form which allows the task to be seen through the child’s
eyes [Bliss, Monk and Ogborn, 1987]. These networks serve to both categorise and describe the children’s strategies and to distinguish their options or choice of action. They display the relationship between these choices, the children’s own wants and needs and the constraints of the context. The networks are both an analytic coding and a knowledge representation device and are generated at different times in the study and for different groups as the children grow older. As the same notation is used each time it is possible to compare and contrast the networks and trace the children’s strategies as they evolve and change.

The first network was structured to make explicit a child determined cycle of strategies. The network distinguishes between two areas; the children’s specific strategies and general characteristics of these strategies, although these sub-networks are interdependent.
A central Bar was constructed of mutually exclusive categories. These categories were couched in young children's phraseology and represented a selection of strategies designed by them to cope with the demands of the problem solving situation. The cycle of the session had a natural recurrence, hence the recursion notation, and aimed to focus not on starting and finishing, as more data is needed here, but on the way the children see themselves as maintaining the momentum of the session or in their own words KEEPING GOING.

Pupils choice of strategies were presented in terms of how they responded at the beginning of the technology session [GETTING ON], how they helped themselves or others [HELPING THROUGH], and how they encountered and responded to error [SURVIVING MISTAKES]. The children's initial strategies such as deciding upon materials and ideas [CHOOSING] and collecting resources [GATHERING] were devised to get themselves started on the task and were shown as mutually exclusive categories in the network. Strategies to aid their individual progression were evident, such as telling themselves what to do [TALKING TO SELF] or offering work to others for their opinion [SHOWING]. Hoping for someone else to act [WAITING] was also apparent and confirming their ideas with others [CHECKING].

Co-operative strategies played a large part for example “I'll get the glue on then you sprinkle the glitter over” [SHARING], and comforting rather than squabbling were surprisingly evident; “You just had a little accident with the paint. Don’t worry, that’s it. There you go” [STROKING]. Conservation strategies were also much in evidence especially where materials such as sequins and tinsel were highly valued by the group, and it was possible to discern the progression of conservation techniques from the youngest to oldest group [SAVING]. However, holding resources for their personal use was also perceived by the children as a useful strategy [KEEPING].

SURVIVING MISTAKES entailed strategies concerned with acknowledging error; “I’m so silly aren’t I. All my hands have gone gold” [REALISING MISTAKES]. Taking action to rectify error [PUTTING RIGHT], and discarding work completely was used by individuals or pairs [GIVING UP]. Categories of behaviour perceived as non-strategic in terms of tackling the task such as unrelated play, off task or other activities were shown separately in the network. Later in the research it should be possible to include greater levels of delicacy as distinct aspects of strategy categories are identified.

This part of the network attempted to create a means of describing young children's strategies in their own words. It was accessible to adults and simple in structure. However this apparent simplicity should not conceal the sophistication of the strategies themselves. The complexity of these procedures apparently designed to achieve certain aims was quite revealing. So what was the motivating force behind these activities for the children? What concerns urged them forward? These formed a GENERAL CHARACTERISTICS OF CONCERNS, co-selection or Bra in the network. The bracket, abbreviated to Bra, is used in a network where options co-exist, therefore although children would use only a selection of strategies all would be subject to their basic concerns.

General characteristics of children's concerns

Having made a first attempt to identify some of the learning strategies young children bring to the technology task some ideas were beginning to form about why they used them. The data was then approached using open coding followed by some selective coding on certain areas of the transcripts focusing on specific categories [Strauss,1988]. Through this type of analysis key concepts or themes underlying children's motivation might be exposed and perhaps some of the basic concerns that motivate young children towards devising and using strategies during problem solving.

The TIME factor seemed important to the children. There appeared to be an underlying awareness of time and an urgency to progress through the task. This was reflected in references in the transcript to time taken,
wasted, passing slowly or quickly. The categories in the network mirror this will to 'get on' as the children described it. The groups had distinct strategies for getting themselves started and an obvious will to push forward. They also seemed to use giving up as a means of moving on from unsuccessful activities to more productive ones. If an activity was too difficult or was taking too long in their terms they would not hesitate to discard it. Finishing strategies were apparent from the children's awareness of the need to finish on time “It's time I finished, I've been here for ages and ages.” to their pride and satisfaction in completing the task.

The children's GOALS formed the stimulus to begin the task and seemed to stem from their will to produce or create. They seemed to have a very strong PRODUCTIVE concern. They were motivated by their wish to make a picture of a toy or a Christmas tree. In all sessions “wanting to do” was the starting point. The older children were more immediately decisive, making what appeared to be instant decisions and wanting to waste no time in starting. The youngest group were not so clear about what to make but all were keen to produce something.

A desire to work with the materials provided seemed to be equally important to the children as a impetus to learning. They had a great urge to EXPERIENCE. When a child announced at the start of the session that his main aim was to use the glitter many of his group nodded in agreement. The type and range of resources provided seemed very important as an incentive to proceed. Certain materials such as coloured glitter, sequins, pins, fur, ribbon, balloons and felt tipped pens were explored eagerly and conserved carefully by all children. There seemed to be an unspoken agreement that these things were highly prized. The children valued them for their own sake and discussed their properties such as sparkle, shine or softness. They were also extremely interested in colour. The colour of card and even scissors was very important particularly to the older children. Choice of experience through the use of certain materials was by far the most important aspect of starting strategies in terms of number of responses. For all the groups colour of material was the prime criteria when choosing resources although the extent of this varied with age.

