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Technology education in South Africa: an evaluation of the impact of an experimental high school curriculum with particular reference to teacher pedagogy and student group work

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Abstract
This paper focuses on the impact of the Technology Education Project in the North West Province of South Africa (NWPTEP) which has aimed to introduce technology education into a group of the Province's high schools, in grades 10 - 12. It reports on an evaluation study carried out in the final stages of the project, looking particularly at the impact of introducing an active, learner centred, problem solving pedagogy into the schools and within this at the effect of using group work in the teaching and learning situation. The paper presents findings derived from the assessment of a pupil technological activity, an evaluation questionnaire and a set of structured interviews with those involved in the project.

Keywords: international persepctives, technology education, pedagogy, groupwork, gender

Project background

The NWPTEP, funded by the Department for International Development (DFID), has been a three year project coming to completion in 1999. The initiative has been a joint venture between DFID, the North West Province Education Department and PROTEC, a South Africa based NGO which, since the early 1980s, has been working with disadvantaged students in townships and rural communities, developing technology activities and resources for use outside the formal curriculum (often in the form of 'Saturday Schools'). The project has been one of a number of initiatives working towards the goal of 'Technology 2005', which aspires to build technology education into the curriculum experience of all South African pupils by the year 2005.

The study reported in this paper is drawn from an independent evaluation of the impact of the development project. The research was conducted by the authors and funded by DFID. The insights presented are drawn from data gathered in the latter stages of the project through a series of questionnaires, structured interviews and pupil capability assessment activities. The development project took a particular approach in terms of pedagogy, promoting a view of technology education that is learner centred, active, participatory and procedural, that integrates theory and practice and sees group working and problem solving as central. This pedagogy is not typical within South African high schools and so the research team have focused in detail on the impact of its introduction. This paper focuses on this aspect of the research and provides insight into the influence the shift in pedagogy had on the learners, the new technology teachers and beyond into the whole school community. Within this, particular consideration will be given to the question of group work. (1)

The research design

The evaluation involved ten project schools and ten broadly equivalent non-project schools, balanced in terms of urban/rural settings and intake and focusing on eighteen year 11 and eighteen year 12 learners in each school. Each learner was involved in a group-based technological activity and individually they completed evaluation questionnaires and attitude questionnaires. In addition we conducted a series of interviews with those involved.

- a technological task is presented;
- the task relates to the context of the students and the schools;
- the task lasts 75-80 minutes;
- the task is broken down into a series of sub-tasks that last between 5 mins and 15 mins;
- these sub-tasks are choreographed by an administrator and are scripted and timed to standardise the administration;
- the task is tackled by design teams of 6 students;
- the activity is designed to operate through several phases
  - initial team brainstorming of possible approaches
  - breaking down the task into three sub-tasks that are tackled by pairs of students and that are targeted at the experimental curriculum, pair A dealing with materials and processes, pair B with energy and power, pair C with communications
  - the pairs present their ideas back to the whole team and debate them
  - the team develops a composite solution
  - the team outlines what still remains to be done and evaluates the strengths and weaknesses of the proposed solution;
- the teams respond to the task in specially designed response booklets; a team booklet for the start and the finish of the activity, and pair booklets (A,B&C) for the targeted activities.

Figure 1 Essential features of test structure, illustrating teamworking features

Developing the performance assessment instrument

The performance assessment instrument devised for this evaluation had its roots in our work for the Assessment of Performance Unit in the UK in the late 1980s, (Kimbell et al 1991) and the essential features of it are shown in Figure 1.

A fresh element in this evaluation, not present in our earlier research, was the assessment of group work. This was made possible because we were evaluating the impact of the project on the **schools** involved in the pilot, rather than on any **individual** learner. We also assessed the ability of the group to work as a team, a further new and useful departure. Our initial inclination was to explore teamworking solely through an evaluation questionnaire - to explore learners' views of this experience. But through trialling the activity it became apparent that we could identify evidence of team work, and hence make judgments of quality, from the responses in the test booklets. We characterised this dimension in terms of the evidence of group decision making, addressing the whole task, amalgamation of ideas and supportive interaction.

