

This item was submitted to [Loughborough's Research Repository](#) by the author.
Items in Figshare are protected by copyright, with all rights reserved, unless otherwise indicated.

The design, development and implementation of cognitive acceleration through technology education (CATE)

PLEASE CITE THE PUBLISHED VERSION

PUBLISHER

© DATA

LICENCE

CC BY-NC-ND 4.0

REPOSITORY RECORD

Hamaker, Tony, and John Blackwell. 2019. "The Design, Development and Implementation of Cognitive Acceleration Through Technology Education (CATE)". figshare. <https://hdl.handle.net/2134/3186>.

This item was submitted to Loughborough's Institutional Repository by the author and is made available under the following Creative Commons Licence conditions.



CC creative commons
COMMONS DEED

Attribution-NonCommercial-NoDerivs 2.5

You are free:

- to copy, distribute, display, and perform the work

Under the following conditions:

 **Attribution.** You must attribute the work in the manner specified by the author or licensor.

 **Noncommercial.** You may not use this work for commercial purposes.

 **No Derivative Works.** You may not alter, transform, or build upon this work.

- For any reuse or distribution, you must make clear to others the license terms of this work.
- Any of these conditions can be waived if you get permission from the copyright holder.

Your fair use and other rights are in no way affected by the above.

This is a human-readable summary of the [Legal Code \(the full license\)](#).

[Disclaimer](#) 

For the full text of this licence, please go to:
<http://creativecommons.org/licenses/by-nc-nd/2.5/>

The design, development and implementation of cognitive acceleration through technology education (CATE)

Tony Hamaker and John Blackwell, King's College, London University, UK;
National Cate Trainer, CATE, UK

Abstract

This paper outlines the design and development of a cognitive intervention programme in design and technology education to Key Stage 3 students in the United Kingdom.

Included is an interim evaluation of effects on students and teachers. Data has been collected and analysed after two years of the developmental programme. Use has been made of:

- *Piagetian Reasoning tasks as pre/post tests instruments*
- *NFER Cognitive Ability Tests and end of Key Stage 3 assessments in order to monitor for far transfer effects*
- *a teacher interview technique to monitor teacher attitudes towards the project.*

The interim evaluation described in this paper suggests that design and technology education has been enhanced at a number of levels by the intervention programme and that there is a little evidence that far transfer effects have occurred.

Keywords

cognitive acceleration, research, Key Stage 3, achievement curriculum

Introduction

An evaluation of a two-year cognitive intervention programme in technology education for Key Stage 4, 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 technology, science and mathematics. The effects appeared pronounced for the concrete operational thinking student, (as measured by the Piagetian tasks that were utilised) but not for the formal operational thinking student.

Cognitive intervention programmes in science and mathematics (CASE and CAME) have both been developed for Key Stage 3. Evidence from CASE (Adey, P. and Shayer, M., 1994) suggests that Key Stage 3 should be an even better starting point than Key Stage 4 for such an intervention programme in order to enhance the performance of all students at GCSE.

In 1997, one of the authors was approached by a school in the UK for help in developing such an intervention programme at Key Stage 3 in design and technology. The school senior management team and the head of design and technology wanted the development to proceed as part of the school development plan.

Since 1998, the CATE programme has been ongoing, with the associated intervention methodology and activities being developed, trialed and revised within three schools in the UK. One school, which shall be labelled school A, from 1998 and two other schools, which shall be labelled schools B and C, from September 2000. The Cognitive Acceleration through Technology Education Programme, the CATE activities and associated classroom methodology are designed to help Year 7, Year 8 and Year 9 students 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. By this is meant that there is no 'hands on' practical or making activity.

CATE is attempting to use a description of development closely associated with Piaget, Vygotskii

and Feuerstein. CATE attempts to use some of the reasoning patterns associated with Piagetian epistemology, as exemplified through the CASE project, (Adey, P. S., Shayer, M. and Yates, C., 1989), together with information processing strategies associated with Feuerstein as exemplified through the Somerset Thinking Skills Course (Blagg, N., Ballinger, M. and Gardner, R., 1988). The classroom delivery methodology utilises an approach based on an interpretation of the Vygotskii notion of social construction of knowledge as interpreted by Feuerstein *et al.* 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.

