

THE DESIGN AND DEVELOPMENT OF COGNITIVE ACCELERATION THROUGH TECHNOLOGY EDUCATION (CATE): IMPLICATIONS FOR TEACHER EDUCATION

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An evaluation of a two-year cognitive intervention programme in technology education for Key Stage 4 (14 to 16 years), was reported in 1998 (Hamaker A.K., Jordan. P, and Backwell. J, 1998). The results suggested that the intervention enhanced the performance of students in GCSE examination in Design & Technology, Science and Mathematics in England and Wales. The effects appeared pronounced for the concrete operational thinking student, (as measured by the Piagetian tasks that were utilised) but less so, if at all, for the formal operational thinking student.

Cognitive intervention programmes in science and mathematics (CASE and CAME) have both been developed for Key Stage 3 (11 to 14 years) in the UK. Evidence from CASE (Adey.P, and Shayer. M, 1994) suggests that Key Stage 3 should be a more effective starting point than Key Stage 4 for such an intervention programme in order to enhance the performance of all students at examination at the end of their secondary education.

WHAT IS CATE?

The Cognitive Acceleration through Technology Education Programme (CATE) has been designed to help 11 to 14 year old students (KS3) develop their thinking and reasoning skills so that they are in a much stronger position to solve more difficult problems that they may well encounter later in the school curriculum. The activities are purely cognitive in structure (i.e. there are no 'hands on' practical or making activities) and such lessons are integrated into the established schemes of work. The authors worked closely with KS3 Design and Technology teachers in order to determine the subject oriented platform from which the cognitive tasks could be developed. Although these tasks were *not* designed to teach concepts or skills directly related to design and technology schemes of work, they did align with a range of focus topics in order for students to feel coherence within the delivery framework of the subject however this might be formulated by the individual schools/departments.

CATE is attempting to use a description of development closely associated with Piaget, Vygotskii and Feuerstein. It also attempts to use some of the reasoning patterns associated with Piagetian epistemology, as exemplified through the CASE project (1989 Adey. P. S, Shayer. M, Yates. C). Furthermore, the information processing strategies associated with Feuerstein as exemplified through the Somerset Thinking Skills Course (1988 Blagg. N., Ballinger. M., Gardner. R) form the basis for the delivery of the CATE activities . Together these strands help define the philosophy behind CATE and provide the theoretical foundation that teachers develop from.

This paper will outline the essential features of the programme and the embedded research tools used to monitor its short, medium and longer term effects. The authors believe much of the success achieved in the pilot schools may be attributed to the methodologies adopted by the participating teachers and in turn the nature and quality of the training they have received. Prior to embarking upon ‘CATE teaching’, a structured and comprehensive in-service training programme is delivered involving all of the design and technology department within a school. In addition some Local Education Authorities in England and Wales have launched aspects of CATE teaching through a centralised training programme and one of the authors has integrated a study of CATE (including training for classroom implementation) into a BA Ed Design and Technology initial teacher training degree. An evaluation of these training strategies will be reported on within this paper and an indication of the further developments of CATE in light of this will be discussed.

THE CATE PROGRAMME

The essential feature of CATE is the concentration on the student’s thinking, reasoning and problem solving capability. The teacher is the director of the activities, of the classroom dynamic and of the resultant discussion that follows. The discussion plays the central role in the development of the thinking in the lesson. The development of a shared language between teacher and student and student and student is critical to the success of the development of thinking in the lesson. This requires much ‘Socratic’ type questioning of the ‘what, why, how’ type, both in discussion with the whole class and with individuals and small groups. Students need to make ideas and strategies available to each other, with justifications as to why they are useful or not.

