

Using the Nuffield approach to teaching 'structures' at Key Stage 3

Abstract

This article discusses the use of knowledge and understanding in designing, focusing on the area of structures and exploring the use of an INSET session to adapt a designing and making assignment (Capability Task) so that it requires the use of particular materials and an appreciation of their structural possibilities. The use of focused practical tasks (Resource Tasks) for learning both structural principles and design strategies is described. The results of the teachers' designing and making are presented and the use of outline sketches as starting points is discussed. Finally, teachers' comments are included.

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Teaching knowledge and understanding for designing and making

Since its inception the Nuffield Design and Technology Project has been committed to the idea that pupils should use their knowledge and understanding in their designing and making. The Project identified two categories of knowledge that would be useful. Firstly "knowledge of the problem". The majority of this knowledge will be context-dependent: pupils will need to find out from others who have insight into the problem – potential users of the solution, those who might market or sell the solution, groups who have particular insights into the needs or wants of potential users etc. This sort of knowledge is difficult to come by; it cannot be taught, and is unlikely to be in books so the pupils must "find this out for themselves". The Nuffield Project provides a range of strategies (Barlex et al, 1995a) that pupils can be taught which will enable them to find this sort of knowledge. The other category of knowledge is "knowledge for the solution". This is much less context-dependent; more easily identified and hence can be taught as part of the learning required for pupils to be successful in their designing and making. It would be naive to assume that acquiring such knowledge is completely independent of the context in which it will be used. Many teachers have experience of pupils being able to access and use learning, often considered beyond their scope, if the context of its application provides sufficient motivation. Similarly, teachers are only too aware that a context in which pupils are uninterested is unlikely to stimulate effective application of knowledge and understanding. McCormick

(1997) has provided a useful discussion of this issue in terms of the relationship between conceptual and procedural knowledge. His exposition of the role of situated cognition goes some way to validating teachers' experience.

Recent Ofsted reports have indicated that many teachers are experiencing difficulty in enabling pupils to use what they have been taught in the knowledge and understanding part of the programme of study in their designing and making. "...weaknesses in pupils' knowledge and understanding sometimes limit the quality of the products they make." (DATA, 1997) "Many teachers....continue to experience difficulty in teaching the knowledge and skills associated with designing and evaluating." (OFSTED, 1996) Note that it is a specific requirement of the Level 7 Attainment Target description for designing that pupils use taught knowledge and understanding. "They use their knowledge and understanding of the Key Stage 3 Programme Study to develop realistic intentions, which they communicate to others through a variety of media, showing how their designs will function in use." (DfEE, 1995)

Developing a designing and making assignment concerned with structures through INSET

The Nuffield Project presents designing and making assignments as Capability Tasks in the Capability Task File (Barlex et al, 1995b). Each task is presented by means of an identical task template which always describes, among other features, the technical knowledge and understanding likely to be needed and gives a listing of Resource Tasks (Barlex et al, 1995c) (equivalent to the focused practical tasks of the National Curriculum Design and Technology Orders) relevant to this learning. This provides the teacher with the means to teach the knowledge and understanding that is likely to be needed. The nature of this learning is made explicit to the pupil by the "You will learn" statement on the Resource Task sheet which shares with the pupil the learning intentions of the task. So the scene is set for the teacher to explain to pupils that they will be expected to use what they have

learned in developing and justifying design decisions.

Structures is a defined area of knowledge and understanding in the Order for Design and Technology at Key Stage 3, and can reasonably be expected to provide the focus for at least one Capability Task in the key stage. The Capability Task "Display your treasures" is such a task and details of the task, task setting and the technical knowledge and understanding likely to be needed are shown in Figure 1.

Clearly this task can be tackled at a variety of levels of difficulty and it was decided that a useful approach to exploring how best to teach with this task was to make it a focus for a one day INSET session. To this end, Jon Parker decided to include it in Northamptonshire's current INSET prospectus and adapted both the task and task setting as shown in Figure 2 to make it more suitable for this purpose. Note that the technical knowledge and understanding likely to be needed is reduced by this adaptation in that knowledge and understanding of electrical systems for lighting and electrical and mechanical system for movement is no longer required.

Jon wanted to ensure that, through designing and making a display system, course members would address those statements in the programme of study which require that pupils should be taught: 'to understand that forces, such as compression and tension, produce different effects, and to take account of these in making their products' and 'to take account of the working characteristics and properties of materials and components when deciding when and how to use them.' So Jon also prepared some additional material to that provided in the Key Stage 3 Capability Task File, writing a more specific design brief and specification and drawing some outline sketches as the starting point for the project (See Figure 3). This was to ensure that course members would be able to contextualise the task quickly and spend the maximum amount of time engaged in modelling and experimenting with materials and physically making structures.