Thirty-six activities have been developed. These are to be administered in design and technology lessons throughout Key Stage 3. Each activity consists of two tasks: a main task that needs to be completed in full and a second task that bridges (links) from this main task. 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 notes.

Subjects and design

In developing this programme, questions needed to be addressed 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?

We wanted to investigate the effects of intervention methodology on perceptions of teacher professional development. School A was used to help investigate all of these questions whilst schools B and C were used to further investigate teacher perceptions. Initially, four

teachers within the design and technology department of school A, implemented CATE in the classroom. A teacher was identified who became the school CATE co-ordinator and eventually became the main CATE contact person and organiser within the school and is in the throes of becoming a CATE tutor/trainer. Another colleague well versed in the notion of cognitive intervention methodology, worked with schools B and C. The project had to operate within the constraints of the existing school policies and practices.

A further problem working with school A was that the school was also developing CASE methodology within the science department. The Year 7 cohort that would be working with CATE would also be receiving the CASE lessons once every two weeks. How could the CATE programme be evaluated effectively? Could any possible CASE effects be filtered out?

Four CATE experimental classes and four non-CATE control classes in Year 7 were identified, with approximately 120 students in each cohort. A non-intervention Year 9 cohort of 240 students was identified as a secondary control group. The experimental cohort would experience the CATE and CASE lessons. The control cohort would experience CASE lessons but not CATE. (There would be a little control over the CASE lessons that were delivered since one of the authors was also the CASE tutor for the school science department.)

A Piagetian type pre-test was administered to these two Year 7 groups and the Piagetian post-test would also be administered to these groups when they were at the Year 9 stage. The resulting data would be used to further measure both short-term cognitive gains and possible far transfer effects.

Use would be made of the data obtained from Cognitive Ability Tests that the school administered to both Year 7 and Year 9 classes. This data would also be used to measure possible short-term gains and transfer effects.

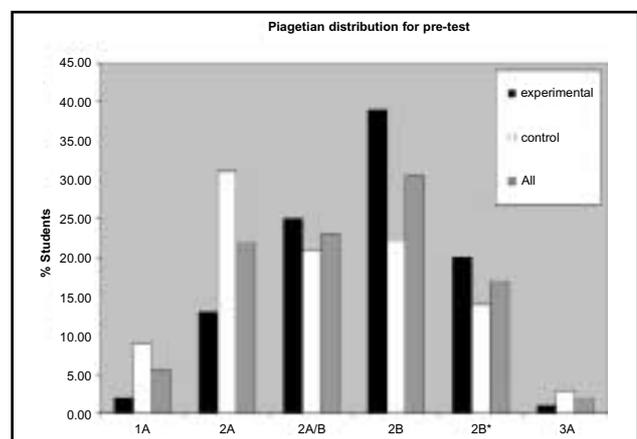


Figure 1.

Figure 1 shows the % Piagetian level distributions for the control and experimental groups in Year 7. This data was obtained using the Science Reasoning Task 11. Volume and Heaviness. (Shayer, 1978)

The control group is showing a positive skew towards the lower end of the ability continuum.

The experimental group distribution is suggesting more of a normal distribution, although this group contains a smaller number of students at the higher levels than one would expect from normalised population data for this test and age group.

These two groups were not completely identical in terms of the Piagetian test distribution data. This is highlighted further by inspection of Figure 2.

The box and whisker plots represent the Piagetian level distributions for the individual experimental and control classes on the Volume and Heaviness pre-test. The bold line within the boxes represents the median value. The top and bottom of the boxes represent the upper and lower quartile values. The range is included, as are the outliers. The black dots denote the outliers (low scoring students).

