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An Experimental Analysis of Two Craft Design and Technology Classes

Summary
Two experienced teachers from the same comprehensive school taught first-year classes for one year. Both used strategies which involved a combination of design and toolwork but with varying emphases. Overall, the outcome in one metal workshop was more predictable than the other.

Of particular interest, is the finding that high ability pupils prefer to work out decisions for themselves, rather than work from designs given to them. Low ability pupils have equal preference for their own designs and the teacher's.

Introduction
It is frequently claimed that teachers of design should emphasise 'journey' rather than the terminus, that pupils should not be provided with readymade answers and that pupils should have more than just a background of manipulative skills (Dodd 1981). Piaget and Inhelder (1966) state that the child does not understand adult thought until he has reconstructed it, and that central to development is a series of active compensations in response to external disturbances.

Designing is a sophisticated activity and much of what takes place cannot be measured simply in terms of the final solution to the problem. Do the activities of defining the problem, searching for a solution, experimenting and evaluating, contribute to the cognitive development of pupils more than activities requiring a passive type of involvement? Would mental processes be stimulated more when the practical outcome of a problem was unpredictable rather than when the solution is clearly predictable from the start?

In an experiment by McCloskey (1979) the progress of pupil's intellectual development in a conventional art course was compared with pupils in a design and problem solving course. Although on several of the test measures differences were small, the design and problem solving group did show greater improvement on a verbal judgement and reasoning test and also on a special test.

The purpose of the present experiment is to attempt to provide further empirical evidence within the field of CDT, where at present little exists; it is to examine different styles of teaching and ways of working and to monitor pupils' progress, interest and attitude. The use of global titles for particular teaching styles can be fraught with danger. For example, the widely acclaimed *Teaching Styles and Pupil Progress* (Bennett 1976) concluded that formal teaching styles foster greater progress in pupils than informal ones. Criticism of this research (Gray and Satterly 1976) focussed most importantly upon the failure to control the external factors adequately. The teaching situation is so complex that attention should be directed more towards specific differences between teachers than to giving importance to various teaching styles. The intention of this experiment is, therefore, to identify and assess specific aspects of CDT teaching rather than to try to evaluate the efficiency of an overall teaching style.

The Experiment
Thirty-one pupils aged eleven, from one comprehensive school took part. All the pupils were from two first year classes which were selected randomly. Allowing for absentees the final results were based upon fourteen boys from one class and seventeen from the other.

The two classes were timetabled for a fifty-five minute metalwork lesson taking place at the same time, once a week, throughout the year. Two teachers were involved in the experiment each teaching one of the classes in separate workshops situated at opposite ends of the school.

The pre-test was carried out during September and a post-test the following July. For these tests, both classes sat together in the same hall under identical conditions. The special test was given during one week and the remaining tests the following week. Throughout the year, each metalwork teacher taught his normal programme of work in his own distinctive style.

To analyse the presentation of the teachers, two lessons were observed and tape-recorded. Each teacher also compiled a list of techniques and operations which were performed by the pupils during the year.

Pupil interest and attitude were assessed, at the end of the year by means of a questionnaire. The five-point bi-polar scales were concerned with preferences the pupils have for working out designs, and handling tools. They were also asked about work at home and enjoyment of the subject.

The Teachers
Both teachers were experienced in teaching metalwork and used schemes of work incorporating basic tool skills and design, but to varying degrees.

Teacher X
Teaching method tends to involve design, whereby the finished product is clearly understood from the start, not in every detail, but in its main form. This

may be described as a 'predictable' or 'safe' approach.

Three articles were completed by all pupils in the year: a pendant, an ornament and a spinner toy. The tool skills employed were marking out, sawing, cutting, filing, drilling, brazing, cold forging, lathework, letter stamping, finishing and texturing.

The design and experimental work required pupils to draw shapes, use a template, experiment with sizes, textures, and finishes and to discuss design improvement.

Teacher Y

This teaching method frequently encourages pupils to experiment before making a design decision. At the start there is some uncertainty about the exact solution to the problem; this then is the 'unpredictable' approach.

Four articles were completed by most pupils: a number or identifying plaque for a door, a wire sculpture, a coffee spoon and a candle-holder. Many of the basic tool skills were taught in this first year, but the individual nature of the work prevented a simple listing of the technqiues involved.

The use of design briefs was emphasised. The brief for each project contained questions and suggestions under three headings; investigation, ideas and evaluation. The pupils were encouraged to search for solutions.