Figure 1 Features from the Capability Task "Display your treasures"

The task

To develop, design and make a display systems for personal use which takes advantage of structural principles in meeting an identified need.

The task setting

Many people enjoy collecting items which are of special interest to them. Thimbles, model cars, weapons, dried flowers, coloured pebbles, soft toys, antique figures and newspaper cuttings about sports, people or entertainers are some examples of what are called "collectables". To display the items in such a collection to best advantage, they may need to be seen all together, on their own, or to be rotated and seen from different angles. The student's task is to identify a personal interest in collecting things, which may be their own or that of a friend or relative, to draw up a specification for what a suitable display system should be able to do, and to make either a complete display system or a representative part of it as a prototype.

Technical knowledge and understanding needed

Some knowledge of:

- balance and stability of complete structures when loaded, unloaded and partly loaded
- systems for propping or hanging things up
- the design of simple beams, cantilevers, frameworks and connections between structural members
- simple mechanical systems such as linkages and pivots
- simple electrical systems for providing lighting
- simple electrical and mechanical systems for providing movement.

Figure 2 Adapted features for the Capability Task "Display your treasures"

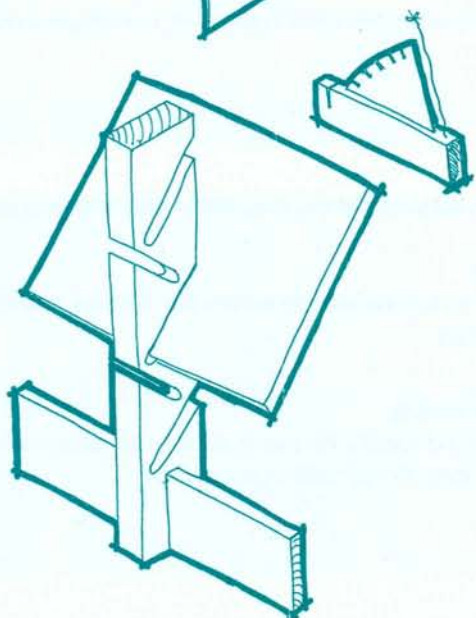
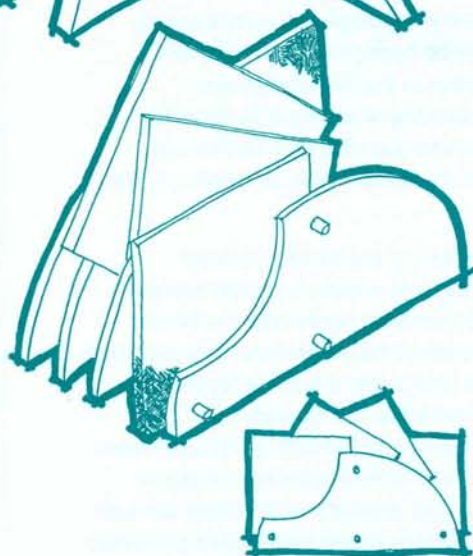
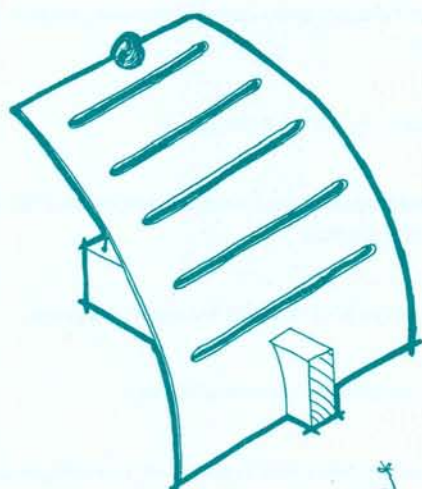
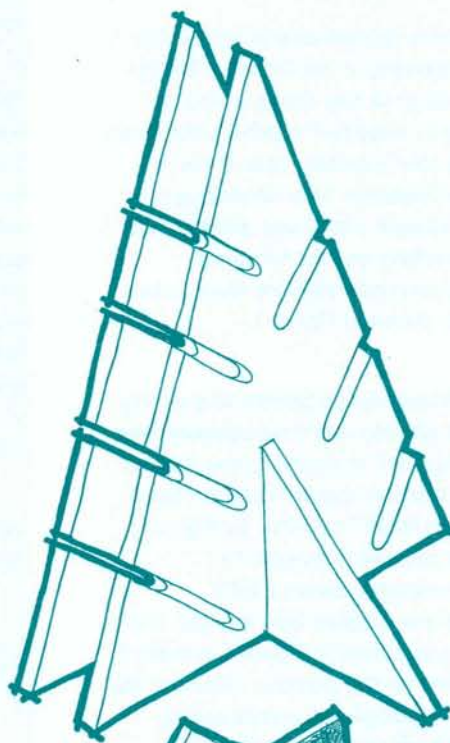
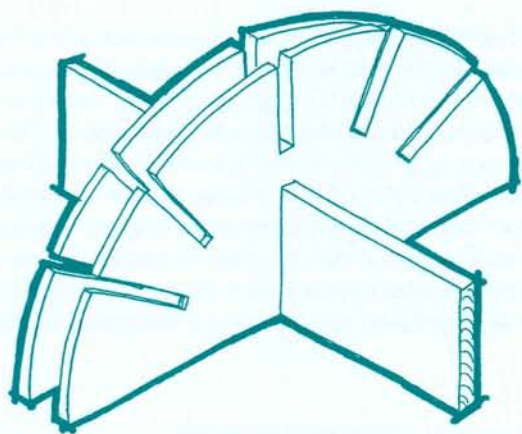
The adapted task