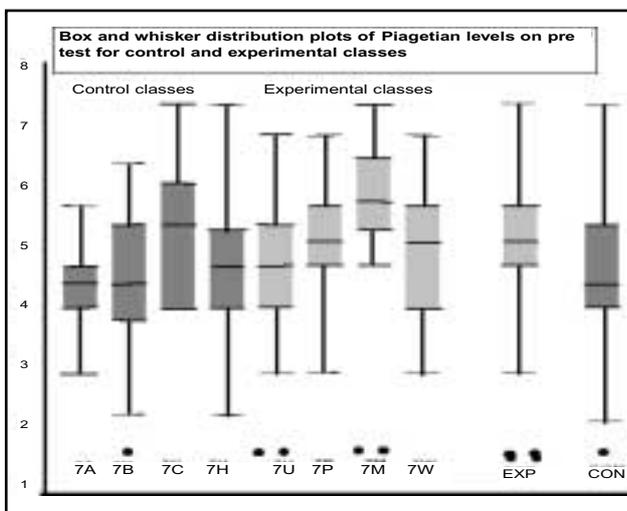


Figure 2.

Three experimental classes have higher median scores than the control classes. This can be seen by comparison of the experimental group to that of the control group. Overall, the experimental group is showing a higher median value than that for the control. Both groups are showing a slight skew towards the lower end of the ability continuum, when compared to the normal population data for this task, thus suggesting that this Year 7 intake is not representative of an all-ability intake. Class 7M contained a large number of students who appeared to be operating at a higher level of processing capability compared to students in the other groups. The school's design and technology department had

identified these groups as the experimental and control groups prior to the administration of the Volume and Heaviness pre-test.

A further Year 9 cohort of 240 students was identified as a secondary control group. This Year 9 cohort had not experienced any form of intervention methodology. A Piagetian type post-test was administered to this cohort. These results, along with the results from the end of Key Stage 3 assessments and NFER cognitive ability tests, would form the basis for the comparative studies of possible far transfer effects. Use was made of the results from the school cognitive ability tests and the resultant student target grades and teacher assessments, in order to measure any effects in design and technology at the end of Key Stage 3. Use was also made of the student and teacher questionnaires to gauge some attitude responses to the programme. The design and technology teachers had to undertake classroom training in the delivery methodology, along with the associated theoretical ideas underpinning the intervention. This was achieved through an extensive programme of in-class support through demonstration lessons and observations and feedback.

Much of the initial training in the first year involved a 'delivery-on-the-hoof' approach. This can be seen as a weakness in the design of this reported study since activities and associated tasks were changed and re-ordered in the light of the previous experience. Initially, some teachers were unsure as to what to do and why they were doing what was asked. Hence the need for much formal training and some demonstration lessons in the classroom by the CATE tutor and trainer. This is an important factor when implementing any new innovation. Thus, the teachers' main classroom programme did not actually begin until January 1999, after the initial first term of demonstration and theory. (The CASE classroom programme had started in September 1998.)

The intervention programme lasted until July 2000, which was the end of Year 8 with these classes. Each intervention lesson was delivered once every three weeks. In this way it was possible for two intervention activities to be delivered within each six week design and technology module operated by the department at Key Stage 3. This was approximately 16% of the design and technology curriculum time in Years 7 and 8, (although as already explained, one term was not utilised in actual classroom delivery of the programme).

Design and technology lessons would then continue in Year 9 without associated intervention, with test data collected at the end of Year 9. This Year 9 cohort would be taught by design and technology teachers

who had not been involved with any intervention delivery at this stage.

Student questionnaires were administered at the end of Year 8 (whilst the students still had immediate experience and record of the intervention programme). Teacher interviews in school A were continuous throughout the intervention period. Teacher interviews took place in the Summer of 2001 in schools B and C.

