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Valuing the complex outcomes: assessing what's important in Technology

Abstract

Technology in the South African National Curriculum Statement is humanistic rather than technical and many of its intended important outcomes are ones that must be assessed by qualitative judgements. We describe such outcomes as complex outcomes, after Sadler (1989). The research question is then, What are the effects of traditional, mark-driven assessment on the teaching of these complex outcomes? We find that mark-driven assessment leads to the complex outcomes being de-valued and the curriculum being attractive to a narrower range of learners. We describe the tension that mark-driven assessment sets up for the teachers in a programme in which formative assessment and the complex outcomes are valued. This aspect of the programme was not intensive enough to resemble an experimental treatment and there was no control group. Bringing about change towards formative assessment in schools is a major undertaking as is clear from Black, Harrison et al (2001) and we made only a start to raising the issues with schools and urging them to try a few formative assessment strategies.

Technology in the NCS is characterised by complex outcomes

Technology, as expressed in the South African National Curriculum Statement of 2002 is characterised by complex outcomes. This concept will be explained below but, briefly, it means the learners' ability to put together a product of the mind which must be judged in terms of its quality and not by counting the number of correct parts it has. The quality of these outcomes depends on the teaching the learners get, and the learners' progress is determined by the formative assessment that the teacher does, according to Sadler (1989) and Black and Wiliam (1998).

The outcomes (with our emphasis) are:

Tech1: The learner is able to apply technological processes and skills ethically and responsibly using appropriate information and communication technologies

Tech2: The learner is able to understand and apply relevant technological knowledge ethically and responsibly.

Tech3: The learner will be able to demonstrate an understanding of the inter-relationships between science and technology, society and the environment

Assessment standards give expression to these outcomes, and the basic assessment standards are the ability to

investigate the problem or need: here progress is seen in depth of thinking about the need of the people who need a solution, the learners' grasp of the situation, or insight into the effects of existing products as they might be used by these people.

design solutions based on the investigations: progress is seen as learners relate or create the product specifications to the needs of the user and concern for the environment, and as they find ways to generate ideas for their design.

make a solution or product: progress is seen as they adapt the design to the materials, time and tools available, and as they incorporate new ideas into the design.

communicate plans and ideas: here all the criteria for good writing or live presentation (description, procedure, illustration, visual quality) apply.

evaluate their solutions and work processes: here we look for learners' insight into the group's work process, and ability to reflect on the product in terms of the original problem of the people who needed a solution.

The underlining above indicates the learning outcomes that are complex outcomes requiring assessment in terms of quality, not quantity.

The assessment of complex outcomes

While we recognise that assessment must say whether or not a learner understands levers, circuits, drawing techniques and so on, in this paper we underline the abilities which Royce Sadler (1989) in a much-quoted paper on formative assessment, calls "complex outcomes":

> The outcomes are not easily characterized as correct or incorrect, and it is more appropriate to think in terms of the quality of a student's response or the degree of expertise than in terms of facts memorized, concepts acquired or content mastered. . . . Assignments and tasks . . . involve students in actively synthesizing and integrating ideas, concepts, movements or skills to produce extended responses in some form. In all assessments of such extended responses, qualitative judgments are of fundamental importance. (Sadler 1989, p. 123, 125)
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> If numbers (or marks, or scores) are used, they are assigned after the judgment has been made, not the reverse. In making qualitative judgments, the final decision is never arrived at by counting things, making physical measurements, or compounding numbers and looking at the sheer magnitude of the result. (Sadler 1989, p. 125)

The research question and problem statement

The research question is then, What are the effects of traditional, mark-driven assessment on the teaching of complex outcomes? The answer seems to be that traditional assessment is summative, it drives teachers to assess what is easy to assess and de-values complex outcomes. We argue that this in turn leads to narrowing the range of children who like technology.

The complex outcomes are motivating to a range of learners

One of the notable things about NCS Technology is that so many different children enjoy the subject; our classroom observations strongly suggest that the aspects we have underlined

above are the aspects that allow children with a range of thinking preferences (e.g. Lumsdaine and Lumsdaine, 1995) to participate and feel validated. The discussions and debates in the *Technology for all* materials have covered, for example, gender differences in games children play, issues of care and cruelty to farmed animals, bias against poor areas in street lighting and indigenous knowledge about plants. These children would not have contributed had the subject been taught as if it were a non-discussion subject like woodwork or technical drawing.