Test Material

The design process requires the application of various types of thinking. At an early stage the need is for divergent thinking in order to bring forward a range of ideas from which a selection can be made. An alternative approach is to juxtapose ideas to produce further possibilities. Later in the design process a convergent type of thinking is required to assess the practical significance of a desired course of action. Problem-solving activity in the CDT workshop clearly requires both types of thinking (Dodd 1978).

The National Foundation of Educational Research Spacial Test 3 was used, not only as a test of spacial ability, but also as an indication of convergent thinking. Items require pupils to mentally manipulate orthographic and isometric projections of geometric forms. This test is thought to correlate with an aptitude for the practical skills of woodwork and metalwork. The shorter revised time limits were used.

The Graves Design Judgement Test was chosen to assess the pupils aesthetic perception and judgement. The most geometric items of the test demand the pupil to select one preferred design from a group of two or three. The correct design is the one which corresponds most closely to the basic principles of design and aesthetic order, ie unity, variety, balance, proportion.

In order to measure divergent thinking, the Uses of Objects test was selected. The pupil is required to write down as many uses for an everyday object as possible and the results are scored according to a number of categories; the fluency category is used here because of its objectivity. Hudson (1968) used a modified version of this test which incorporated a list of examples of possible uses before the test commenced. This had the effect of alerting pupils to the possibilities of the situation whilst still revealing high and low divergent thinkers. This preliminary list of examples helped to standardise the test conditions at the beginning and end of the year. The three everyday objects chosen for the test at the end of the year were of the same fluency difficulty as those used at the beginning of the year (Hudson 1968).

Results

Analysis of Teacher/Pupil Talk

Two important areas of CDT teaching were selected for examination. One was the design procedure associated with the introduction of a new piece of work and the other was the skill and technique of brazing. In each case the teacher/pupil talk was recorded for fifteen minutes and later analysed according to the Flanders Interaction Analysis Categories (Flanders 1970). The existing categories were considered to be sufficiently inclusive to be appropriate to the workshop situation, with the exception that a 'brazing' category was added to allow for the period of time when the excessive noise of the brazing equipment made talking impossible.

The category of talk was recorded every three seconds. The Flanders categories are shown in Table 1. The categories shown in Figure 1 are percentages of the Design Introduction part of the lesson and Figure 2 categories relate to the Brazing Demonstration.

For these categories of teacher/pupil talk, the approaches of the two teachers appear to be similar both in their introductions to the design and in their brazing demonstrations. The lecturing category is clearly prominent in both teaching situations, but categories three and eight (pupil talk and using ideas of the pupils) are greater in the design work than in the demonstration. This would suggest that CDT work orientated towards design, would be likely to increase pupil involvement and thereby enhance cognitive development. The low percentage of category nine (expressing own ideas) may mean that pupils' ideas were expressed through sketches on paper rather than through discussion.

Analysis of Design Lesson

The introduction of new work was examined to find if the approach of each teacher was similar. Teacher X chose for his pupils a pendant to be made from sheet aluminium and Teacher Y chose a candlestick holder from a range of metal sheet, strip and wire. Both teachers used the class method of teaching for approximately fifteen minutes and then allowed the pupils to design individual work by means of freehand drawings. Teacher Y also made card and wire available.

Table 1

Teacher Talk	Response	1. *Accepts feeling.* Accepts and clarifies an attitude or the feeling tone of a pupil in a non-threatening manner. Feelings may be positive or negative. Predicting and recalling feelings are included.
		2. *Praises or encourages.* Praises or encourages pupil action or behaviour. Jokes that release tension, but not at the expense of another individual; nodding head, or saying 'Um hm?' or 'go on' are included.
		3. *Accepts or uses ideas of pupils.* Clarifying, building, or developing ideas suggested by a pupil. Teacher extensions of pupil ideas are included but as the teacher brings more of his own ideas into play, shift to category five.
		4. *Asks questions.* Asking a question about content or procedure, based on teacher ideas, with the intent that a pupil will answer.
	Initiation	5. *Lecturing.* Giving facts or opinions about content or procedures; expressing *his own* ideas, giving *his own* explanation, or citing an authority other than a pupil.
		6. *Giving directions.* Directions, commands, or orders to which a pupil is expected to comply.
		7. *Criticising or justifying authority.* Statements intended to change pupil behaviour from non-acceptable to acceptable pattern; bawling someone out; stating why the teacher is doing what he is doing; extreme self-reference.
Pupil Talk	Response	8. *Pupil-talk – response.* Talk by pupils in response to teacher. Teacher initiates the contact or solicits pupil statement or structures the situation. Freedom to express own ideas is limited.
	Initiation	9. *Pupil-talk – initiation.* Talk by pupils which they initiate. Expressing own ideas; initiating a new topic; freedom to develop opinions and a line of thought, like asking thoughtful questions; going beyond the existing structure.
Silence		10. *Silence or confusion.* Pauses, short periods of silence and periods of confusion in which communication cannot be understood by the observer.