Results

Evidence of cognitive acceleration

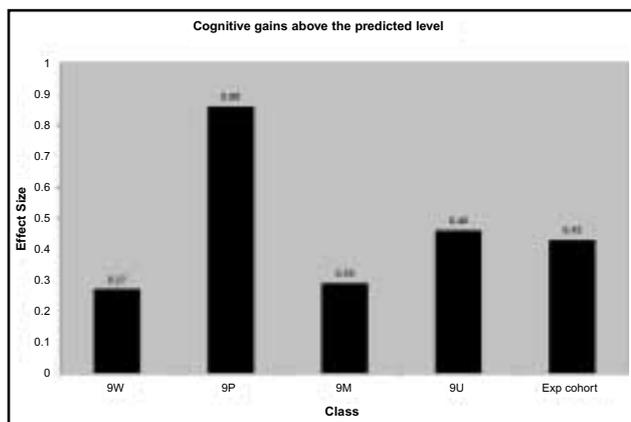


Figure 3.

This is data obtained from the Piagetian Reasoning Tasks. The pre-test mean scores were used to predict the mean scores two years on from the population data gathered in the original CSMS survey, assuming the same standard deviation. These predicted scores then became the new control data. The actual post-test data became the experimental scores. The Effect Size was the difference between experimental and the control scores divided by the pooled standard deviation for the control and experimental data.

Figure 3 shows the gains over and above what would be expected by normal school development and maturation effects. There is a statistically significant effect for the complete experimental group ($p < 0.0005$, $N = 93$), suggesting a cognitive acceleration effect.

Closer inspection of the data reveals effects that are statistically significant for classes 9P ($p < 0.005$, $N = 24$) and 9U ($p < 0.025$, $N = 24$), but not for classes 9M ($p < 0.25$, $N = 25$), nor 9W ($p < 0.25$, $N = 24$).

Use was also made of the school NFER Cognitive Ability Test (CAT) data. Data from such tests was collected by the school, prior to the start of the intervention, and then after two years of intervention development, at the beginning of Year 9.

Comparison was made between the non-CATE control group (which had received CASE

intervention) and the CATE experimental group that had received both intervention programmes.

Figure 4 shows the results from a residual gain analysis of the data obtained from the cognitive ability tests. The displayed data shows the effect sizes obtained after comparison of the experimental classes with the control classes.

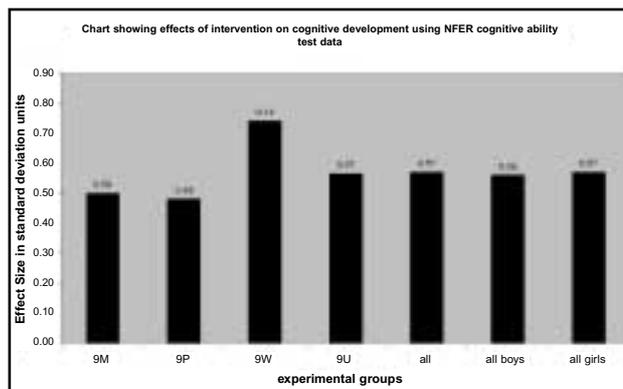


Figure 4.

Results from Cognitive Ability Tests was collected for pre-test and post-test data. A residual gain analysis (regression) was performed on the data by comparing the CATE classes with the non-CATE classes. The above effect sizes are in standard deviation units. Figure 4 data is showing gains over and above what would be expected by normal development and maturation.

The effects are all significant. The suggestion here is that the CATE intervention is enhancing cognitive development beyond that for CASE alone, as measured by these test batteries.

For this test, the effect for class 9W is much greater than for the other three classes. There does not seem to be any difference with respect to gender from this data.

Evidence for design and technology enhancement?

Use was also made of this cognitive ability test data to set target grades for the students in design and technology to complete by the end of Year 9. Teachers could then compare the grade levels that they would give to students at the end of Year 9 with the projected grade levels obtained from the targets established through the use of the cognitive ability data. Use was also made of this cognitive ability test data for evaluation of possible effects in design and technology. Direct comparison was made between the CATE experimental group and the non-CATE control group. The original CATE experimental groups were now taught by different teachers for their Year 9 course. The new teachers had not been involved in the original teaching of the CATE intervention.

