Summative assessment and the empowerment of teachers

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This exploratory paper looks at assessment and the use of examinations and the empowerment of teachers within the examination process. A comparison of two national assessments, the Danish educational system and the Victorian (Australia) education system, with that of the International Baccalaureate will be undertaken.

Introduction

> The examination combines the techniques of an observing hierarchy and those of a normalizing judgement. … That is why, in all the mechanisms of discipline, the examination is highly ritualized. In it are combined the ceremony of power and the form of the experiment, the deployment of force and the establishment of truth. (Foucault, 1975)

Foucault and Morgan (2000) along with many other authors have eloquently demonstrated the power that assessment has over teachers, students and administrators in schools. Particularly, when the assessment is seen as a gatekeeper for the progress of students into tertiary education. (Matos, 2000) stresses the different types of power exerted by participants in education in his response to (Morgan, 2000):

> teachers over students, in the psychological discourse,
> reformers over teachers, in the curriculum reform discourse,
> educational officials, politicians, and the overall society over teachers and schools, in the standards discourse. (Matos, 2000)

It is often assumed though that teachers are the disempowered members of the institutional assessment processes, that is they have no power over the assessment process while the key officials within the educational organization have the power to control and to exert influence on what is considered valid assessment practices and processes.

It is the intention of this paper to look at three assessment regimes from two national assessment systems and one international assessment system and compare the differing levels of involvement that teachers have in the assessment system and the consequential power distribution within each system.

Assessment as empowerment

There is no doubt that forms of assessment which are institutionalised in curriculum documents can be considered as official texts and as (Bernstein, 1975) recognises it is in these official texts that the system

> selects, classifies, distributes, transmits and evaluates educational knowledge it considers to be public, reflects both the distribution of power and the principles of social control. (Bernstein, 1975)

Thus examinations have as one of their major functions the selection and control of what is considered valid knowledge within the particular educational system. (Bernstein, 2000) also notes that "power constructs relations *between*, and controls relations within given forms of interaction." (p.5) He uses two concepts to describe the translation of power and control within what he has called "symbolic control". The first of these concepts is classification which is related to the categories of the interactions and the insulation (separation) between the categories. In the case of assessment these categories will include the examining board, the examination question writer, the teacher and the student. Bernstein's second concept is framing which is the balance of control over pedagogic communication at the local interactional contexts. Framing in this case applies to the level of control that the examination question writer and the teacher have over the resulting mark scheme which is the interactional context. That is if the teacher has a significant input into the preparation and interpretation of the marking scheme then the framing is said to be weak, but if on the other hand the framing is strong the teacher has no input over the examination markscheme and as a consequence the markscheme developer has significant control over the teacher.

Examinations also fulfil another purpose, that of a resource, according to (Adler, 2001). The author suggests an alternative and equally valid perspective on examinations in her discussions about resources for teachers. That is while examinations in principle aim to classify and control students and teachers, the examinations also have a resourcing aspect. The examinations, and accompanying material, can be used by teachers, students and administrators as part of the "training" process for future examinations. Thus the examination once sat does not disappear into the wilderness but is continually used and consequently has an ongoing influence and control over what is taught in the classroom. How teachers use and perceive the examination as a resource is an important consideration in the empowerment of teachers in the assessment process.

The openness/restrictiveness of the assessment system can therefore help to empower teachers in the classroom or alternatively make them subservient to the educational system that they are working within.

Overview of the assessments in mathematics for the three systems.

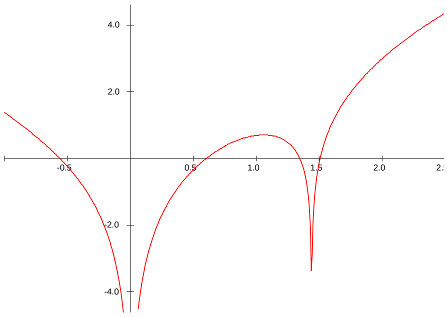
International Baccalaureate Organisation Diploma

The International Baccalaureate Diploma programme caters for over 800 schools in more than 100 countries. There are four mathematics subjects, all of which include topics found in most upper high school curricula world-wide. (See (Brown, 1999) for further information.) There are 2 written examinations as well as an internally assessed component. After the written examinations teachers have the opportunity (and are encouraged to) to submit feedback forms to the IBO with comments concerning the academic level of the questions, the content etc. Approximately half of all schools send feedback. This feedback, along with the students' scores, are considered as part of the final grade awarding process, which results in the final published result for each student.