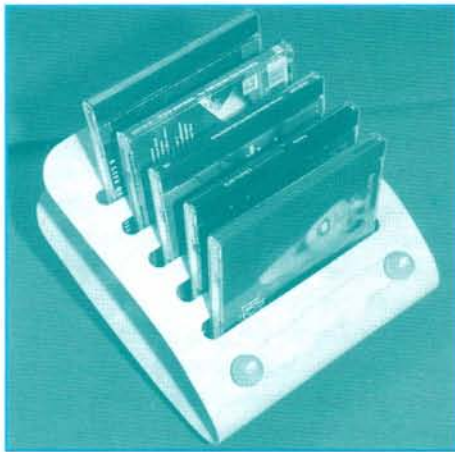
Design and make a desk top storage system that will hold and display at least 5 compact discs.

The adapted task setting

The product should be suitable for sale in IKEA so the design will need to reflect the "house style" of this retail organisation

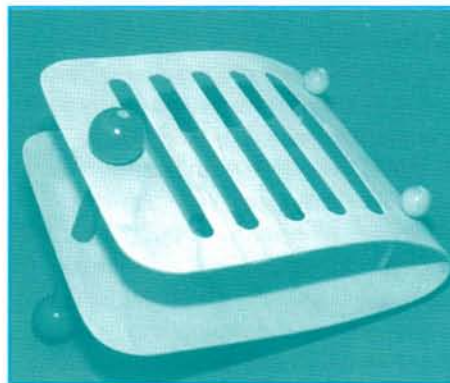
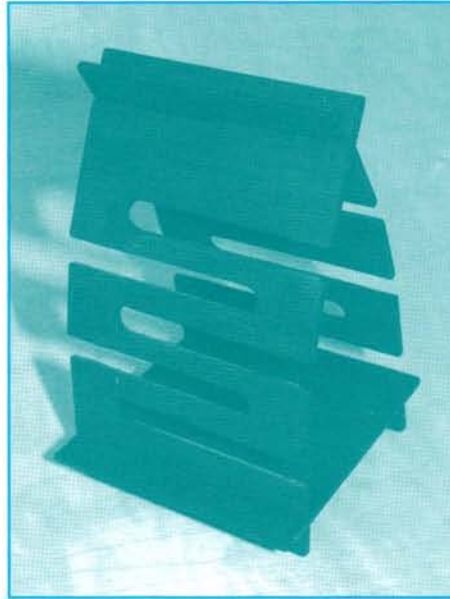
Design sketches





Exploring the Resource Tasks

Following an introduction to the day and the Nuffield approach, course members considered the Capability Task and the additional material provided. They were then invited to evaluate the suitability of two of the Nuffield Key Stage 3 Resource Tasks written to support the teaching of structures: StRT 5 "What makes a framework?" and StRT 6 "What makes a beam bridge?" The experimental test rigs for these tasks can be easily constructed in school and provided the opportunity to introduce the teachers to the range of materials available for the Capability Task, different types and thicknesses of man-made boards, different timber sections and wire and cord to use as flexible ties. StRT 5 enables students to learn about the forces acting upon a simple framework by varying the type of struts and ties used on a test rig. In StRT 6 students learn about the behaviour of beams by varying the loading and the types of beam, and measuring the deflection that occurs. In both activities students are able to record their observations on a table of results. Both provide excellent opportunities for group work, the presentation of conclusions and



discussion of the relevance of these Resource Tasks to their own designing and making activities.