Control group	Verbal	Quantitative	Non verbal	Triple score	Target level	Teacher
CB1	106	128	114	116	6.1	6
CB2	118	116	119	118	6.2	6
CG1	112	110	109	110	5.7	6
CB3	109	108	108	108	5.6	5
CG2	96	107	117	107	5.5	6
CG3	105	93	106	101	5.2	5-
CG4	95	97	89	94	4.7	5-
CG5	90	90	92	91	4.5	4
Experimental						
EG1	105	130	129	122	6.5	7+
EB1	96	110	113	106	5.5	7+
EG2	97	102	108	102	5.2	6+
EB2	98	89	111	99	5.0	6+
EG3	104	90	88	94	4.7	6+
EB3	100	91	89	93	4.7	6
EG4	98	86	87	90	4.5	6
EG5	87	82	84	84	4.1	5
EB4	98	78	70	82	4.0	5

Table 1.

At the end of Year 9 the teacher assessed National Curriculum level grades for each student, along with the cognitive ability test triple score, which was used to compute an effect size, by residual gain analysis. This effect size acted as a measure as to whether design and technology capability had been enhanced. The results are shown in Table 2 with sample data displayed in Table 1.

Table 1 contains some sample data for display purposes. This data has been sampled from both groups. Names have been coded. The overall average from the three test batteries yields the triple score. The target level is the actual predicted grade using the NFER triple score. The teacher grade is the actual score awarded by the teacher.

This triple score and associated teacher assessment grades was used to compute a regression curve for the control group of students. (N = 109). Grade scores were transformed into whole numbers to help account for the positive and negative divisions of the teacher-assessed marks and to help with the analysis. The experimental group was compared to the control group as a whole and then broken down into individual classes (Figure 5). The regression equation for the control group was computed using the Year 7 triple score and the transformed scores related to the teacher grades.

This regression equation was used to analyse the experimental group data (N=107) in order to compute residual gains and an overall effect size.

Table 2.

Mean grade (NC level) for CATE experimental cohort = 5.8 (N=107)
Mean grade (NC level) for non-CATE control cohort = 5.2 (N=109)
Effect Size for experimental group = 1.15 SD units (P<0.0005)

Table 2 represents the result from the residual gain analysis for the experimental group when compared to the control group (see Table 2 for further clarification of the methodology). Such an analysis allows use to be made of all available data.

The effect size, 1.15, obtained for the experimental group is substantial and statistically significant.

Figure 5 shows the effects for each class and the effects for the girls and boys. The apparent design and technology effects are substantial for all classes and statistically significant, suggesting effects for all

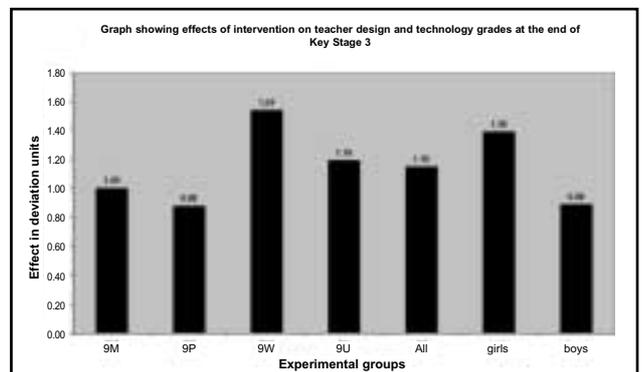


Figure 5.

teachers who were trained in the methodology. Class 9W is showing the largest effect. Girls appear to show a greater effect than boys for design and technology enhancement.

Figure 5 represents the residual gain scores for the individual experimental classes when compared to the control classes using the actual teacher assessment grades for both groups, and the associated Cognitive Ability Test triple scores for both groups. The effect size is expressed in standard deviation units.

These teacher grades were based on the work achieved for each student by the end of Year 9. Obviously the teacher grades are somewhat subjective. They were not moderated. However, the teachers making these level assessments were experienced design and technology teachers. Furthermore, as they were not involved in the initial intervention training programme, they did not know which of their Year 9 students were in the original CATE classes and which were in the original non-CATE classes. (Data was not available to compare these two cohorts with the non-intervention cohort).