The examination and the marking scheme as a resource

All IBO registered schools have access to the examination, the mark scheme and the Examiners' report which is published within 6 months of the examination session. An example of the information that is available to teachers is given in Figure 1.

Here teachers are provided with a detailed marking scheme, which both empowers and disempowers them. The marking scheme can be considered to be the official text and as such is the accepted way of doing the questions and submitting their responses. The final marking scheme is subject to review from the examination teams before publication and incorporates the teachers' comments in the reports. The availability of this avenue for input by the teachers provides an empowering aspect that is not seen in the other examining boards considered.

Question 3 (International Baccalaureate Organization, 2000a)	**Marking scheme**	
Let $f(x)=\ln\left\|x^5-3x^2\right\|, -0.5<x<2,$ $x \neq a, x \neq b;$ (*a*, *b* are values of *x* for which *f(x)* is not defined). (a)(i) Sketch the graph of $f(x)$, indicating on your sketch the number of zeros of $f(x)$. Show also the position of any asymptotes.		Award 1 for correct shape, including 3 zeros and 1 for both asymptotes.
(a)(ii) Find all the zeros of f(x) (that is, solve f(x) = 0)	f(x) = 0 for x = 0.599, 1.35, 1.51	3 Marks
(b) Find the exact values of a and b.	f(x) is undefined for $(x^5-3x^2)=0 \quad \therefore \quad x^2(x^3-3)=0$ $\therefore x=0$ or $x=3^{1/3}$	1 Mark 2 Marks
(c) Find $f'(x)$, and indicate clearly where $f'(x)$ is not defined.	$f'(x)=\dfrac{5x^4-6x}{x^5-3x^2}\left(\text{or}\dfrac{5x^3-6}{x^4-3x}\right)$ $f'(x)$ is undefined at $x=0$ and $x=3^{1/3}$	2 Marks 1 Mark
(d) Find the exact value of the x coordinate or the local maximum of f(x), for $0<x<1.5$ (You may assume that there is no point of inflexion.)	For the x-coordinate of the local maximum of f(x), where 0 < x < 1.5 put $f'(x)=0$ $5x^3-6=0$ and $x=\left(\dfrac{6}{5}\right)^{\frac{1}{3}}$	1 Marks 1 Mark 1 Mark
(e) Write down the definite integral that represents the area of the region enclosed by *f(x)* and the x-axis. (Do not evaluate the integral.)	$A=\int_{0.599}^{1.35} f(x)\,dx$	2 Marks

Subject report:

The subject report for the question includes all the answers along with the following statement.

This problem was intended to test whether the candidates could get the proper window for the graph and interpret what their calculator showed them, including the presence of vertical asymptotes. Generally a good understanding of calculus was seen. Mistakes included making the graph continuous, ignoring the absolute value signs, not giving the roots (or zeroes) to three significant digits, writing the derivative of $\ln|x| = \frac{1}{|x|}$, and not recognizing that $|y| = 1$ implies $y = \pm 1$. The term "region enclosed" was erroneously interpreted by some candidates. (International Baccalaureate Organization, 2000b, p. 11)

Figure 1

Danish Upper Secondary

The Danish National Curriculum for Gymnasiums is made up of three mathematics subjects of which Matematisk Linje 3-Årigt Forløb Til A-Niveau, (three year A level, for students studying the Mathematics line) is the most academically demanding. From 2000 there were two written examinations for the A level. Between 1995 and 2000 there was one written examination in which scientific or graphic calculators were allowed. In addition there has always been, and continues to be, an oral examination. Beginning in 2000 four hours were allotted to the first written examination for which all aids such as formula books, graphic calculators etc could be used. The second written examination is of two hours duration and is to be completed without recourse to formula books, and calculators. Figure 2 provides an example of the examination question and its corresponding published marking strategy is given.