This urge to produce and experience existed alongside LIMITATIONS in the form of the CONSTRAINTS OF THE SCHOOL system. The children were continually checking their ideas with peers, the researcher, and the teacher who represented the ultimate authority on what was appropriate in a given situation. When asked by her friend “Can you put birds on Christmas cards” Hanna replied thoughtfully, “Only robins. But fairies fly.......No, angels are OK.”.

All strategies occurred within a perceived need for CONFORMITY by the children and a framework of what was seen as ALLOWED, from using cotton wool to staying in the classroom to finish the task at playtime. This awareness of the need to conform was constantly apparent in the data as the children strove to make sense of the classroom culture, often meeting my questions concerning everyday out of school events with school based answers. This did not mean however that they always acquiesced to expected patterns of behaviour. Within the limitations of the expected codes and frames of the classroom the children managed to SATISFY THEIR OWN WANTS AND NEEDS by reposing tasks to suit their wishes. They played the system and were good at it.

A concern to COLLABORATE seemed evident from the research data. The children appeared not only to strive to achieve themselves but to attempt to take some responsibility for the achievement of group members. They shared ideas and materials, encouraged and praised each other when things went well, and comforted and made helpful suggestions when mistakes had been made. Again this happened to a greater or lesser extent depending on the age of the group and indicated a development in strategic learning.

Changing strategies
There were noticeable differences in the strategies used by pupils mainly characterised by the amount of time spent in school. This
time corresponded to their age but although the type and range of strategies used by all groups were similar the number of times these were exhibited seemed to vary. Children from the oldest and middle age groups used more frequently strategies associated with 'assertiveness' such as showing and choosing. The youngest pupils used only infrequently CHOOSING and GATHERING strategies but exhibited a more passive and possibly 'watching and learning attitude' by using more NOT MINDING and WAITING strategies. Throughout the technology task the oldest group were perceived to be the most decisive pupils.

During the progression of the technology task there seemed to be a levelling of responses as the children got older. The incidents of SHOWING their work to others increased in the middle age group but decreased again in the oldest pupils. This also happened in checking ideas with friends and the researcher. There was a sharp increase in CHECKING as the children grew older followed by a slight decline in the oldest group. The perceived strategy of talking to themselves in order to aid activity also followed this pattern.

Comparing the analysis of the first and second task data it was apparent that many of the same strategies exhibited by the children in the first task were still present in the second. The youngest group were now using the same strategies as the oldest in the first study and were pro-active or assertive judging from the numbers of responses collected and classified. The middle group were quite active in terms of learning strategies during the task but the oldest group's strategies were fewer in number. Over the six months from December 1992 to June 1993, the time from the first to the second task, the youngest children's strategies had appeared to develop rapidly, the middle groups to stabilise, and the oldest had seemed to exhibit appreciably fewer strategies.

An equally interesting aspect of the data was the identification of newly emergent strategies of a different nature to those found in the first task. As SHARING strategies seemed to decrease in number in the oldest children so COPYING and BLAMING emerged as new strategies and as TALKING TO SELF appeared to decrease so HELPING TEACHER appeared. Alice declares “Katy's gone. She isn't helping you tidy up. She crept outside like a little old tortoise.” After many accusations concerning one member of the group copying another, Orin whispered “See that tape recorder. It's copying everything you say. Don't say a word”.

Implications

It is debatable whether the perceived strategy developments outlined in this study are conducive to better learning and success in design and technology. We are beginning to learn to value children for the way they are at present and not always for what they may become. Their experiences are valid in their own right. This research goes further to suggest that young children may have skills and capabilities that they do not have later in their childhood. This idea mirrors work by Strauss on U-shape behavioural growth in children aged 4-13 years [1982], and research by Karmiloff Smith on three phases in children's problem solving [1984]. Is there a time in the development of young children's control processes when positive strategies peak? Are there optimal times of capability in Technology?

Questions also arise from the research about the relationship between children's motivation, their learning strategies and the classroom culture. Children's strategies seem designed by them to create maximum individual and group satisfaction in terms of productivity and experience, in the minimum time. The children sought to make sense of the task by reposing the activity in their own terms [Gilligan,1982]. They focused on their own values of producing a product, using the resources and working with friends regardless of the task as perceived by the adult.

In seeking to comply with the constraints of the context the older children revised their strategies accordingly. They constantly checked their ideas against those of their peers and their teacher and worked within what they perceived as 'allowed', sometimes negotiating
this as they grew in confidence. The maintenance of young children’s collaborative strategies in particular is extremely important as early learners do not distinguish between social and academic success in their first year in school. For young children successful collaboration leads to high self-esteem which leads to better learning [Entwisle,1987]. Should we therefore be identifying and enhancing young children’s collaborative strategies?

The research findings pose a number of other interesting questions. During the Technology process children appear to start school with an initial set of available learning strategies. These may vary according to maturity but they develop rapidly and are subject to change. Does the Technology process or cycle of strategies outlined in the attainment targets of the National Curriculum orders acknowledge this? Are the pupil and National Curriculum strategies compatible and is an attempt to match them appropriate?

The work so far, based on data gathered by working with children during their first year at school, has gone some way in identifying these children’s learning strategies during two similar design and technology tasks. This is merely a starting point for further in-depth observation and classification of children’s own strategies and techniques used during practical problem solving. This study by no means indicates that other children will exhibit similar strategies, indeed it is important to bear in mind that there may be large sociocultural differences between same age children with respect to their self-regulation and strategic problem solving skills. Much more work needs to be done.

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