CAN EXAMINATION-DRIVEN TEACHING CONTRIBUTE TOWARDS MEANINGFUL TEACHING?

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Abstract
Meaningful and examination-driven are discussed underpinned by teaching as the organisation for learning. Examples from a continuing professional development project on the development of teaching mathematics are used to demonstrate how teaching can proceed by incorporating aspects of meaningful teaching in examination-driven teaching. It is concluded that, regardless of what reforms in teaching are desired and agitated for, it will always be examination-driven as long as summative examinations are used for the awarding of certificates with which learners can trade upon graduating from schools.

Introduction
Soon after the advent of a single system of schooling and education in South Africa, “teaching and learning” became the catchphrase to drive the quest for quality education. Curriculum-making went through mutations and there was virtually a new variant with every new minister of education. Despite this “teaching and learning” remained and whatever research, debates and deliberations emerged were somewhat anchored in this catchphrase. However, in these debates and deliberations, teaching as a distinct social practice (Langford, 1989) was backgrounded. Davis (1997, p. 14) early on drew attention to this neglect of focusing on the work of teaching since “the teacher is banished from the text and the teaching of mathematics is left to the student [and it is signified] that all students are competent autodidacts”. The re-insertion of teaching and its development into debates and deliberations about schooling and education generally gained impetus in recent times with Morrow (2007, p. 1) again calling attention to the invisibility by asserting that
...in our policies and plans we think very little about teaching...we think that it is better to talk about ‘facilitation’ or ‘instruction’...perhaps we think that teaching is no longer needed because of ‘learner-centred education’...Perhaps this silence [about teaching] is due to the fact that in South Africa we no longer have any teachers, but, instead, now have ‘classroom educators’

Titles of books such as *Retrieving teaching: Critical issues in curriculum, pedagogy and learning* (Shalem and Pendlebury, 2010) in a sense remind us that we need to seriously attend to teaching as the central aspect of teachers’ classroom activity—the overall work of a teacher during class periods. Meaningful teaching and examination-driven teaching should be part these deliberations and debates. In this paper the intention is to contribute to the debate about teaching of mathematics and focusing it on the two constructs mentioned in the aforementioned sentence. The pursuit is to investigate whether the two constructs are as divergent as it is made out to be.

With respect to teaching, I draw on Morrow’s definition of teaching. His definition started with teaching “as an activity guided by the intention to promote learning” which he later changed to “the organising of systematic learning” due to “the weight carried by the word ‘intention’”. (Morrow, 2007, p. 3). The two constructs are delft into in the next two sections.

**Meaningful teaching**

As is the clear from Morrow’s notion of teaching, teaching has as objective learning. Hence meaningful teaching is directed towards this objective. Meaningful teaching is a kind of shorthand for meaningful teaching for meaningful learning. This notion has been researched extensively. Underlying meaningful teaching for school mathematics is the idea that learning environments should be structured in such a way that learners are allowed to experience learning mathematics in the same way as expert mathematicians work to develop mathematics at the frontiers of the discipline. Emblematic of this is Papert’s (1972) notion of “Teaching children to be mathematicians versus teaching them mathematics”. Ostensibly, learning environments of this nature will allow learners access to and consequently gain command of the epistemological—knowledge-making—machinery of mathematics. This machinery is characterised as the processes of mathematics. Watson and Mason (1998, p. 7) provide an exhaustive list of these processes and amongst them processes such as “specialising, generalising, verifying, refuting, conjecturing and justifying” are mentioned. The general belief is that if learners experience
Learning mathematics in environments fostering the explicit use of these processes, then they will develop flexible ways of knowing and be able to productively deal with mathematical problems in a variety of situations including examinations. This kind of learning environment is always contrasted with the product-inducing one, which focusses the promotion of the mastery of products of the established knowledge of a discipline. Meaningful teaching is thus intimately connected with learning environments which foregrounds the process aspects of a discipline and examination-driven teaching, discussed in the next section, is linked to product-inducing ones and in its harshest version it is viewed as meaningless teaching for disconnected short-term learning.