The programme comprises thirty six activities each of which consists of two tasks. These are to be administered in Design & Technology lessons throughout Key Stage 3 (age range 11 – 14 yrs). The main task fulfils one or more key cognitive objectives and should be completed in full. The second task allows students to ‘bridge’ from the initial main task to ideas, strategies or prior experiences and although it would not be necessary to complete this in entirety, it is nevertheless an important aspect of the

programme. Each of the activities have been designed to increase in cognitive demand as the student moves from Year 7 through to Year 9. Each activity is accompanied by a set of teacher's guidance notes.

In developing this programme, the authors wished to address questions concerning the effects of the intervention on the students' performance, including the following:

Would cognitive intervention methodology improve the technology capability of the student?

Would such an intervention programme improve the general information processing capability of the student?

Would such an intervention programme allow for transfer into other areas of the school curriculum?

These have been reported on at several junctures of the development period. We wanted to investigate the effects of intervention methodology on perceptions of teacher professional development and outline the implications for future teacher education.

CATE TRAINING STRATEGIES

Initial Teacher Training

the key element within initial teacher training both on undergraduate programmes (3 and 4 year years) and postgraduate programmes (1 year and 2 year modular) was awareness raising. This was introduced this year as part of the 'learning and teaching' framework across each programme with the opportunity provided for support for students wishing to trial materials whilst on 'school experience' placements. It is too early to provide 'take up' or evaluative data at this stage. However, initial responses (albeit anecdotal) have been very positive.

In-Service training –

training for key personnel within local education authority regions and/or of whole departments in schools has been by far the most favoured format to date.

RESEARCH RATIONALE AND METHODOLOGY

The authors have reported extensively on the effects upon student learning and cognition since the initial inception of CATE. Much interest has been aroused throughout this time as to the effects CATE might have upon teaching practitioners

and educationalists acting in supporting roles and what this might mean for future teacher education and professional development. A post-training analysis of evaluation has been collected over the past two years – this has been the first indicator of possible changes in perception of design and technology teaching roles and subsequent practice. A trial in three schools in 2002 included a more extensive analysis based upon open discussion with participants (all three schools) and individual interviews (two of the three schools). The open discussions occurred post-training and followed-up in departmental meetings at least three months after initial training. Interviews took place eighteen months after training and the use of the CATE programme in those schools. Further interviews are planned in three education regions in the UK over the next year to provide a more comprehensive view.

INITIAL FINDINGS

Formal interview evidence from teachers was obtained from schools B and C (Table 1) but not from school A. Evidence from school A was accrued through open discussion.

Table 1

	School B	School C
1) What do you feel has been successful with the use of CATE?	<ul style="list-style-type: none"> ▪ Pupils developing learning skills ▪ Motivating the less able ▪ Pupils ability to develop and explain strategies for problem-solving. These are getting better each lesson ▪ Pupils talking to each other constructively. Some pupils not used to success are finding their efforts in the lessons successful ▪ Some pupils with behavioural problems are becoming more sensible in the lessons ▪ The pace of lessons means pupils cover a lot of work. 	<ul style="list-style-type: none"> ▪ Allows the facility for class teacher to step back and observe individuals and small groups(reactions and interactions) ▪ More reasoned responses as the lessons have developed ▪ Some of the later lessons have proved very difficult
2) What do you think have been the effects or benefits, if any, upon your teaching?	<ul style="list-style-type: none"> ▪ Awareness of the different strategies has a beneficial effect upon pupils who do not respond well to the usual style of teaching ▪ On occasions last minute organisation has been difficult with the provision of other curriculum areas. 	<ul style="list-style-type: none"> ▪ More aware now when producing in-house material. – The approach and content have been highlighted. ▪ Now more conscious of what I'm trying to achieve and can use the model/approach of CATE to develop subject specific tasks.
3) What do you feel have been the effects on your pupils?	<ul style="list-style-type: none"> ▪ Raised self -esteem. ▪ Co-operation ▪ Raising independence ▪ Some behavioural problems have been more stable in the lessons ▪ Pupils feel better equipped to answer questions/problems in the lessons 	<ul style="list-style-type: none"> ▪ For some pupils a noticeable improvement in their ability to make judgements and decisions. ▪ The introduction and reinforcement of specialist terminology. ▪ Increased confidence when sharing thoughts/ideas with others ▪ Transferable skills