The activity evaluation questionnaire

We created an evaluation questionnaire that enabled us to build a picture of the typical responses of categories of students to the technology task. The questionnaire addressed working in teams, and also girls and boys working together. It included a response section headed "I **don't** like working in teams" which offered a number of options for them to agree or disagree with (eg 'because I get bossed about', or 'because other people are lazy') and a section headed "I **do** like working in teams" which offered other options (eg 'because we can divide up the work' or 'because people bring different skills').

The interviews

Interviews were conducted with the school principal, the project teachers, six students from each school, the college tutors who trained the project teachers, the project field officer, responsible officers of the Province Education Department and the director of PROTEC. Each interview was semi-structured and notes were taken on a prepared response sheet. The findings enabled us not only to interpret the performance data but also to speculate on wider issues concerning the impact of the project.

Findings

Findings from the technological activity

Performance on the task was scored on a 1-4 scale and focused on procedures (identifying

and specifying, generating and developing, evaluating, team working) and technical knowledge application (of materials and processes, of energy and power, of communication systems). Each team was also given an holistic score that indicated their overall response to the task.

In overall terms the assessment activity showed a higher level of performance in the pilot schools. (2) This result was reassuring, but not overly surprising. What was of more interest were the differences within the sub categories. Within the design procedures, *evaluating* was **very** significantly stronger in the project sample, *identifying & specifying* and *team-work* were significantly stronger, but with *generating & developing* solutions there was no significant difference between the samples. In the use of knowledge, *communications* and *energy & power* were **very** significantly stronger in the project sample, and *materials & processes* was significantly stronger.

These results speak strongly of the impact of different approaches to teaching technology, even within an active, procedural model. The PROTEC materials used in the project take a strong problem solving approach to technological situations, but within this little emphasis is placed on learners generating and developing ideas and no teaching aims to develop graphical communication. We were therefore not surprised by the lack of significant difference in respect of generating and developing ideas. In the use of knowledge the higher scores in the project schools attests to the teaching and learning in this aspect of the development project. Learners' ability to deal with *communication* systems, and *energy & power* were clearly enhanced. The slightly lower significance for *materials & processes* is attributable to this area being more readily developed through every-day experience of the world.

Team work

Of particular relevance to this paper, we were encouraged to find evidence of an anticipated effect on students' team working, partly because it is not a common practice in South African schools (so would be less likely to be part of the learner experience in non-project schools), and partly because the whole pedagogy of the project deliberately fosters it. The overall difference in team working scores between the project and non project samples is significant (project = 2.65, non project = 2.27, t test probability = 0.02), but this result becomes more interesting when the groups are broken down into year groups. While there is little significant difference between the year 11 and year 12 in the project schools (beyond year 12 having got marginally better at it), the difference between year 11 and year 12 in the non project schools is quite startling in that the year 12 performance is dramatically worse! This is not a healthy condition for students who are (hopefully) about to enter the world of employment. Building this dimension into the NWPTEP would appear to have reversed the dropping off of this skill in quite a dramatic way.
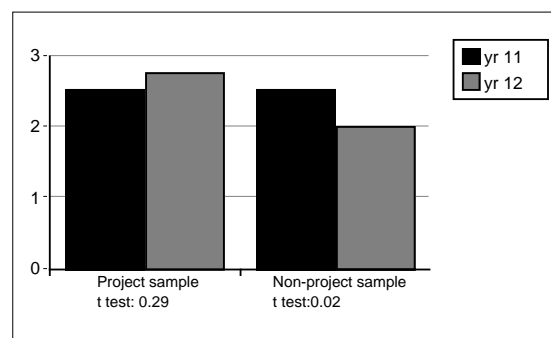

Figure 2 Team working

Findings from the Activity Evaluation Questionnaire

These findings are further illuminated when we look at the responses from the evaluation questionnaire. The data from the positively posed statements (see Figure 3) shows little difference between project and non-project schools, both presenting a healthy balance of positive attitudes.