Evidence of far transfer effects

End of Key Stage 3 assessment data was used to analyse for far transfer effects from design and technology into English, mathematics and science. Results are shown in Figure 6.

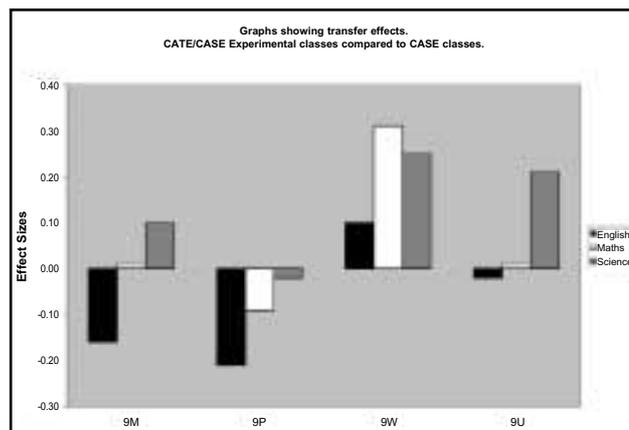


Figure 6.

The result for a far transfer effect on the performance of the experimental group is not conclusive. Three of the classes are showing positive effects for science but

Table 3.

	School B	School B
1) What do you feel has been successful with the use of CATE?	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.	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?	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.	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?	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.	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?	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.	Although not food specific, the lessons complement 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?	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.	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	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 design and technology. CATE would now become part of the Key Stage 3 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.
---------------------------------	--

they are not statistically significant. For English language, three classes are showing negative effects. Again, these are not statistically significant.

Use was made of the school cognitive ability test data (NFER) in Year 7 and end of Key Stage 3 assessment data for the intervention Year 9 cohort. Using the cognitive ability test data as the baseline data, regression curves were computed for each of the three subjects examined at the end of Key Stage 3 for the CASE control cohort. The data from the CATE experimental intervention cohorts was then fed into these regression curves and analysed for residual gain effects. Such effects were then transformed into an equivalent Effect Size for each class.

Closer inspection of this data suggests that there is not strong evidence of any transfer effect. However, experimental class 9W did appear to make the largest

gains in all three core subjects, albeit without statistical significance. This compares well with the pattern of data produced from the analysis for both cognitive enhancement and design and technology enhancement. The transfer data shown in Figure 6

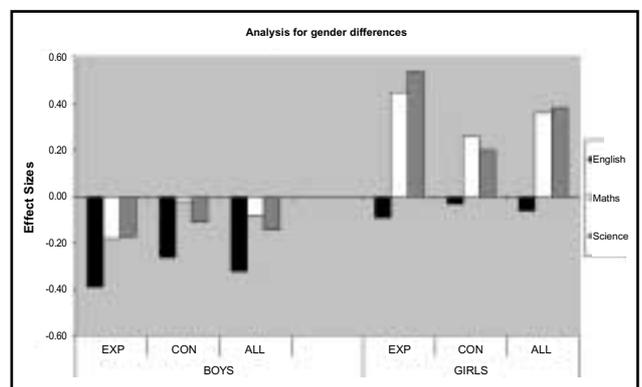


Figure 7.

was further analysed for any possible gender bias effects. The result of this is displayed in Figure 7.

Comparisons were made between the experimental and control cohorts that received the cognitive intervention programme with the non-intervention cohort. Fig. 7 is displaying the data when each particular sex was removed from the group under study. CASE/CATE boys and girls are from the (EXP) experimental group. Non-CATE boys and girls are from the CON (control) group that received CASE intervention.