4) What do you feel have been the effects on the department?	<ul style="list-style-type: none"> ▪ See question 2 ▪ We may implement these strategies as part of the normal Technology curriculum provision ▪ We feel effects will be more obvious in years to come. ▪ 	<ul style="list-style-type: none"> ▪ Although not food specific, the lessons compliment the Technology and support/extend what is already going on. ▪ Some of the activities could be easily adapted to be specific if desired ▪
5) What further support does you or the department need in the future?	<ul style="list-style-type: none"> ▪ More structured timetable for CATE ▪ Guidance as to how to develop these strategies into the normal Technology curriculum ▪ More of a Technology focus on the worksheets e.g. equipment/tools/materials instead of animals ▪ Suggestions on how we can measure the effectiveness of the ▪ Programme as we do it. ▪ 	<ul style="list-style-type: none"> ▪ There is only one pilot group operating in Year 7 this academic Year. ▪ Will be discussing with Faculty Head and other staff the possibilities to develop this pilot with more groups and staff. ▪ Would like support with the new Year 7 groups. ▪ Also to develop work already carried out with the pilot group as they move into Year 8. ▪
School A. (Anecdotal evidence)	<ul style="list-style-type: none"> ▪ All teachers involved in CATE delivery believe that they have developed enhanced classroom skills. ▪ The headteacher commented that the Design and Technology department was now one of the more powerful departments in terms of teaching and learning methodology ▪ Year 10 Classes that had not been involved in CATE but had gone on to take GCSE, have improved their grades due to the teachers having improved their skills through 18 months of CATE. ▪ Students in CATE classes were better behaved than those students in non-CATE classes for normal D & T. ▪ CATE would now become part of the Key Stage Three curriculum for all Year 7 classes. ▪ All teachers would become trained in the CATE methodology. ▪ The school was working to become a CATE training establishment ▪ 	

DISCUSSION

Teachers commented in school A that the behaviour of the students from the experimental groups was much better than from those in the control groups, when all were compared in normal D & T lessons. Whilst this anecdotal evidence is interesting, it might be due to something other than intervention. The control group was not as able as the experimental group was according to the Piagetian pre-test data. Hence such students in the control group may have found D & T more difficult and showed this difference through impulsive behaviour. However, teachers in schools B and C also commented upon the positive behaviour of their particular students. Perhaps there is an indication here that CATE does allow students to become more concentrated and less impulsive in lessons. Teachers in all schools commented upon the improvement in the way that their students were solving problems through discussion and feedback.

The project does appear to have improved the teachers' professional development within the schools, or at least their own perceptions of professional development. The Design and Technology department in school A decided that from September 2001,

CATE would now operate to all students in Year 7. The school is taking part in a full evaluation of the project to help answer the four questions posed at the start. This has further implications for teacher professional development and training. Design and Technology teachers not versed in the underpinning principles and classroom delivery of CATE are now supported by the CATE co-ordinator and trainer within the school. At the end of the two years, the headteacher in school A reported that the Design and Technology department was now one of the more powerful departments in teaching and learning methodology within the school.

FURTHER RESEARCH DIRECTIONS

The pilot evaluative study was used to seek trends in effective training models with respect to empowering participants with key strategies for department-wide implementation using an appropriate intervention methodology. The early analysis points more to direct in-class development as the effective means of sustained curriculum inclusion.

Pre and post research data has always been central to all cognitive acceleration projects that have evolved from the original CASE material (*Adey, P., Shayer, M & Yates, C (1989)*). Our next stage will be to investigate formally, the possibility of correlation between sustained success at classroom level, if shown to exist, with the training models under scrutiny. Longitudinal data is currently being collected from the first pilot schools and the authors are presently engaged in initial analysis.