Intriguingly however, the negative questions expose some significant differences between project and non-project schools. Across almost every question in the negative group, there is a difference, and, without a single exception, the project schools are less negative than the non-project schools.

I like working in teams:	I don't like working in teams:
because we can share ideas	because I get bossed about
because there are lots of different ideas	because I can't work at my own speed
because people bring different skills	because other people are lazy
because it helps to develop communication skills	because I don't like having arguments
because we can divide up the work	because other people have silly ideas
because you are not marked as an individual	because other people ignore my ideas
because other people can do all the work	because it is more difficult to make decisions

Figure 3 Positive and negative statements about team working

I don't like working in teams:	project	non-project
because I can't work at my own speed	2.20	2.40
because other people are lazy	2.50	2.70
because I don't like having arguments	2.00	2.20
because other people have silly ideas	2.00	2.30
because it is more difficult to make decisions	1.90	2.10

Figure 4 Differences in negative statements

This would appear to be solid evidence that the sustained experience of teamwork has enabled the learners not only to see the benefits of teamwork, but also to grow beyond some of the archetypal complaints about it. When this negative set is broken down by gender, there is a further interesting trend - with girls in the project schools showing greatest advantage.

Girls don't like working in teams:	project	non-project
because I can't work at my own speed	2.20	2.50
because other people are lazy	2.40	2.70
because I don't like having arguments	2.10	2.30
because other people have silly ideas	2.00	2.40
because it is more difficult to make decisions	2.00	2.20

Figure 5 Gender differences (girls) in negative states

However, these differences do not arise because girls in project schools are less negative than their male counterparts. In fact their scores are remarkably equivalent. The differences arise because in the non-project schools the girls are far more negative about teamwork than are the boys. This would indicate a somewhat unexpected argument in favour of the groupwork ethos of the project schools. It would suggest that the major

beneficiaries of the pedagogy are the girls, who are able to overcome the very negative attitudes towards teamworking that predominate in non-project schools and that probably originate in traditional cultural conceptions of gender roles.

The positive value of team work was further supported by views expressed in the interviews, where sharing ideas, developing learners' reasoning skills and improving their communication skills were identified along with increasing the enthusiasm of the learners.

- Lots of experiences, communication is good, helping each other.
- We can help people in rural places. It's practical and groupworking is good, sharing ideas - girls and boys together.
- Involves teamwork - it helps communication and you get to know yourself and other people better.
- In other lessons you are on your own - we prefer to work together and share ideas.

The pedagogic shift

Many issues arose in the course of the interviews that reflected on the development and quality of the technology programme. In particular, the dramatic shift in pedagogy had an impact throughout the project, starting with the training of the new technology teachers. When we asked teachers to reflect on the quality of the training, two contrasted (apparently paradoxical) positions emerged. On one hand teachers commented that the training was highly effective in helping them to completely transform their approach to teaching and learning. This pedagogic

transformation was attested to by almost every teacher in the project schools and is observable in views such as...

- Yes, it's a very different style of teaching - but not difficult - it's better dealing with small groups - very interesting and effective.
- Professionally I am a changed person - it's a question of management - I am not oppressed by the dictatorship of the teacher.
- In technology you are not spoon-fed - there is no authority there - you are there to help not to control.

Moreover, having adopted this new approach to teaching and learning, the teachers also said that they have adopted it into the other subjects that they teach (all the teachers we spoke to were recruited into the project from other subjects - from Africaans to history or science).

- I have acquired innovative teaching methods which are transferable to other subjects.
- The training enhanced our ways of teaching, and the methods are permeable (sic) to other subjects.

On the other hand, the small number of teachers that criticised the training did so in terms of the expectation that they had for acquiring more technological knowledge and skills.

- I had more expectation - training was just basic - not deep enough.
- But we need to learn more content and skills than students would learn.

This dissatisfaction highlights the fact that the training had to do two distinct jobs. It had to help teachers to transform their style of teaching and it had also to provide teachers with technological knowledge and skills. The interviews illustrate that it is difficult simultaneously to do both jobs; transforming teachers' pedagogy and ALSO making them expert technologists. This tension is highlighted in the following viewpoint.