Opgave 4 (25 points) (Danish Ministry of Education, 2000a)	(Danish Ministry of Education, 2000b)
A function f is defined by $f(x) = x - 2\sqrt{x}$ $, x \geq 0$	
Calculate the zeros for *f*.	2 points
Define the intervals of growth for *f*.	5 points
Draw a graph for *f* and indicate the range.	4 points
In the fourth quadrant the graph for *f* and the first axis define an area *M*. Calculate the area *M* using the definite integral.	6 points
Calculate the volume of the body produced by rotating 360° around the first axis by using definite integrals.	8 points

Figure 2

Twelve months after the examination an examiners' report had not been made public. It is evident that the amount of information provided to teachers, students and markers is considerably less than that provided by other examining boards. According to (Bjerg, Callewaert, Elle, Mylov, Nissen and Silberbrandt, 1995)

> [Danish] Curricula and ministerial regulations for the individual courses lay down the framework for the various institutions at various levels. Teachers are responsible, often together with their students/pupils, for the implementation of

> the requirements. To a large extent teachers are ensured *freedom of method* [though there has been changes to administrative policies in recent times the authors state] it is still true to say that Danish teachers enjoy a traditional freedom in the choice of teaching methods. (p.37)

This freedom of choice is also exemplified in the way that assessment is undertaken. There is no one “legitimate text” (Bernstein, 2000) for a markscheme and the development of the solutions for the given grading scheme is left up to the examination markers who work in teams to complete the marking of all papers. These markers are almost exclusively mathematics teachers within the gymnasium system. (Vagner, 2001) That is, the examination and its corresponding marking schemes empower the teachers by allowing them to choose their own method for the solution of the problems. There is also a disempowering aspect as teachers are unable to critically comment on aspects of the “approved marking scheme” or they are unable to participate in a debate about the appropriateness or otherwise of the assessments due to their exclusion from the process itself.

Victorian Certificate of Education, Victoria Australia.

The Victorian Certificate of education is the statewide assessment system taken by students in Victoria, Australia. There are 3 mathematics subjects which are examined at the end of the school year by two written examinations, one consisting of mostly multiple choice questions and the other of extended answer or analysis task questions, there is also an internal assessment component. In the case of the VCE there is no detailed marking scheme published, instead an examiners report which includes the correct solutions and comments on student performance is all that is provided. A sample examination question and the corresponding examiners’ report are given in Figure 3. Teachers can be involved in the marking the examinations though markers do not have to be teachers of secondary school, which is similar to the IBO, in contrast with the Danish system where all markers must be teachers within the Gymnasium system. In the VCE therefore there is some involvement of a representative group of teachers in the development of the marking scheme but other wise their influence is limited.