The results for science and maths suggest that the girls in these intervention classes are showing science and maths gains compared to the non-intervention cohort. Boys are not showing transfer effects from the intervention. The data supports the view that boys within this year group have not performed too well in the end of Key Stage 3 assessments in all three subjects compared to the girls. The results for English suggest that something else might be in operation here to affect these results. Girls in the CATE groups are showing moderate transfer effects when compared to the girls in the CASE intervention control group. The positive effects in the girl experimental group for science ($p < 0.0005$) and mathematics ($p < 0.0005$) were statistically significant ($N = 54$). For the girl CASE control cohort, the effect in science ($p < 0.05$) was significant but that for mathematics was not. For both boy cohorts, the negative effects in English language for the experimental cohort ($p < 0.005$) and control cohort ($p < 0.05$) were statistically significant.

Teacher evaluation of CATE

Formal interview evidence from teachers was obtained from schools B and C (Table 3) but not from school A. Evidence from school A was accrued through continuous verbal feedback.

Discussion

The design, development and implementation of CATE at Key Stage 3 started in school A in 1998, and has continued into 2000 and thence 2001. The final version has changed somewhat from the initial conception back in 1996.

The data collected and displayed here has also been influenced by the continual changes to the activities and associated tasks and to the actual classroom delivery of the programme throughout the two years that it was in operation in school A. The changes were a response to the continuous feedback received from teachers and students within the school. Thus, the data presented needs to be reviewed with this in mind.

The four questions that were posed at the start of the project have yet to be answered fully. However, there

is enough here to share with our colleagues at large, both within the so-called 'Thinking Skills' movement and within design and technology education.

Inspection of the data from figures 1 to 4 suggests that there is evidence of enhanced cognitive development. Initially the experimental and control groups identified in Year 7 were deemed to be identical in ability groups and hence operating with similar information processing capability. The groups were identified through internal school procedures and practises. The Piagetian pre-tests suggested that this was not quite the picture. The CATE experimental cohort appeared to contain more students operating at a higher processing level than the control cohort. A comparison of the Piagetian post-test data with the pre-test data suggests evidence of cognitive acceleration overall, as shown in Figure 3.

The Cognitive Ability post-test data, shown by figure 4, suggests that the experimental cohort is showing a cognitive acceleration effect in addition to any produced by CASE. The evidence collected here suggests that once again cognitive intervention methodology does seem to enhance the processing capability of students, as measured through the use of Piagetian reasoning tests and Cognitive Ability Tests. This further supports the evidence reported by Adey and Shayer. (1994) Has this cognitive acceleration effect been transferred to normal subject performance? The data obtained for the effect on design and technology is strong evidence that near transfer effects have occurred. An effect size of 1.15 in design and technology, if repeated at GCSE examination level, would mean that the *average* design and technology student who had received the intervention programme would score higher in design and technology GCSE than 87.5% of students in an equivalent non-intervention group.

Care needs to be placed on the accuracy of the teacher assessments, as these were not moderated. However, it should be repeated that the teachers were very experienced design and technology teachers and part of their job is to be able to make accurate assessments on such student outcomes as 'end of key stage assessments'. The teachers that allocated the students the final end of Key Stage 3 levels in design and technology were not the original teachers involved in the delivery of CATE. Neither were they informed as to which students were in the experimental and which were in the control groups. Obviously this information was not a secret nor was it part of the original design to operate a double blind type test.

The size of the effect is very large and totally unexpected. Further inspection and analysis of the raw data suggested that the girls showed bigger gains than the boys did in their design and technology

performance. This was opposite to teacher perceptions when delivering the lessons, but this is not surprising when one inspects the data for possible far transfer effects. Girls seemed to show far transfer effects into maths and science compared to the boys. However, the data on transfer is not conclusive from this study. This is not too surprising when one considers the way that teachers were asked to implement the innovation within the first year. Effective transfer from one domain to another does not happen automatically. Examples of effective bridges or links from one domain to another need to be made by teachers or peers and then internalised and applied by the students themselves. This was not a priority for teachers at school A when starting, even though this was part of the formal training in the first term. Thus appearance of far transfer effects, albeit in favour of girls, is surprising and very exciting. This finding shows a similar pattern with the evidence from U.K. governmental sources, suggesting that girls seem to be achieving higher grades than boys by the end of Key Stage 3 in design and technology (DfES, 2002).