* There is *no* scale implied by these numbers. Each number is classifactory; it designates a particular kind of communication event. To write these numbers down during observation is to enumerate, not to judge a position on a scale.

Figure 1
Design Introduction

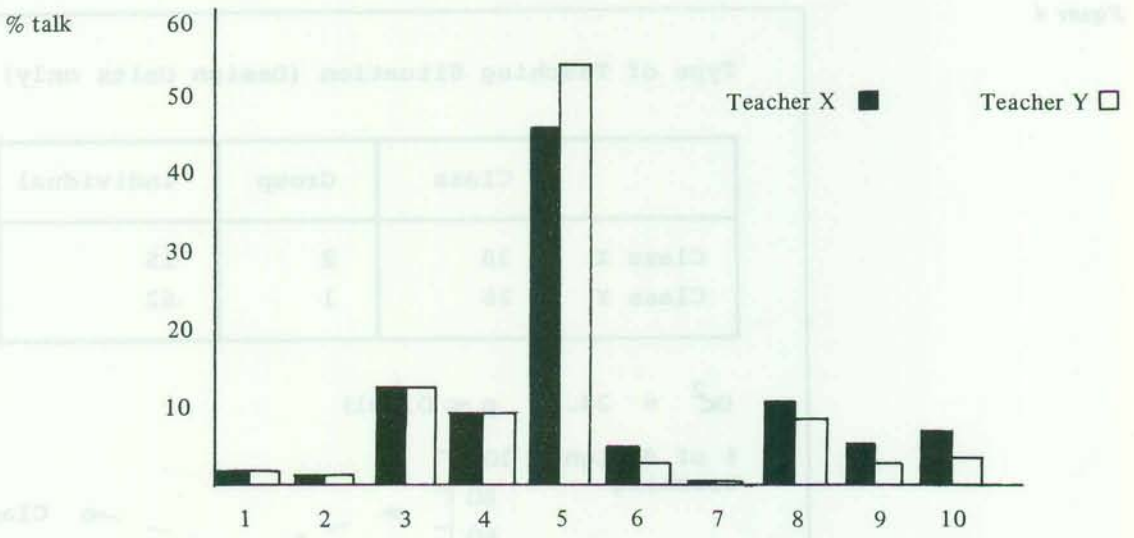


Figure 2
Brazing demonstrations

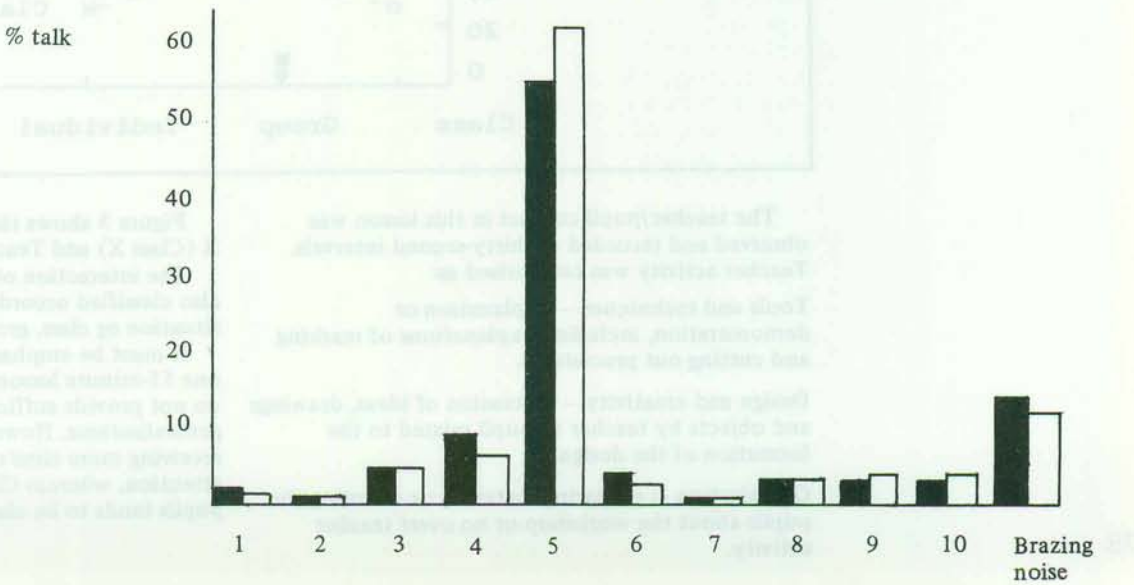
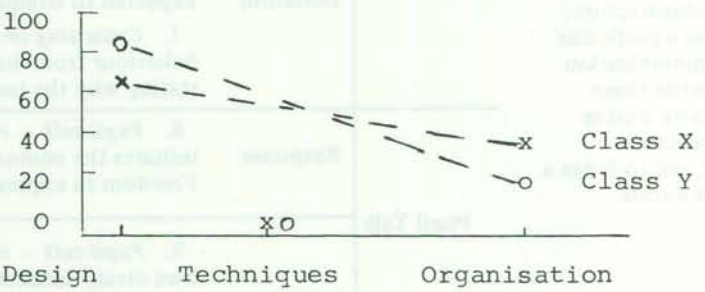