The context of the research

The research took place almost incidentally during a programme which was set up as a trial implementation of the NCS for technology. Working from a university base, the *Technology for all Pilot Programme* (TFAPP) conducted an intensive 3-year implementation in eight primary schools located within a 5 km radius of each other, in the semi-industrial area south-west of Johannesburg CBD. The details of the programme and its evaluation are described elsewhere (Moodie, 2010), but suffice to say that we took the NCS Technology at face value and tried to do all of it, starting in a situation where almost no technology was being done by the learners. The programme is based on a set of materials called *Technology for all*, published by Setlhare Trust and Macmillan SA. Schools joined the programme voluntarily and the teachers met with us in after-school workshops every two weeks, in which we prepared lessons and reviewed the past fortnight's lessons. Each teacher was visited in his or her classroom by a programme staffer each week. During the first three years of this programme, teachers taught at least three full projects per year in Grades 5, 6 and 7. In terms of pedagogical content knowledge (PCK), we progressed from basic lesson management to issues of professional judgement and formative assessment.

TFAPP's approach to growing professional judgement

Formative assessment of complex outcomes requires teachers to develop professional judgement, as their assessments must be defensible. TFAPP began from a situation in which almost all the teachers were novices in technology, so we rely on three strategies:

First, teachers must personally do almost all the project activities in workshops so as to experience the meaning of the assessment standards, and then they must ensure that their learners do those same assessment standards in class.

Secondly, we relate those assessment standards to the NCS in the form of a progression table. This is a table that sets the assessment standards for Grade 4 to 7 side by side, as shown in **Figure 1** below.

This means that the assessment standards are not locked to Grades. If, for example, work from a Grade 6 learner looks more like the Grade 7 assessment standards we would judge it as "Success beyond this Grade Level" and flag it with a "4". Work that looks more like the Grade 5 assessment standards we would rate as "Some success" and flag it with a "2". The purpose of this is that teachers should always be aware of the performance that lies just ahead of a learner's present performance, and the level that lies below the Grade level and which a learner might be working at successfully.

Figure 1 An extract for designing, from the NCS written as a progression table

	Grade 4	Grade 5	Grade 6	Grade 7
Designs	Writes, with assistance, a short and clear statement (design brief), for the development of a product for a given purpose. Suggests and records at least two possible solutions to the problem or need that link to the design brief and to given specifications or constraints (people, purpose, safety, environment) Chooses one of these solutions, giving reasons for the choice.	Writes, with assistance, a short and clear statement (design brief) related to a given problem, need or opportunity that demonstrates some understanding of the technological purposes of any solution. Suggests and records at least two alternative solutions to the problem, need or opportunity that links to the design brief and to given specifications and constraints ((people, purpose, safety, environment) chooses one of these solutions, giving reasons for the choice and develops the idea further.	Writes a design brief for the development of a product related to given problem, need or opportunity that clarifies the technological purposes of any solution. Suggests and records at least two alternative solutions to the problem, need or opportunity, that link clearly to the design brief and to given specifications and constraints. (people, purpose, safety, environmental impact, appearance). Chooses one of these solutions, giving valid reasons for the choice and further develops the choice with graphics and/or modelling.	Write a short and clear statement or a design brief for the development of a product or system related to a given problem, need or opportunity Lists, with some assistance, product and design specifications and constraints for a solution to a given problem, need or opportunity based on some of the design key words below. **People** (Age, Target market, Human rights, access), **Purpose** (Function, what will product do), **Appearance** (Colour, shape), **Environment** (Where it will be used or made, impact of use or manufacture on the environment), **Safety**, (for users and manufactures); **Cost** (Cost of materials, wastage, manufacture, maximum selling price) Generates at least 2 alternative solutions and annotates the ideas Chooses possible solutions and gives sensible reasons for choice and Develops a chosen idea using graphics or modelling techniques

Finally, teachers must be part of a community of practice where learners' work is discussed. TFAPP teachers have attended group meetings voluntarily for 3 years, in their own time. Qualitative judgements rely on teachers' "guild knowledge" (Sadler, 1989, p.126 but see also 141). Guilds, in medieval Europe, were trade and craft associations where skilled people passed their knowledge to new members. We rely on teachers' ongoing involvement in the programme to build this "guild knowledge" which allows them to make professional judgements of learners' work.