- It seemed like chaos at first - especially if you are used to the teacher being the boss - but it has definite advantages.But it is time consuming. We could have gone much deeper into the technology, but I think it was good for them to see technology in everyday problems.

But from the trainers' perspective transforming the pedagogy was critical.

- The benefits to the teachers were definitely in learning classroom skills - of groupwork - of questioning and thinking about teaching interactions.

This pedagogy is consistent with the nature of technological activity - and the evidence suggests that it has had a profound effect on teachers and learners alike. We found support for this new pedagogy in a number of categories.

It makes learning easy and enjoyable.

- It is easier to learn because you have practical and theory- put theory into practice.
- Enjoy the teaching styles and interactive learning (participatory learning).
- There is fun.

It is empowering for learners.

- In other lessons the teacher says what is right - in technology I find out.
- Technology makes you feel proud - you can do things you didn't think you could do.
- It has altered my life, knowing how to solve problems. I feel so strongly I want to spread the word.

It develops transferable skills.

- Big impact on business and economics and natural science - pupils are transferring skills.
- Technology lessons have very exciting activities and it makes us understand the practical application of mathematics and science.
- In science there is instructing/ teaching of

Newton's Law. In technology you apply the law and the mathematical principles.

It's good for learners with special educational needs.

- Good for slow learners. In technology slow learners can achieve more.

And there is plenty of evidence of teachers developing the approach in other areas of the school.

- Methodology translates to all subjects and the majority must do it.
- There have been changes in approach from other teachers e.g. more experiments and practical work in science.
- Other members of staff have copied the learner-centred approach from the technology teacher and use it effectively.
- ...technology teachers are taking new teaching styles to other subjects.
- Other teachers are visiting the technology class and becoming interested in the approach.

Furthermore both teachers and learners identified general benefits to learners.

- Students' performance - academically - has improved drastically in other subjects.
- I used to hate being challenged - now I like challenges.
- Their reasoning skills have been enriched.
- Technology encourages their independent thinking.
- It gives us a different way of thinking - to see things differently - to solve problems on our own.

And these benefits were seen to continue once the learners left school: first through expanded opportunities to gain useful employment; second through the skills and confidence to create employment for themselves; and third in the contribution they can make within their communities.

- Learners get important skills - to make themselves marketable and go into the community.

- Developing entrepreneurship - they can see they they can do things.
- It improves our college opportunities; getting first choice with technicons[3].
- Good for the future - for getting a job - creating your own job - choosing a career.
- They help us become more businesslike - and get rich!
- Its helpful to all, whether going to university, or into work, or whatever.
- It has changed their lives - they are out there in the country - in the villages - and they can make things better. They can say 'What is the problem here'. It's a real life benefit.

Not one teacher expressed any regret or doubts about having been part of the programme. For all of the hard work, they saw it as an enriching and empowering experience. In many ways the project was a mere drop in the ocean in terms of what is still needed for the continuing development of a technology curriculum in South Africa. But as a model for both the current developers and others to build on, it provides a wonderful starting point, and hopefully there will be continuing resources made available for its further development. The developers have taken heed of the outcomes of the evaluation - both in rejoicing and building on those aspects that have shown themselves to be successful and also in areas that were highlighted as needing further attention, such as the development of generating ideas and graphic communication skills. And the overarching optimism in taking up this challenge is expressed in the view of one of the new technology teachers ...

- Professionally I am a changed person. For 13 years I have never had such fun. I feel completely part of the African renaissance.

Notes

1 This paper presents selective dimensions of the research. For information about other aspects of this evaluation project, please contact the authors.

2 The probability data are derived from a t test, which is used to determine the probability of two samples having come

from the same underlying population. We have used the 'two sample; equal variance' (homoscedastic) form, that assumes that the means of both data sets are equal.

3   A technicon, in UK parlance, is similar to an FE Technical College.

Reference

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