**Examination-driven teaching**

Examination-driven teaching (EDT) is normally viewed as teaching only the content of previous examinations and anticipated questions that might crop up in an upcoming examination of a subject. Other terms used are measurement–driven instruction (MDI), assessment-driven instruction (ADI) and data-driven instruction (DDI). The weak notion of EDT is that of teaching to the test. This is conceptualised as “classroom practices that emphasize remediation, skills based instruction over critical and conceptual oriented thinking, decreased use of rich curriculum materials, narrowed teacher flexibility in instructional design and decision making, and the threat of sanctions for not meeting externally generated performance standards.” (Davis & Martin, 2006, p. 10). Popham (1987, p. 680), on the other hand, does not take such a hard stance and asserts that “MDI occurs when a high-stakes test of educational achievement, because of the important contingencies associated with the students’ performance, influences the instructional program that prepares students for the test.” He sees the focussing on what is expected in examinations as inevitable due the consequences success or not on these examinations have for teachers and learners and presents a sort of strong view of EDT. For Popham this strong view has to do with tests measuring outcomes deemed of value by educational authorities, learners and parents. Important advantages EDT, it is argued, are that the instructional goals are clear, it is a cost-effective way to improve the quality of education, it motivates learners in that the learning objectives are clear and it provides valuable feedback to teachers for instructional decision-making. (Popham, 1987, Shepard & Cutts-Dougherty, 1991, Wayman, 2005)
Opponents point to disadvantages EDT has. They assert that EDT fragments knowledge, focuses on low level content which frequently becomes the only content learners are exposed to, leads to a loss of disciplinary coherence, mitigates against flexible knowing, contributes towards curriculum contraction by placing an inordinate amount of time on test preparation, leads to teacher stress and demoralisation, deskills teachers and the psychometric paradigm, which underlies most of the major high-stakes tests, is not always conducive for making sound instructional decisions. (Shepard & Cutts-Dougherty, 1991, Davis & Martin, 2006, Van den Heuvel-Panhuizen and Becker, 2003, Furner and Kumar, 2007, Hagan, 2005, Gilmour, Christie, and Soudien, 2012).

The debates about EDT’s advantages and disadvantages have its focus primarily on high-stakes standardised tests with the multiple choice format being the preferred one. However, between the opposing camps there are others who view EDT as an opportunity and catalyst for reform in the teaching of school mathematics. (Burkhardt & Pollak (2006), Van den Heuvel-Panhuizen and Becker, 2003). They essentially base their position on the notion that no matter what the disadvantages of EDT are, teaching will always be driven by what is examined. All camps in the EDT debate use tests and/or their content as their major points of departure. I advance a position beyond this and contend that it is an essential characteristic of practices which involve assessments that these assessments demarcates and defines the legitimate knowledge of the area of interest.