Initial Teacher Training postgraduate students completing in August 2004 (Secondary Design and Technology PGCE programmes, Goldsmiths College) will be tracked with respect to their employment destinations and whether these have a CATE involvement. The latter will require 'positioning' within a spectrum of possible CATE developments. These may range from 'no CATE teaching' to that where the new post-holder has significantly introduced CATE into the teaching programme. New to this study will be an undergraduate cohort of final year students completing a four year BA Education (Secondary Design and Technology) in August 2005. CATE training will be provided for this group and the current PGCE cohorts – both groups will be tracked from September 2005. The model of CATE training for ITT students will be consistent and college oriented – this allows for a different focus to be placed on future research paths.

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KEY WORDS

Achievement Cognitive acceleration Curriculum Initial teacher training In-service teacher training

Research Secondary education Technology education

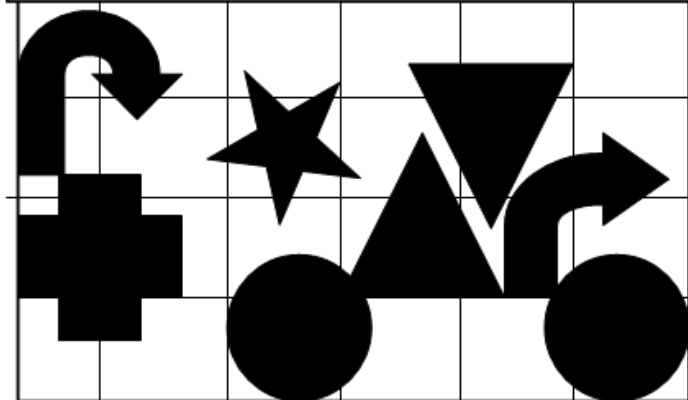
APPENDICES

A. Extract from CATE programme – Activity with accompanying teachers' notes

B. Post-training questionnaire

A. Extract from CATE programme – Activity with accompanying teachers' notes

Cognitive Acceleration through Technology Education

Activity 17 Task 17 Patterns and relationships	Murals			
				A tiled mural designed for a school reception area has to be moved from the current school to a new site fifteen miles away. The mural has to be taken down one tile at a time and reassembled in a similar way on the new

Decide how this could be done effectively in order for the mural to be reassembled correctly on the new site.

Write clear instructions to explain how the tiles should be assembled on this new site, using the existing mural as a model

Activity 17 Patterns and relationships	Murals	
<p><i>The Aim of this activity is to allow students the opportunity to develop further an awareness for structural analysis and to write clear instructions</i></p> <p><i>Student outcomes involve the following information processing strategies</i></p> <ul style="list-style-type: none"> • <i>Selecting questions to clarify explicit and implicit instructions</i> • <i>Visualising the task requirements.</i> • <i>Linking previous procedures into this task</i> • <i>Selecting ways of working to suit the task</i> • <i>Checking and evaluating procedures</i> • <i>Sharing and comparing ideas with others</i> <ul style="list-style-type: none"> • <i>Scanning, reading and understanding explicit instructions.</i> • <i>Analysing and synthesising information.</i> • <i>Labelling, coding, and comparing information.</i> • <i>Writing clear instructions</i> <p>This activity follows on and reinforces the processes established in the previous activities, especially activity 16.</p> <p>Task 17 requires the student to code each tile and then to write explicit instructions as to how it is to be re-assembled some miles away.</p> <p>The second task 17A shows a wall mural which acts as a plan or template for identifying and locating the</p>	<p>individual panels. The explicit instructions ask students to construct the panels into the mural with an explanation as to how this could be done.</p> <p>Students have to analyse the mural in terms of its structure and synthesise each panel into this structure.</p> <p>This requires the student to analyse similarities and differences between the mural and panels and to code each panel before synthesising the original mural.</p> <p>Phase One Introduction. You can begin by asking the students to imagine that they have to move a mural on a wall by dividing it into parts. How could they do this? Form the class into small groups and issue the first task sheet to each group or put up OHP slide of the activity. Encourage students to scan the task page and define the problem.</p> <p>Phase two - group work Allow students to work in pairs or small groups. Here they now have to write instructions to explain how to put this mural together after taking it apart. Observe and support where necessary. Give the class no more than ten minutes to complete this task then bring the class together.</p> <p>Phase three - The Discussion</p>	<p>Share and compare ideas and solutions to the patterns and relationships as well as the written instructions. Ensure that students justify their solutions. Investigate the codes or labels used (if any). Analyse any unusual responses, asking for comments from class group members. Interrogate students for the ease or difficulty that they had with this task. Compare similarities and differences between this task and those in activity 16.</p> <p>Phase four - Transfer Distribute the second task sheet 17A. Invite students to scan the sheet and identify the main features of the task.</p> <p>Invite volunteers to explain the contents of the activity. (Students will need to consider the number and form of each panel; the position of the panels; the shading and the position of the shading as a requirement prior to coding/labelling each panel). This needs to be identified before allowing small group work.</p> <p>Invite students to compare similarities and differences between this task and task 17.</p> <p>Allow students about 5-10 minutes to work on this task in pairs or small groups then regroup the class and explore solutions and any unusual methods of working. Invite students to provide real life examples of the applications.</p>