This apparent effect on design and technology is even more astonishing when one considers the nature of the intervention during this 18-month developmental period. (It was a developmental period and all were on an accelerated learning curve. Mistakes were being made. Teachers were unsure as to whether they were delivering the lessons in the way that such lessons were designed. The tutor/trainer was unsure as to whether enough support had been forthcoming.)

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 design and technology 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 design and technology 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. Department members observed and reported that the improved results at GCSE design and technology in the non-CATE Year 11 classes, (not reported in this study) at the end of the intervention, was due to teachers acquiring new skills and transferring such skills into their teaching in Year 10 and 11. These new skills were linked to the way such teachers were operating in CATE lessons. We report these comments but offer no discussion.

However, this aspect of the project is a most pleasing and important development if it can be sustained. Feedback from the students throughout the two years but especially from the questionnaires that were set, have influenced the nature of the activities and associated tasks in the final CATE product.

Project tasks have been changed and re-ordered and the activities analysed for cognitive demand and re-ordered accordingly. The degree of task difficulty now increases as one moves from Year 7 through to Year 9. The activities have been set in a greater design and technology context. The activities have become more personalised through the introduction of a character named 'CATE', who appears throughout the activities along with members of her imaginary family. Each activity still contains two tasks. These tasks are still demanding and challenging for all students, as that is central to the design of CATE. The nature of differentiation in CATE lessons is through the planning of the CATE lesson rather than through the delivery of different tasks for different students. CATE emphasises group work and discussion. CATE lessons are now designed to last for a maximum of one hour, although each activity can be set for a longer or shorter time allocation if necessary, since there are two tasks to each activity. A number of students found that more than one hour was rather long for this type of work. One hour is now the recommended maximum time allocation for the delivery of each CATE lesson. Interestingly enough, verbal feedback throughout the first year of development suggested that the boys were enjoying the tasks more so than the girls were. Teacher observations suggested that CATE was more male orientated. The data for design and technology

performance and far transfer effects does not seem to support this notion. The girls seem to be able to apply ideas and strategies to different subjects more effectively than the boys can. Nevertheless, there was a feeling from some teachers that there was not enough contexts concentrating on materials, control processes and food technology. This has since changed in the light of the above evidence.

Conclusion

It is therefore acknowledged that the data presented here represents one school only. However, the results are very suggestive. The limited evidence supports the notion that cognitive intervention methodology can be applied to design and technology at Key Stage 3 to produce near transfer effects (effects in design and technology). Teacher interviews and feedback suggests that those involved in the delivery of CATE are also experiencing professional development which they can transfer into other non-intervention lessons.

Complete field trials started in September 2001 in a number of schools in Newport, Sunderland, Wiltshire, and London.

The aim is to try and answer the questions posed at the beginning of this paper. CATE is due to be published in the near future by Nigel Blagg Associates.

References

- Adey, P., Shayer, M. and Yates, C. (1989) *Thinking Science: The curriculum materials of the CASE project*, London: Macmillan
- Adey, P. and Shayer, M. (1994) *Really Raising Standards: Cognitive intervention and academic achievement*, London: Routledge
- Blagg, N., Ballinger, M. and Gardner, R. (1988) *Somerset Thinking Skills Course: Handbook*, Oxford: Basil Blackwell
- DfES (2002) Gender Differences in Design and Technology, DfES web site: www.DfES.gov.uk
- Hamaker, A.K., Jordan, P. and Backwell, J. (1998) 'An Evaluation of a Two Year Cognitive Intervention Programme in Technology Education for Key Stage 4 Students in the UK', *The Journal of Design and Technology Education*, 3 (1): 26-33
- McGuinness, C. (1999) *From Thinking Skills to Thinking Classrooms: A review and evaluation of approaches for developing pupils' thinking*, DfEE Research Report 115: HMSO