Question 1 (Board of Studies, 2000)	(Victorian Curriculum and Assessment Authority, 2001)
Consider the function $f: R^{+} \to R$ where $f(x) = \frac{6}{x} - 6 + 3\log_e x$. a.i. Find f' (x) a.ii. Find f''(x)	a.i. (Average mark 0.84/Available mark 1) Answer: $\frac{-6}{x^2} + \frac{3}{x}$. Well done. A small number of students retained a 'log ' term in their answer. a.ii. (0.78/1) Answer: $\frac{12}{x^3} - \frac{3}{x^2}$. Well done. Most students who got part i correct also got this part correct.
b. Verify that the graph of $y = f(x)$ has an x-intercept at x =1.	b. (0.75/1) Answer: f (1) = 6 – 6 +0 = 0. Well done. A small number of students tried to do the 'impossible ' and solve the equation.
c.i. Sketch the graph on the axes given. c.ii. Find the exact coordinates of any stationary points. c.iii. Find correct to two decimal places, any x-intercepts other than x = 1.	ci. (1.75/2) Very well done. This question tested a student's ability to use a calculator to assist in accurately sketching a graph. The main features looked for in the graph were: correct shape, asymptotic behaviour at x =0, and reasonably accurate x intercepts. The most common error was to have an 'out-of-range ' second x intercept (95.28), apparently caused by using $\log_{10} x$ in the equation instead of $\log_e x$.This confusion probably arose because the corresponding keys on some calculators are labelled 'log ' and 'ln ' respectively – a fact that of course should be well known to students who are familiar with the use of their calculators. cii. (1.36/2) Answer: (2, $3\log_e 2 - 3$) Reasonably well done, but many students gave an approximation (e.g.-0.9,-0.92)for the y co-ordinate instead of finding the exact value as directed. ciii. (0.65/1) Answer:(4.92,0) Reasonably well done. As in part b., a small number of students tried to do the impossible and solve the equation, but most students realised they needed to use their graphics calculators. Some students only gave the answer to one decimal place (4.9), whilst others had the second decimal place incorrect – presumably because they had used the 'Trace ' feature of their calculator to locate the intercept. Students should be aware that the precision of results obtained by 'tracing ' is limited by the screen resolution and, accordingly, they should always use the appropriate numerical function (e.g.'zero ' or 'root ') instead.
d. The graph in c.i. has a maximum positive gradient. Find its exact value.	d. (0.83/2) Answer:0.375 (at x =4) About half of the students realised that they had to solve f "(x)= 0.Many of those who correctly obtained x = 4,then either stopped or evaluated f (x) of f '(x)
e. Carefully sketch and label, on the axes in c.i., a curve with equation $y = F(x)$ where F is the antiderivative of f.	e. (0.46/2). Not well done, with many students not attempting this part. This was a new topic in the course ('the relationship of the graph of a function and the graphs of its antiderivatives ') and clearly students need more practice at deducing antiderivative graphs from the graph of a function. Some students tried in vain to antidifferentiate f (x) so that they would have a rule to graph, however, this question only required graphical analysis. Many students who deduced correctly that F must have a local maximum at x =1 and a minimum at x =4.92, drew their curve cutting the y -

	axis (rather than having it as an asymptote).

Figure 3

Discussion

Table 1 provides an overview of the three systems under consideration.

Assessment Design Features	International Baccalaureate	Danish Upper Secondary A Level	Victorian Certificate of Education
Who is the setting authority?	International Baccalaureate Organization	Ministry of Education	Victorian Curriculum and Assessment Authority
What is the past examination availability?	For purchase from IBO	Contained in books of past papers from Mathematics Association	From schools who have sat the exams in the past.
Availability of Exam papers	Only available to schools sitting exams	Available on the ministry web pages within 2 weeks of examination	All schools receive copies soon after examinations.
What is the availability of solutions?	For purchase from IBO, all markers get solutions at the time of the exam.	No solutions publicly available. Mark breakdown available on ministry web pages within 3 days of examination for paper with aids.	No solutions publicly available.
What reports made available to teachers?	Chief Examiners report sent to all schools approximately 6 months after exam.	Examination report may be available on the internet.	Chief Examiners report available on web within 6 months of exam
Who sets the examinations ?	Set by examining panel of IBO	Set by team of examiners and ministry rep.	Set by team of examiners on behalf of VBOS
Who does the marking?	Markers from all round world.	Markers from all over Denmark must be gymnasium teachers.	Markers from state, mostly VCE teachers.
Who writes the Marking schemes?	Developed by question setter and sent to examiners prior to examination	Developed by each marker and discussed at meeting at conclusion of marking.	Developed by Chief Examiner and discussed at preliminary meeting.
What is the Teacher Involvement ?	Required to submit report to IBO within 2 weeks of examination, for consideration by examining panel.	Involvement of some teachers as examination markers.	Involvement of some teachers as examination markers, can send comments to the Board of Studies.

Table 1

It is evident that looking at the three systems as a whole, each system has differing involvement of the classroom teacher in assessment process, which is indicated in Table 2.