The programme's emphasis on formative assessment

Some of the key principles of formative assessment (Black and Wiliam, 1998; Sadler, 1989; Black, Harrison, et al 2002) are that learners show the greatest gains when assessment is done formatively, and teachers provide detailed feedback in a way that the learner can use. Formative assessment shows the learner how to do better while there is still time in the term to improve; summative assessment should be left to late in the term. Judgements of quality should be recorded, should serve as progress indicators during the term but they should not accumulate to a summative assessment.

The fundamental purpose of formative assessment and feedback is that the standards of good work should end up in the learner's head (Sadler, 1989). Peer assessment can be a powerful strategy toward that result.

In a Grade 7 project learners design a bag to help a mother with a new baby to carry the baby's bottle, milk formula, nappies, etc. We found that learners, working alone, got stuck on their initial idea and found it hard to come up with an alternative design. In addition, it was

difficult for the teacher to give feedback on the designs. What we do now is to have learners work in groups of three; each learner does a first draft design based on his/her own initial specifications. Then the design is passed to the next learner in the triad who comments on it in the form of questions or suggestions or a drawing that illustrates other ideas. The annotated design then goes to the third learner who builds on the existing ideas or takes another direction. In this way each learner's initial idea is assessed and given feedback by two others. The result is much richer designs and sets of specifications that evolve. The approach derives from Stevens (pers.comm., 2009)

A programme staffer interviewed six of the learners in one school.

> Thembeka (staff): When somebody looked at your bag design and improved it, how did that make you feel?
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> Blessed: When they improved my bag I felt a little bit sad, because I felt I did not take enough time to do my design, then I felt happy when they showed me how to make the bag attractive
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> Naledi: When they improve [my bag] you feel a little bit nervous and happy at the same time. You take a lot of time designing your bag -- when they show you something more it is helpful. You think you have put everything, but they show you, you need to put more.

The teacher's assessment was based on the extent to which each learner had improved his or her final design, as evidenced by the comments and sketches of the two partners.

There was no memo that could show how to get a 10/10 for design.

Counter-forces to formative assessment and complex outcomes

This work has taken place in a context where teachers get mixed messages about assessment from district officials and school managements. Policy is that assessment is done to aid learners to improve the quality of their work, but teachers get detailed instructions about recording, calculating and reporting results. These must always be ready for officials to see during school visits.

Though year-end ratings are four statements like "not achieved", through to "excellent achievement", (coded as national 1, 2, 3, or 4), these statements are based on a percentage range, which in turn is based on a collection of marks. (DoE, 2006) So there is an obvious reason for teachers to concentrate on assessment that generates marks from tasks that are easy to mark.

Assessment has a disciplinary function in schools – in some schools the children write "cycle tests" every two weeks in each subject. This system is intended to keep not only the learners on their toes, but the teachers also. TFAPP learners would be part-way through a stage of their project, but the date for the test would arrive. The teacher had to find some task that would generate a mark, breaking into the sequence of the lessons. Cycle tests make summative assessment drive the sequences of learning, but meaningful learning does not begin and finish in two-week tranches.

However, there are deeper reasons for school managements' belief in a regime of getting and recording marks, as we now show.

School 01/2007 is one of the best-run schools in the programme.

Principal: . . . parents want to know what is your reason [for giving a code of 1, 2, 3 or 4, but] we've got **marks**, which are the proof of the pudding.

Interviewer: . . . the proof of the pudding? You can show parents the mark?

Principal: Yes, then it's accepted – my child got an 81 . . . That is better than 80, you know. We'll have no problems there. . . . the moment you have awards, the moment you have certificates, . . . you get that competitiveness coming out . . . which we want from the children . . . that is great.

In School 08/2007 marks are seen as valuable because they can differentiate between learners and decide which child should win the Grade subject prize at year-end. These prizes matter a great deal to learners and their parents and it is essential for the teachers to be able to justify why Child A gets the prize rather than Child B – these two children might be separated by only 1% by the end of the year, and therefore every mark matters, all through the year.

Mr Ismail the technology teacher at this school brings artistic skill and decades of experience to the subject. He has no problem with the idea of qualitative judgements, and gives careful thought about how to allocate a "2", "3" or "4" to a piece of work. He has no problem with the principle of making qualitative judgements, he is just concerned about finding points of reference. However, he encounters the competitive assessment policy in the school which is set up to identify the top ten learners each month, and at year-end Grade prizes are awarded. So Mr Ismail is often confronted by parents who demand an explanation why their son or daughter has slipped from first place or did not get the prize.