Figure 3

Content of Design Lesson in 30-second Units of Activity

	Design	Techniques	Organisation
Class X	55	2	32
Class Y	89	2	17

(χ^2 = 10.8 $p < 0.01$)



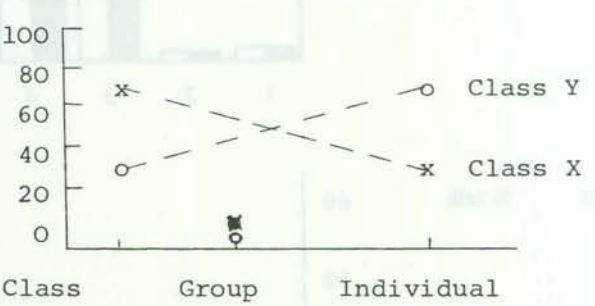
Notes:
X^2: Chi-squared statistical test.
$p < 0.01$: the probability of the difference occurring by chance is less than 1 in 100.

Figure 4

Type of Teaching Situation (Design Units only)

	Class	Group	Individual
Class X	38	2	15
Class Y	26	1	62

(χ^2 = 24.3 $p < 0.001$)



The teacher/pupil contact in this lesson was observed and recorded at thirty-second intervals. Teacher activity was categorised as:

Tools and techniques – explanation or demonstration, including explanations of marking and cutting out procedures.

Design and creativity – discussion of ideas, drawings and objects by teacher or pupil related to the formation of the design.

Organisation – preparing materials or directing the pupils about the workshop or no overt teacher

Figure 3 shows the relationship between Teacher X (Class X) and Teacher Y (Class Y).

The interaction of the teacher with the pupil was also classified according to the type of teaching situation eg class, group or individual.

It must be emphasised that these results refer to one 55-minute lesson by each teacher and as such do not provide sufficient evidence to make generalisations. However, Class Y appears to be receiving more time on design and more individual attention, whereas Class X teacher contact with the pupils tends to be class-orientated.

Table 2 **Mean gain scores for each class on the test measures and the differences between the two classes**

		Spacial test max 100	Design judgement test max 45	Uses of objects test
Class X (n = 17)	September mean July mean mean gain	33.3 45.2 11.8 ns	21.4 20.9 −0.5 ns	11.5 13.7 2.2 ns
Class Y (n = 14)	September mean July mean mean gain	27.1 46.5 18.0 t = 3.08 p < 0.01	20.6 18.8 −1.7 ns	10.5 15.5 5.5 t = 2.34 p < 0.05
Difference between mean gains	difference t	6.2 2.22 p < 0.05	1.2 0.62 ns	2.8 1.50 ns

Notes:
ns not significant
t : a measure of the significance of the difference between two means.
p < 0.05 : the probability of the difference occurring by chance is less than 5 in 100. This is an acceptable level of significance.

Table 3 **Mean Scores of Pupil Questionnaire**
(Scale 1-5. 5 indicates maximum preference)

	Class X (n = 17)	Class Y (n = 14)
Preference for teacher's design, rather than own	2.5	2.4
Preference for working with tools rather than designing	4.0	4.3
Amount of sparetime doing metalwork	3.6	3.6
Enjoyment of metalwork lessons	4.8	4.0
Preference for more metalwork at school	4.6	4.1

The Test Measures

Each class of boys was tested together in September and again in July. Absentees from either of these tests were withdrawn from the calculations. That is, the same pupils are being compared in the September and July tests. Because of the importance of writing in the uses of objects tests, two remedial pupils, one from each class, were not included. The results are shown in Table 2.

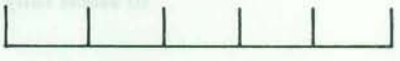
The tests of Spacial Ability and the Uses of Objects show that Class Y gained significantly from the beginning of the year to the end. With regard to the differences between the gains of the two classes, Class Y gained significantly more than Class X on the Spacial Ability Test. All theother gains or losses were not significant.