Teacher Involvement	International Baccalaureate	Danish Upper Secondary	Victorian Certificate of Education
Information to Teachers	Examination Papers Marking Schemes Examiners' Report	Examination Papers available on the web.	Examination Papers available on the web. Examiners Report available on the web.
Examination Markers	Not exclusively IB Teachers	Almost exclusively Danish Gymnasium Teachers	Not exclusively VCE Teachers
Teachers and Marking schemes	Prepared by Examination writers and distributed to all schools	No official marking scheme prepared, markers (teachers) prepare their own.	No official marking scheme. Answers and statistics provided in examiners report.
Other Teacher Involvement ?	Expected to submit a report to IBO within 2 weeks of examination, for consideration by examining panel.		Can send comments to the Board of Studies.

Table 2

Teacher Resources

As a resource there is no doubt that the use of past examination papers and their corresponding marking schemes are a vital component in the end of high school assessment regime. Students in some cases are able to purchase past examination questions or, as is more often the case, these past examinations are made available through the classroom teachers and the schools. All too often though these examination papers can become the "curriculum" where students are taught to the examination. There are of course many reasons for this including

- Expectation on teachers to have high pass rates
- School expectations
- Students and parents wanting "top marks" and a belief in repeated practice of examination questions ensuring success.

The examination can therefore adopt the status of "official knowledge" and as such have a significant impact on the classroom instruction. The power of the examination to modify and to control the classroom process cannot be underestimated and has been seen as a way of bringing about change. (Barnes, Clarke and Stephens, 2000; Morgan, 2000)

The availability then of the examination-marking scheme can further enshrine what is considered to be official knowledge and in the case of the IBO the publication of markschemes that provide great detail on what is expected can quickly become the bible by which teachers will teach. This is further evidenced by the recent publication of Solutions Using a Graphic Display Calculator by the (International Baccalaureate Organization, 2001) which establishes a set of “approved” methods in the assessment process. There is though, an alternative view to this. Many of the International Baccalaureate teachers come from different cultural and educational backgrounds thus there is a need to educate and support teachers in their role no matter what their background is. This dichotomy can then both empower and disempower teachers at the same time.

By not providing a marking scheme the Danish system is encouraging the “freedom of method” which is a fundamental part of the educational system. The downside though is that teachers can be disempowered by being “locked out” of knowing how to ensure that their students are given every opportunity to achieve at the highest level. Though as (Bjerg et al., 1995) state

> There are nevertheless grounds for believing that Danish education, especially in its practices at schools and institutions of higher education, will strike observers as being more characterised by democratic tendencies than the education systems and teaching practices of other countries. (p36)

Teacher empowerment

Can teachers have a voice in the assessment process? It is evident from this exploratory study that teachers have differing impacts on the assessment process. In the case of the IB, the teachers have the opportunity, which they are encouraged to take, to have an impact on the marking and grading process. Their comments are taken into account in the awarding process as well as in the preparation of the final marking scheme. In the case of Denmark the link between the teachers and the assessment is less clear, though all teachers can be a member of the examining teams there is a limit to the number that can take on this role. Though all teachers are represented through the involvement of their peers in the marking and grading of students. The VCE on the other hand is somewhere in the middle. Teachers can be involved in the marking process and they can comment on the examinations but there is no clear procedure for this to take place. The differences in the way that each system handle the marking and distribution of examinations demonstrates the cultural aspects that are evident in each system.

Conclusion

In this preliminary study there appears to be opportunities for teachers to have some power within an educational assessment system and though links to this power is in some cases tenuous it perhaps goes some way to the democratisation of mathematics education as suggested by (Bishop, 2000). Furthermore it is evident that if we are to develop a criticality within mathematics education then it is necessary for the assessment system to become transparent. Or as (Bernstein, 2000) has suggested there is a need for the reduction of “insulation” between the examining board, the marking scheme writer and the teacher in the classroom. By doing so the teacher will become empowered within the examining process. The investigation has provided an insight into how

Bernstein's pedagogic codes can be interpreted within high stakes assessment. This will be explored further in the forthcoming conference and in future papers.

This investigation has provided some options for how a system could begin to open up its assessment process for the teachers and as a consequence empower teachers in what is considered by some to be the most important feature of mathematics education: the final grade.

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