The constitution of legitimate school mathematics knowledge

Elsewhere I have argued that school mathematics is a particular genre, hybrid and elementarised form of the mathematical sciences. (Julie, 2002). It is well-known that for schooling, knowledge is formally declared in the intended curriculum and operationalized in the interpreted curriculum. However as Bishop, Hart, Lerman and Nunes (1993, p. 11) argued “the examinations operationalise the significant components of the intended mathematics curriculum, so they tend to determine the implemented curriculum.” The intended and interpreted curricula provide only boundaries of content to be dealt with but the implemented curriculum is heavily driven by the examined curriculum depicted in Figure 1 below.
The examined curriculum is the one that is eventually used as the one which is constitutive of the legitimate knowledge that is taught. One observational study on the functioning and deliberations of an examination committee (Kvale, 1998) bring to the fore how such committees certify and legitimate knowledge. At a more esoteric level, reviews of articles submitted to journals bring to the fore how the knowledge legitimating process proceeds. In this case the selected reviewers are the examiners. Lerman, Xu and Tsatsaroni (2002) remind us that reviewers, dependent on their frames of reference, make judgements on whether knowledge elements in a submitted article are, in a sense, legitimate or not. They assert “Each editor/reviewer/examiner has her or his own interests and concerns, and her or his own trajectory of development as researcher, and these experiences are reflected in how one reads research, what one considers valid, and therefore what one allows to enter through the gates of this particular academic discipline.” (p. 24). I offer examples from my own experience of articles that were rejected along the lines intimated by these authors. The first article dealt with how practising teachers following a distance education diploma programme appropriated or not the ideas of a module in the programme dealing with the methods of teaching mathematics. The module dealt extensively with a version of constructivism as found in the problem-centred approach to teaching mathematics. In the descriptive section of the article it is made clear that the programme had different modules and the majority was on mathematics content with one module dealing with the method of mathematics. The major reasons given for the rejecting the article was around differences between constructivism and problem-solving, a perceived differentiation between conservatism and liberalism between rural and urban teachers, that current approaches in other environments was not to separate mathematics courses for teachers into content and methods of teaching but to integrate subject
matter and pedagogical content knowledge and that naming courses ‘methods’ courses are problematic.

A second example was an article dealing with the strategies and tactics practising teachers employed to construct a mathematical model. It was situated in ethnomethodology and the new sociology of laboratory practices. As such it analysed how the teachers’ ways of working in real-time was driven by the discursive resources they constructed. Although it was concluded that the referees found the research problem and question of interest for the mathematics education community, the article was rejected on the basis that one of the reviewers could not discern what the article had to do with Mathematics Education. In addition, one of the reviewers even directed me to a paper that was not yet published.

The above is not to make judgements about reviewers but rather to bring to the fore that how valued and legitimate knowledge gets constituted and formatted through assessment procedures. Not knowing such constitutions invariably lead towards non-success. My contention thus is that the primary contributor to legitimate school-going mathematics is the mathematics that is assessed in summative high-stakes examinations. The emphasis to be placed on various components of this mathematics are fairly prescribed in the intended curriculum. The current Curriculum Assessment and Policy Statement (CAPS) for Mathematics in grades 10 to 12 gives the weighting of knowledge hierarchies as depicted in the Table 1 below.

<table>
<thead>
<tr>
<th>Knowledge</th>
<th>Routine Procedures</th>
<th>Complex Procedures</th>
<th>Problem Solving</th>
</tr>
</thead>
<tbody>
<tr>
<td>20%</td>
<td>35%</td>
<td>30%</td>
<td>15%</td>
</tr>
</tbody>
</table>

Table 1: Percentage Distribution of Knowledge Problem Types for Mathematics Examination (Department of Basic Education, 2011)

Read in conjunction with the minimum criterion (30%) for a pass and accepting that examining authorities must ensure that there is compliance with these prescriptions, it is not hard to observe that the opponents of EDT’s concern about EDT focussing on low-level skills. A question then is can EDT be pursued without sacrificing the ideals underpinning meaningful teaching? In the next section I describe how this is done in a continuing professional development for teaching mathematics.
Incorporating some elements of meaningful teaching in an EDT-underpinned initiative

As alluded to above the school mathematics knowledge that is legitimised through summative high-stakes examinations such as the National Senior Certificate (NSC) examination for Mathematics. For the past two years I have been involved in a project which aims at increasing the number of learners offering Mathematics as an examination subject for the NSC and improving the quality of the passes in this examination. The project works with teachers from about 13 schools, most of them are non-fee paying schools and on the school-feeding programme of the Western Cape Education Department. At the start the project worked with teachers teaching in grades 10 to 12. After a year it was realised that teachers teaching in grades 8 and 9 should also be included. The project focusses on the development of teaching of Mathematics based on what happens in classrooms. By this is meant that actual classroom teaching is taken as points of leverage to consider the development of teaching school mathematics better. For example, lessons of teachers are observed, translated into lesson narratives and with the permission of the teachers concerned used as lesson scripts for reflection in workshops. Figures 2 and 3 are examples of the observation notes of a lesson and its translated lesson that was used in a workshop.

