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Metadata Record: https://dspace.lboro.ac.uk/2134/3427

Publisher: © DATA

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Collaboration in Design and Technology: The First Years of School
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Abstract
Design and technology in school, as in the workplace, is a social practice which takes place within a network of social relationships and often requires collaborative teamwork. This paper describes the emergence of children’s collaborative problem solving during their first years of school and the implications of this for teaching. In the design and technology classroom the way a group of five year-olds use strategies to collaborate during problem solving is very different from the way a group of seven year-olds use them. This research demonstrates broadly that children use two types of strategies: those that are personally and interpersonally determined, and those that are subject specific. It shows that many of the personal and interpersonal strategies that children devise and use in general group situations are enhanced and extended in design and technology activities. These personal and interpersonal strategies change qualitatively as children grow older, but beyond this each strategy changes in a different way because some decline or seem to disappear while others are used more extensively. The factors involved in that change are reported here within a discussion of how teachers can encourage children’s collaborative strategies during their early years in school.

Keywords
primary children, collaboration, problem solving strategies, teaching, strategic change

Introduction
All design and technology activities are basically social processes and the actions of pupils and teachers are “enframed” by the social structures of school and society (Mitchell, 1991). It has been suggested that design and technology is a special context in that it enhances these social strategies. However, they exist not only in design and technology activities but across subject boundaries and other learning situations. These situations are found in school, at home and in the community, and these strategies develop within everyday life as children communicate with others and become social beings.

While there is a body of recent social psychology literature which informs work on collaboration in general (Galton, 1992, 1999) in the field of design and technology there is little work in this area. Hennessy and Murphy (1999) have stated that “despite the rhetoric of the curriculum, the use of collaboration as a learning mechanism is almost ignored in practice in design and technology and has not previously been the subject of research”. The research reported in the present paper forms part of the results of a longitudinal study tracing young children’s collaborative problem solving throughout Key Stage 1. It details the emergence of personal and interpersonal strategies and the change in the way children negotiate, co-operate and share problems with peers and adults.

The recent review of the National Curriculum for design and technology 2000 has stemmed from a genuine desire to clarify how children develop capability and to “reorder the programmes of study in line with general practice”, (DfEE, 1999). For the first time the proposed orders describe children as “creative problem solvers” (DfEE, 1999). This mirrors the creative challenge of problem solving discussed in the recent report All Our Futures (DfEE, 1999). The natural way of learning, both in the workplace and in the design and technology classroom, is not to work in isolation, but parallel or in teams or groups, and the National Curriculum for England Design and Technology (1999) recognises children as problem solvers, “both as individuals and in working with others” (p.122). This distinctive view of the social contribution of design and technology to children’s learning makes it a necessity that we know more about the collaborative problem solving strategies children use in the classroom.

The present study
The main question that generated the research reported here was the extent to which it was possible to identify and classify the collaborative problem solving strategies that young children use in design and technology tasks in school. The basic problem was, that in design and technology education, the area in which we knew least about was the way young children worked together to tackle designing and making
activities. Questions needed to be asked concerning the nature of their collective strategies and possible strategy change in relation to children’s age, tasks, and resources over Key Stage 1. This was a longitudinal study of groups of children, between the ages of five and seven, engaged in design and technology. Qualitative analysis was carried out of children’s problem solving in a range of design and technology tasks (Roden, 1997).

**Major findings**
Initial results have been published previously by DATA (Roden, 1999). These indicate a set of strategies, or taxonomy, used by different groups of children in the study, but these results also provide evidence of similarities and differences in the pattern and sequence of strategy use. It was found that some strategies had remained the same in nature but evolved with age. Others had changed qualitatively, while some were simply unchanged; some disappeared, and some new strategies had emerged. Further analysis revealed that the major findings are now as follows:

There is a set or ‘taxonomy’ of design and technology problem solving strategies that can be described in a sufficiently general way as to be used over a range of tasks and ages. This taxonomy can be seen to comprise of two essentially different categories of strategy. These are:

**Personal and interpersonal strategies**
- Personalisation:
  - negotiation and reposing the task
  - talking self through problems
  - sharing and co-operating
  - panic and persistence

**Subject specific strategies:**
- Identification of wants and needs:
  - focusing on tasks, tools and materials
  - practice and Planning
  - Identifying difficulties
  - tackling obstacles
  - showing and evaluating

The two categories of strategy complement and build upon each other during designing and making. The context of the task, that is the resources, or the task itself, prompts design and technology subject specific strategies, but this practical way of working necessitates social interaction and generates personal and interpersonal strategies. Then, in turn, children’s increased social behaviour allows for subject specific strategies to be enhanced.

The strategies in the taxonomy are not invariant with children’s age, but the two categories, personal and interpersonal and subject specific, develop differently as children grow older:

- Personal and interpersonal strategies change in a qualitative way so that they are essentially different later. This change comes from increased social experience both in and out of school.
- Subject specific strategies evolve gradually depending upon children's accumulation of knowledge and skills gained from their increased expertise and experience of design and technology activities. These strategies change in a cumulative way.