THEJB CATE

B. POST-TRAINING QUESTIONNAIRE

EVALUATION OF THE COGNITIVE INTERVENTION METHODOLOGY

School (mixed; comprehensive; selective etc).....

Teacher (female/male).....

Age groups taught.....

Subject Specialism.....

Number of years in teaching.....

INSTRUCTIONS: The following pairs of statements provide the opportunity to record your views about the use of the Cognitive Intervention methodology. Each pair of statements is separated by five positions. Please rate yourself in each case by ticking the appropriate position. The closer you tick to the left statement the more often this applies. The nearer you tick to the right statement the more often that applies.

Cognitive Acceleration through Technology Education

1.Improves my confidence as a teacher	1 2 3 4 5 6	Undermines my confidence as a teacher
2 Provides great satisfaction for the teacher	1 2 3 4 5 6	Provides little satisfaction for the teacher
3. Does not promote classroom discussion	1 2 3 4 5 6	Provides ideal material for classroom discussion
4. Involves useful terminology for problem solving	1 2 3 4 5 6	Involves learning irrelevant jargon
5. Is altering my perception of student capability	1 2 3 4 5 6	Is not altering my perception of student capability
6. Invites a teaching style I am happy with	1 2 3 4 5 6	Invites a teaching style I am unhappy with
7. Has no implications outside Thinking Skill lessons	1 2 3 4 5 6	Has implications for my teaching in all years
8. Offers little motivation for the students	1 2 3 4 5 6	Helps to improve the motivation of students
9. Does seem to improve problem solving skills	1 2 3 4 5 6	Does not seem to improve problem solving skills
10. Has a great deal to offer all subject disciplines	1 2 3 4 5 6	Has nothing to offer other subject disciplines
11. Is not liked by other teachers in the school	1 2 3 4 5 6	Has attracted a positive response from teachers
12. Involves a teaching style difficult to manage	1 2 3 4 5 6	Involves a teaching style easy to manage
13. Does not affect my work preparation	1 2 3 4 5 6	Causes more thorough work preparation
14. Helps pupils think for themselves	1 2 3 4 5 6	Has no effect on pupils thinking themselves
15. Has improved my effectiveness as a teacher	1 2 3 4 5 6	Has not altered my effectiveness as a teacher
16. Involves an uneconomical use of teacher time	1 2 3 4 5 6	Involves a reasonable return for time and effort
17. Involves unreasonable material cost	1 2 3 4 5 6	Involves reasonable material costs.