Figure 2: Excerpt of observational notes
The content was on trigonometry word problems. The solution of triangles—the sides and/or angles of a right triangle—was completed.

Learners were called to work out assigned problems on the board. These were

2. 

![Diagram](image1)

3. 

![Diagram](image2)

Figure 3: Excerpt of cleaned observation notes used for reflection on teaching

In addition to reflections and discussions on actual classroom teaching episodes, issues related to teaching and EDT form the content of the workshops and institutes offered to teachers. In line with EDT, the outcomes of learners’ achievement on summative high-stakes examinations are discussed. This is done by determining the difficulty levels of items as displayed by the performance of learners and using the outcomes of the analysis for designing activities which display high levels of difficulty. For example in 2012 the participating schools wrote a common end-of-year grade 10 mathematics examination. A Rasch item difficulty analysis was done, presented to the teachers in a workshop and they had to design activities for the topics that displayed high level of difficulty as given in Figure 4.
Figure 4: Task based on item difficulties presented to teachers

At the grade 12-level, the actual scripts of the schools are obtained, analysed in terms of difficulty levels and provided to teachers to plan their revision activities for the NSC grade 12 examinations. An excerpt of this is presented in Table 2 below.
<table>
<thead>
<tr>
<th>Item Question 1</th>
<th>Item (Sub-question)</th>
<th>Difficulty level (1—easiest; 53—most difficult)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 Solve for ( x ) in each of the following:</td>
<td>1.1.1 ((2x - 1)(x - 4) = 0)</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>1.1.2 (3x^2 - x = 5) (Leave your answer correct to two decimal places)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1.1.3 (x^2 + 7x - 8 &lt; 0)</td>
<td>4</td>
</tr>
<tr>
<td>1.2 Given (4y - x = 4) and (xy = 8)</td>
<td>1.2.1 Solve for (x) and (y) simultaneously</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>1.2.2 The graph of (4y - x = 4) is reflected across the line having equation (x = y). What is the equation of the reflected line?</td>
<td>26</td>
</tr>
<tr>
<td>1.3 The solutions of a quadratic equation is given by</td>
<td>1.3.1 Two equal solutions</td>
<td>49</td>
</tr>
<tr>
<td>(x = \frac{-2 \pm \sqrt{2p+5}}{7}). For which value(s) of (p) will this equation have</td>
<td>1.3.2 No real solutions</td>
<td>52</td>
</tr>
</tbody>
</table>

Table 2: Example of difficulty analysis provided to structure revision

Two issues related to EDT worth mentioning about the difficulty analysis of the items based on learners’ performance on these summative high-stakes examinations are worth mentioning. The first relates to the grade 10 example given in Figure 4. The teachers are reminded to keep in mind the value of regular/spiral revision of completed work. The notion of “regular/spiral” revision is discussed later. The second is concerned with the difficulty of items such as 1.3.1 and 1.3.2 which were experienced as extremely difficult by the 2012-cohort of examinees. Through deliberations in a workshop teachers came up with the suggestion that concepts underpinning
problems of this nature should be dealt with from grades 8 onwards where the system of real
two numbers as a component of the curriculum is commenced and continued to grade 12. The fact
that they referred to the underlying concepts for problems of this nature points in the direction of
the development of conceptual understanding in lower grades and maintaining problem-solving
fluency with problems of this nature throughout the last 5 years of the learners’ school
mathematical experience. One consequence related particularly with 1.3 was that for the 2013
planning teachers included the example problem “For which values of x is \( A = \sqrt{\frac{9}{11-x}} \)
undefined.” This indicates the strive for disciplinary coherence across grades and not dealing
with mathematical constructs in a piecemeal fashion from grade to grade. The EDT-paradigm
thus opened horizons for and pointing to directions for dealing with topics as desired by
meaningful teaching. What is of importance here is that although the EDT-paradigm forms the
basis of the project to enhance teaching, it catalyses some other way to bring ideas consonant
with the meaningful teaching paradigm into the repertoire of teachers’ strategies.