Although the same taxonomy of strategies is used regardless of task and resources, nevertheless, the way the strategies are used is determined by the design and technology task itself, and the tools and materials available. Strategies are used spontaneously, either in response to interest in creating the product, or to meeting the challenge of working with new tools and materials. In this way design and technology problem solving strategies are context specific.

**Implications for classroom practice**
These findings may have implications for design and technology in the primary classroom. It seems that very young children devise and use their own problem solving strategies in design and technology activities. These strategies appear to develop and change as children move through the first years of school, possibly in response to the new ideas, knowledge and the culture of school. This strategy development seems to depend not only on age, but also on experience of design and technology activities, the types of tasks undertaken, and the variety of resources available. A set of strategies used to tackle problems have been identified, and when using these in the primary design and technology classroom, children usually work alongside each other in groups. This is a collaborative environment, where general social and subject specific strategies complement each other in an integrated process of designing and making. But it is also a guided environment where children are helped to learn what is new and different about school knowledge and interaction. Teacher or peer scaffolding and bridging is often necessary to help children in this understanding. We still know very little about how this scaffolding takes place, but it may be possible to recognise, build upon, and support children’s problem solving strategies in the classroom.

**Supporting personal and interpersonal strategies**

There are a group of personal and interpersonal strategies, to do with children’s collaboration, that suggest ways in which teaching might be organised in order to benefit from these type of strategies, and support pupils’ further work in the classroom. The present study suggests that when they first come to school young children tend to use a **Personalisation** strategy. This seems to be an important strategy for reception and Year 1 children but tend to decline later. Children ask questions or make comments in order to relate the design and technology task to themselves, their personal world, and past experiences. This seems to promote feelings of security and confidence, and helps them to link everyday knowledge and school knowledge. Therefore, it would seem that in order to foster this self-scaffolding, it may be necessary to encourage discussion that helps bridge the gap between the technological environment of home and school. For example, comparing home and school tools and materials.

This important continuity between the contexts of home and school may increase children’s confidence in building technical vocabulary, and skills, and in understanding new ideas. At Key Stage 1, children are still expected to “explore how familiar things work”, and “evaluate familiar products” in the National Curriculum for England (DfEE, 1999). Clearly, encouraging children to talk about designing and making that goes on at home in the most familiar surroundings, and discuss school and home relative meanings, is a way of inducting children into the specialised knowledge and culture of school. But this may also validate everyday practical learning and help maintain and enhance Personalisation strategies in older Key Stage 1 pupils, so preventing their decline.

A **Talking to Self** strategy is apparent in the way very young children tackle tasks, and again it may be a form of self-scaffolding. Young children use this strategy to reflect upon what they have done so far, alert themselves to what they are doing, and tell themselves what to do next. This strategy heightens children’s self-awareness and aids planning. This may be encouraged as children design and make, and may also be enhanced through the use of creative role play areas and construction equipment. In older children this self directed speech seems to disappear but is internalised when thinking through a tricky problem or snag. The strategy of Talking to Self is useful to children because, like writing, talking about action intensifies the reality and enables more objective reflection and evaluation. Self-directed speech is a natural activity which is difficult for teachers to promote but can be viewed as a reflective process, thus children may be encouraged to talk their ideas through with a friend when they encounter difficulties.

Using **Negotiation** as a strategy, to discuss aspects of the design and make assignment with teachers and other children, seems to play a large part in design and technology activities. The present study found that children responded well when they were allowed some choice in what they designed and made. They liked to use their own ideas, selection of tools and materials, and individual designs. Their confidence was seen to grow during Key Stage 1, from accepting tasks as given, in the reception class, to negotiating the most appropriate tools and materials, working space and partners, in Year 2, when they may ask to change or repose the task to suit themselves. Therefore, it seems that flexibility about task boundaries may encourage children to modify and improve their strategies so that they have as much personal and collaborative scope.
as possible, while retaining some awareness of what is ‘allowed’ within the constraints of the classroom culture.

Although these may appear to be off task behaviour, Pretend Panic strategies can include ‘dramatic play’ which has a practical function for attracting attention and help when mistakes have been made. Thus, in the classroom it may be important to recognise that this dramatic behaviour is devised as a worthwhile strategy towards gaining a solution to a problem. The study has shown that children’s problem solving strategies grow and change within the school community. But children’s own community of practice is essentially that of their peers. Here most learning is a communal activity and a sharing of culture that creates a sense of belonging to home, school and local community, but children have their own special child culture that adults rarely enter into. Here designing and making is intuitive through children's play. They draw, construct, and role play spontaneously and they may extend this drama to design and technology lessons in pretend panic strategies.