Tackling the Capability Task

The group of teachers spent some four hours developing their own prototype display systems. 'Theme-boards' of products from the IKEA catalogue were used to familiarise course members with the colours, shapes and materials used throughout the product range. They were encouraged to develop their initial ideas in sketch and model form and, in particular, to familiarise themselves with the range of materials available, experimenting for example with the flexible plywood sheet, bending it, soaking it and generally building up a picture of its properties and potential. As the day progressed, ideas for each prototype were developed and course members worked hard to complete their constructions, assemble and finish their projects in the short time available. At the end of the

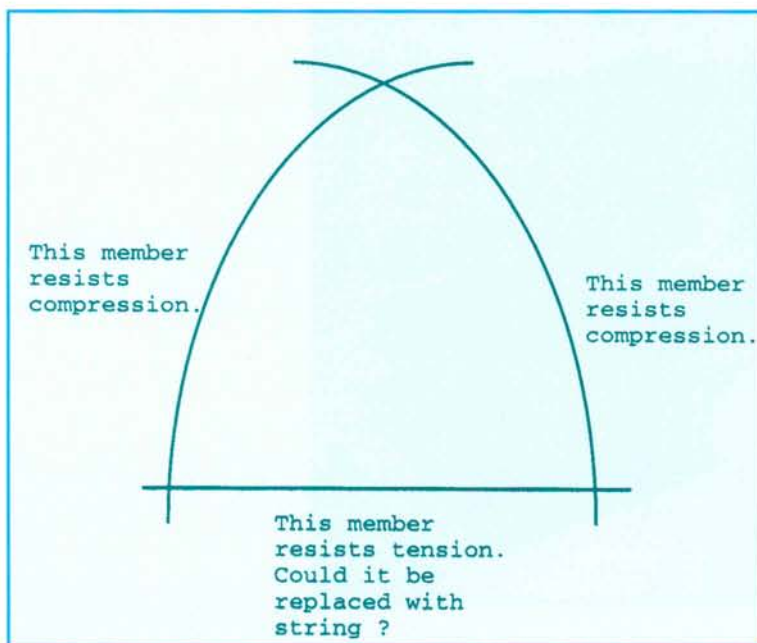
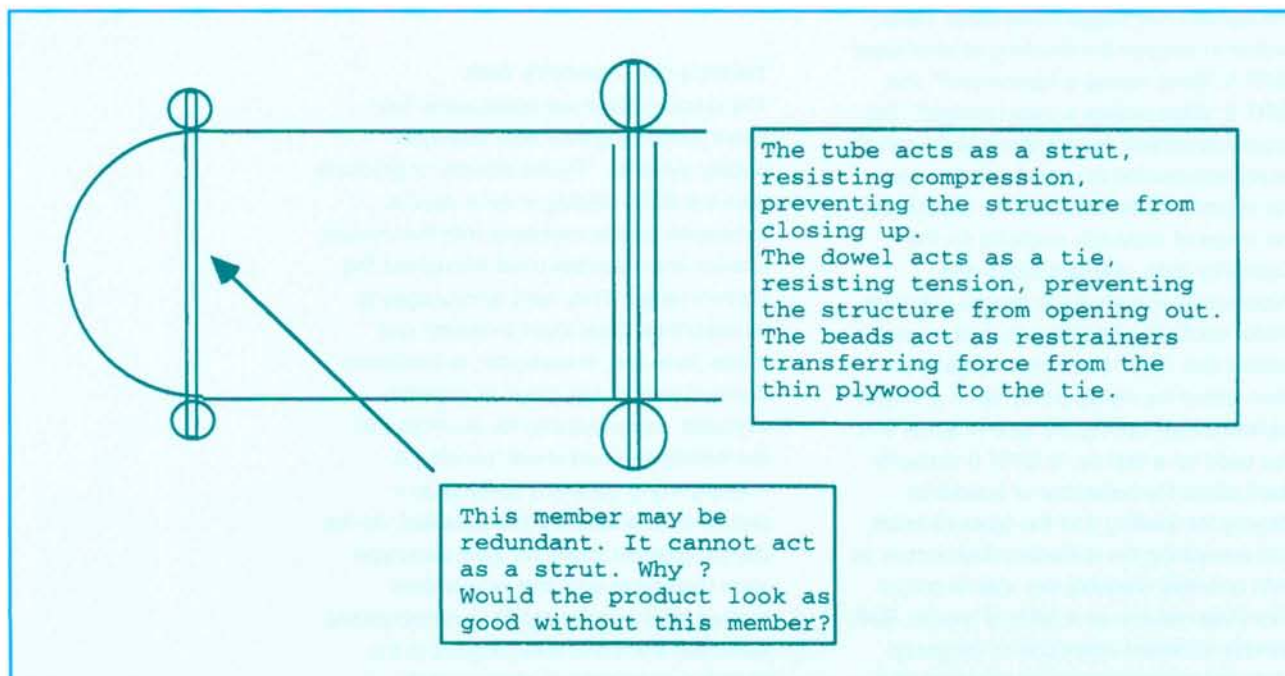