A cornerstone of the project is its adherence to the principle of immediacy of applicability in
classrooms, which systematic reviews of continuous professional development initiatives found
was a crucial factor for teacher buy-in of the goods distributed by CPD initiatives (Cordingley,
Bell, Rundell & Evans, 2003). Early in the project teachers raised the issue of learners’
reluctance for doing homework. The strategy that emerged from deliberations from this concern
was that of spiral revision and regular practice referred to above. Spiral revision implies
presenting learners with activities and exercises to practice work that was previously done so that
what was taught can be consolidated. They are ‘short’ activities and exercises to be completed
within less than 10 minutes at the start of a period. They might contain exercises on more than
one topic but contain examination-like problems. In a sense they replace the crammed practice
before an examination with distributed practice throughout the school year. Initial reports from
teachers indicate that learners take positively to this kind of in-class revision and one teacher
reported after her implementation of it that a learner commented “Ms we must do more of this,
because I forgot what we did in the first term.”

Accompanying spiral revision is the idea of productive practising. Productive practising (Selter,
1996) has to do with allowing learners to develop general ways of working in school
mathematics through “deepening thinking”-like problems whilst practising. Examples of such problems are given in Table 3 below. They are driven by Watson and Mason’s (1998) Questions and Prompts. They allow for engagement with mathematical constructs in that learners have to ‘work’ with such constructs. During this working with the constructs they are also practising and consolidating skills necessary for dealing with items that are normally included in a summative high-stakes examination. Moreover such questions focus on the process skills referred to above and develop the kinds of flexible knowing which meaningful teaching is advancing.

<table>
<thead>
<tr>
<th>Grade 8</th>
<th>Khulisa said she found a “good” way to add two integers when one is positive and the other one is negative. She described her method as follows:</th>
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<tr>
<td></td>
<td><em>I first look at the two numbers without worrying about the signs. Then I take the largest number. I split this number into two numbers. One of the two numbers must be the smallest number without the signs. For the largest number I got and split into two, I leave out the smallest one. The final answer I get by putting the sign of the largest of the last number I got.</em></td>
</tr>
<tr>
<td></td>
<td>Use some examples to check whether Khulisa’s method is working.</td>
</tr>
</tbody>
</table>

| Grade 9          | Is 20,567X10^7 the scientific notation form for 2,056,7?                                                                 |
| Grade 10         | To find the value of \(x\) for which \(\frac{4^x - 36}{2^x - 6} = 10\), multiply both sides with \(2^x - 6\), to get \(4^x - 36 = 10(2^x - 6)\), complete this. |

| Grade 11/12      | Is 3 the third term of \(\sum_{n=5}^{20} 3^{n-2}\)?                                                                 |

Table 3: “deepening thinking”-like problems for productive practice

**Conclusion**

The guiding question in this paper is the title of the paper. The answer to it is neither yes nor no. On the one hand EDT does provide openings for dealing with some of the tenets of meaningful teaching for meaningful learning. On the other hand it inhibits the development of some
attributes deemed important for learners to graduate from school with. Meaningful teaching and EDT are not complementary in the sense of being different sides of the same coin. They can at most be intersecting with each one serving its particular purposes and goals. These purposes and goals are intensely personal but most teachers, regardless of the conditions under which they teach, are acutely striving for the best interest of their learners particularly if success, however defined, is crucial for learners obtaining a certificate of worth, such as the NSC, upon exiting school. It is, however, not hard to conceive that if summative high-stakes examinations focus on the goals of meaningful teaching then the knowledge and content of such examinations will steer and structure teaching in the same way as the knowledge and content of current summative high-stakes examinations do. It will just be the old emperor in new clothes. Hence, the dilemma, if it is a dilemma indeed, of examination-driven teaching, no matter the best intentions of whichever group of teaching reform proponents, will remain for a long time. It seems that it will be impossible to get out of this dilemma as long as examinations are deemed important. And are they not?

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