The present study suggests that design and technology is a potentially rich environment for collaborative learning and that children use Sharing and Co-operating strategies to support this learning. Very young children may sometimes ignore offers of support from others, but as they become more experienced they begin to value, first manipulative help from peers, and then intellectual collaboration with a partner. By Year 2, they will appreciate opportunities to choose working partners. The study has shown that children will ask each other for help and, as they grow older, will gradually be able to distinguish between the type of support best provided by peers, and the kind that may be requested from an adult. However, they seem to respond to the aspect of the task, be it the end product or tools and materials, that offers the most novelty and challenge. They are enthusiastic about tackling new ideas and resources and may set themselves really tricky problems. Careful intervention is important here so that they are supported in seeking help and, although guided towards choosing realistic problems to solve, are not tempted to favour easier options. In this way they are encouraged to collaborate as problem solvers and problem seekers.

Supporting some subject specific strategies
It is not possible to detail all of the strategies in the taxonomy here, but there are a group of subject specific strategies used by young children to do with Focusing on Task, Tools and Materials, Identifying Wants and Need and Tackling Obstacles that suggest ways in which teaching could be organised in order to benefit from these types of strategies, and support children in further work. Considering first the Focusing on Task, Tools and Materials strategy the children in the study directed their attention to the product they would design and make and the resources they would use to do this. While focusing on the task itself children working with clay showed that sometimes their products were ‘transient’ in that they could be created and recreated a number of times during one lesson. Children often rolled the clay products into a ball and started again in a different way. At other times, when designing and making puppets or toys, the idea of making a ‘prototype’ seemed inappropriate as they considered everything they designed and made intrinsically valuable and an end product in itself. This may need to be kept in mind at the start of the lesson, when setting design and technology assignments, helping children to think about what they want to design and make, and discussing whether this is a model, prototype, or final product to be kept and used.

When Focusing on Tools and Materials as a strategy, young children may concentrate so intently either on new tools that they are using, or interesting materials that are provided that sometimes, because of the novelty or excitement, they forget the objective of the task. They may focus on these by structuring play in order to explore the properties of the materials, or in order to use the tools. Clearly, it would be crucial to ensure that this enthusiasm for the resources is maintained and play is nurtured, while bringing children back to the main task would respect the need to achieve the goal. However, once over the novelty of the tools and materials, children will still need to practise with tools in order to enhance their own skills, or investigate materials in order to understand them better. The use of such a strategy permits them to acquire skills in the use of tools and accumulate knowledge about materials they are using. The National Curriculum for England, Design and Technology (DFEE,1999) provides for focussed practical tasks so that teachers can help children practise skills to use in longer design and make assignments, but it would be helpful to create tasks which have a sufficiently open-ended nature, so as to allow children to spontaneously focus on tools and materials as part of the overall goal.
As children make progress in design and technology and move towards the end of the key stage their problem solving strategies progress from structured play to include Practice and Planning. Children see the need to practice skills before beginning to design and make, and will readily engage in focused practical tasks, if they see that these will support subsequent design and technology assignments. They use their problem solving strategies to begin to understand how the characteristics of tools and materials relate to how they are used, or how they need to select different types of glue to join heavy and lightweight materials. They begin to understand form and function, and see the shape of certain clay tools dictate how they might be used. They make informed choices when planning verbally, plan by placing materials together, and start to make lists and draw images and labelled diagrams. Then it may be important to provide for different ways of planning, such as verbal planning and picture planning, mark making and placing materials together for design representations. In this way they may begin to see designing and making as an integrated, organic process that grows gradually. However, children create plans but do not necessarily follow them. They may need support to discuss what can realistically be made within the constraints of time, resources, and their own expertise, and would need to be able to change their plans as they design and make.

The study demonstrates that very young children often show and share their work openly using Showing and Evaluating strategies, and can respond to evaluation and modify strengths and weaknesses in design, but sometimes pupils can be sensitive to the ‘opinion’ of others. It is important to children that they get positive feedback on their products so that their confidence in showing as a strategy is maintained as they grow older. Often young children are reluctant to modify their work as they are satisfied with the outcome regardless of the original design specification or the opinions of others. This can make evaluative activities difficult at times. The children in the present study showed that, at Key Stage 1, shared evaluation can work well and children may be less reluctant to improve their work if it is in response to peer assessment. Therefore, at the end of the lesson, it may be appropriate to pair children with a ‘critical friend’.

**Conclusion**

The present study has gone some way in identifying and describing young children’s collaborative problem solving strategies in design and technology. The work has focused on children working in groups and concentrated on group collaborative action. But this study by no means indicates that all other groups of children will exhibit exactly the same strategies, indeed it is important to bear in mind that there may be socio-cultural differences between same age children with respect to their strategic problem solving. Much more work needs to be done.

**References**

DfEE (1999) *All Our Futures: Creativity, Culture and Education*, London: NACCC