Figure 4a

session course members were invited to mount their work as a display for use within school, to demonstrate to their own pupils how they had personally tackled the Capability Task. They were requested to prepare a short presentation to justify to IKEA why their prototype should be included in the product range and to describe the significant technical and aesthetic features of their designs. In so doing, they demonstrated another way in which design and technology can support the development of speaking and listening skills, and how pupils can be encouraged to use

Figure 4b



an appropriate technological vocabulary in making their own presentations.

Some of the results are shown in the photographs. Note that the manufacturing processes are kept simple by this range of materials: drilling, cutting and shaping the sheet and strip materials. Note also that there are interesting forces at play in the simple structures produced. The annotated diagrams in Figures 4a and 4b shows the interplay of tension and compression in two of the outcomes.

Comments

The work produced by the teachers indicates that they were able to use 'taught' technical knowledge and understanding about the forces in structures in responding to a small scale product design task. The practical and investigative nature of the Resource Task exploration of forces in structures contributes significantly to this. Note also that the Capability Task provided the opportunity for the teachers to apply their knowledge, understanding and skills of handling these materials in a realistic context, allowing plenty of scope for individual creativity. The only design constraints were set by the materials available: man-made boards, a variety of pre-planned timber sections, a selection of dowel-rods and plastic tubes, wire, cord, beads and a selection of surface finishes.

The outline sketches provided by Jon are only starting points. Teachers will readily reject these in favour of their own ideas! It is important, however, not to 'gloss over' the apparent simplicity of recreating one of the ideas in the outline sketches. Many designing and making decisions have to be taken in order to translate such sketches into successful products, and for many pupils this would be a suitably demanding task at Key Stage 3.

The success of this project as an INSET activity was also due to the familiarity that the teachers were able to develop through handling such a range of materials and resources. The opportunity, therefore, for students to model with materials in a way that is informed by technical knowledge and understanding at an early stage in their designing and making activities is likely to be paramount if they too are going to be able to design and make with materials confidently in ways that are exciting both technically and aesthetically.

Teachers attending the course have made the following comments in evaluating the INSET and its effect on their practice.

How did the course help you reflect upon the way in which you teach 'structures' to pupils?

"It made me realise that teaching the concept of structures' could be included in all designing and making activities rather than just in special topics."
Iain Baverstock, Guilsborough School

"The 'Display your Treasures' course changed my way of thinking about structures and construction techniques. It is essential today that students working in resistant materials realise the potential of designing and making with man-made boards and are able to experiment with different methods of constructing with them." Roger Barnaby, Mereway Upper School

"The course has influenced my thinking about how structures can be delivered as part of a challenging and creative unit of work and caused me to totally re-think my approach to this topic." Barry Taylor, Welland Park Community College

As a result of the course have you incorporated any of these ideas into your own practice over the last two terms? How successful have the results been?

"Since the course some of my students are now realising the potential of using modern materials and construction techniques. For example, a student has recently completed a wine rack using hardboard slotted together, cut using a 'gablo guillotine'. From September, I will be incorporating these materials and techniques into a new scheme of work"
Roger Barnaby, Mereway Upper School

Do you have any additional comments to make about the course, for example have any other issues discussed, changed/confirmed your practice this year?

"The approach and ideas used on the day encouraged me to review my own way of teaching particular design and make tasks.

The opportunity to work on both individual and group tasks to prototype ideas and then discuss them with colleagues, was valuable both as professional development and as an opportunity to produce resources for display and use within school." Barry Taylor, Welland Park Community College

Note

The Key Stage 4 Capability Tasks include all the features of those at Key Stage 3 but also a design brief, specification, design drawings and working drawings to allow teachers to choose different entry points into the task (Barlex et al, 1996)

References

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