It is possible that a teaching situation which emphasises individual design work will accelerate the development of creative abilities. This statement must be qualified in the present experiment because of the inability to control all the extraneous variables. For example, the personalities of the two teachers involved have not been allowed for. Experiments which incorporate a range of teacher personalities would help to control this factor.

Pupil Questionnaire

On a five-point scale, pupils were asked to indicate their preferences for particular ways of working. For example, question 1

I like the teacher to give me the design shape and size — I like to work out the design shape and sizes for myself

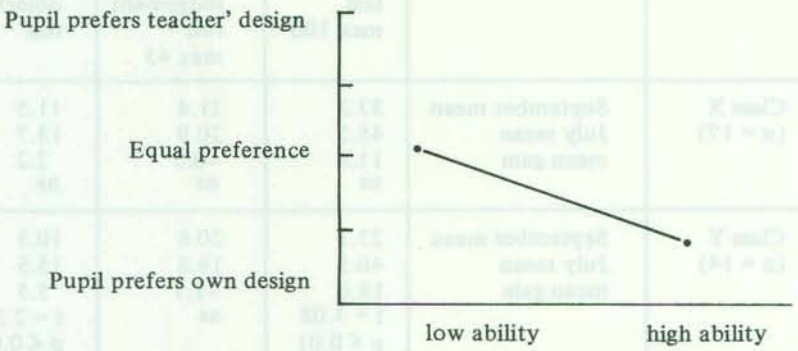


The pupil was asked to indicate the strength of preference by marking with a cross. Table 3 shows the means for each class. Figure 5 analyses the answers to question 1 in terms of high and low ability pupils.

None of the differences between the means in Table 3 is significant. The question referring to the amount of enjoyment is just short of the 5% significance level (t = 2.04). It is not clear whether this higher enjoyment level in Class X can be attributed to the working situation, personality of the teacher or other factors.

Of particular interest is the significant difference between high and low ability pupils' preference for

Figure 5 A comparison of high and low ability pupils' preference for designing (scores from Class X and Class Y combined).



(Means: 2.93 (low ability) 2.07 (high ability)
$t = 1.89$ $p < 0.05$ one-tailed test)

producing designs. The division of high and low ability was taken as 104/105 on the NFER Verbal Reasoning Test EF. Low ability pupils showed equal preference for their own designs and the teachers' designs, whereas the high ability pupils had a greater preference for working out their own designs. This raises the question of whether teachers are sufficiently flexible in their teaching strategies to allow individual differences to operate with respect to guidance in design.

Discussion

To compare the teaching strategies of two teachers is a complex task as many variables interact upon each other. This study has however identified a number of factors which appear to affect the outcome. Where the outcome of activities tends to be more unpredictable there is some indication that creative abilities will be fostered. This is a tentative conclusion because of the many variables which have been left uncontrolled. Future experiments could be undertaken in this area, with a range of teacher personality types, to produce sufficient evidence to form an indication of effective teaching.

Further research could well examine the acquisition of practical skills in relation to teaching strategies. A short practical exercise in the present study was given to both classes at the end of the first term. This revealed no significant differences between the two classes in practical skill with techniques and use of tools. The pupil questionnaire revealed interesting attitudes towards CDT work; in particular, the preference of high ability boys to design more themselves than the teacher, and for low ability boys to prefer an equal share of the design with the teacher. Thus all pupils preferred a co-operative sharing of ideas at the design stage. In Craft, Design and Technology teaching, both old and new methods need to be examined empirically to assess fully their educational value.

References

Bennett, S.N. Teaching Styles and Pupil Progress. Open Books (1976).

Dodd, T. Design and Technology in the School Curriculum Hodder and Stoughton (1978).

Dodd, T. Assessement and Evaluation of Design Based Courses. Practical Education Vol. 79, No. 2, 61-63 (1981).

Flanders, N.A. Analysing Teaching Behaviour. Addison-Wesley (1970).

Gray, J. and Satterly, D. A Chapter of Errors: Teaching Styles and Pupil Progress in Retrospect. Educational Research Vol 19, No 1, 45-56 (1976).

Hudson, L. Contrary Imaginations. Pelican Books (1968).

McCloskey, P. The Facilitation of Spacial Ability and Problem Solving in Adolescent Pupils through Learning in Design. Educational Review, Vol 31, No 3, 259-267, (1979).

Piaget, J. and Inhelder, B. The Psychology of the Child. Routledge and Kegan Paul (1966).