> I have to explain to Mrs So-and-So that her daughter did not get 100 out of 100 marks because we assess technology differently. We look at the Assessment Standards and see whether this child is doing what we expect at Grade 6 or if she is doing much more. But mother says her child gets 98% in maths and she wants to know why her child does not get a "4" for technology. I want to say to her, "Madam, if I had a 5-point scale, to include university-level things, then you will want to know why your daughter did not get a 5."

The effect of this of course is to make Mr Ismail feel that he could not defend a qualitative judgement if challenged, and so it is safer to assess just those things that can be marked clearly correct or incorrect.

The staff of the school generally do not question this policy and the heads of departments believe that competition makes the children work harder.

The examples I have chosen come from two of the best-run schools in the programme. They believe in competition based on marks, based on assessing what is easy to assess. However, we also know from other data that some of their Grade 5 learners can barely read and write.

Teachers who have begun to think differently about assessment

Mr Ismail is not convinced about the value of competition:

> Competition works only for the high-flyers – the rest of them want to do enough so that they don't get into trouble. So for them, this competitive search for marks does not motivate them.

Mr Ismail's view finds support in the research of Black and Wiliam, (1998) who say that a marks regime serves to convince the low-achieving learners that they lack ability.

In School 01/2007, Abraham the technology teacher has become articulate about his subject and a keen advocate of it. As regards assessment, he often contributes to TFAPP workshops with advice such as

> If we get to know the progression table [the assessment standards arranged side by side from Grade Level 4 to Grade Level 7], then we can decide quickly whether a piece of work must get a 1 or 2 or 3 or 4. The progression table lets you give the child feedback quickly . . . they want that. It's no use giving them feedback after two weeks, then they are not interested any more. If we can use this progression table we can cut down on all the marking but [also] we can give them immediate feedback.

In his classroom he has not put into practice all that he advocates but he is increasingly comfortable with submitting term-end marks which are derived from qualitative judgements.

In School 05/2007, an independent school, Maria has been willing to challenge the school reporting policy. The school uses a computer programme that allows teachers to select comments from a list in each subject. Maria's new awareness of the technology assessment standards led her to question the comments that were being added to reports. In other subjects the comments all relate to classroom co-operation with the teacher and disciplined working habits; for example, for Economic & Management Sciences, entering No.42 generates *Does not do homework, does not complete tasks and must learn to follow instructions*, while No.50 generates *Congratulations you have displayed an outstanding performance this term. Keep up the good work.*

By contrast, Maria has persuaded her department head that the technology report comments should be drawn from the content of the term's project. For the first term, the projects were on processing of materials; Maria entered the comments:

No.58 → Success beyond Grade Level in identifying different materials and their uses.

No.59 → Some success in expressing opinions about impacts of technology on society and environment.

Her comments refer to both the task that had to be done and a standards-related level of performance in that work.

By August 2009, the school management had accepted that the fortnightly cycle tests are not necessary if Maria does summative assessment in another way.

Conclusion

We feel that TFAPP, guided by the work of others, has made teachers aware of the value of the value-laden outcomes. The teachers have begun to recognise and assess learners' products of the mind, and know that they should be judged in terms of their quality and not by counting the number of correct parts they have.

The problem of valuing the values is of course not just a South African problem. From the UK we have Paul Black (1990) addressing a conference on the implementation of technology in the UK national curriculum:

> The final issue to which I want to draw attention is the issue of awareness and values. . . . it is one of those issues which could be ignored entirely unless it is given special attention. . . . it is not just "knowing about" effects, economics, social considerations, values, judgements, etc. We ought to be aiming at more, . . . giving value to and arguing about the values implied by different choices. . . .
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> However, . . . [schools report teachers saying]: "it's wishy-washy, this part of it, we can't get a hold on it" and "Well, these values things are just a lot of waffle and we don't get on with it." Pupils say, "We can't really swot this stuff, we can make things and we can swot the knowledge but this stuff doesn't seem to get us anywhere."

. . . What may look to some teachers and pupils like an inconclusive discussion which did not get anywhere may in fact be an occasion in which pupils expanded their insight, moved away from prejudices and went away seeing that there was far more to an argument than they, in their summary quick judgements, had imagined. Real learning can be going on and an inexperienced teacher . . . can say "That was wishy-washy, we didn't get anywhere".

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