SMC&PA Submission 120
Also refer Submission 53
Received: 9 May 2013

You, the politicians, NEED to KNOW what our system is ALL ABOUT.

I posit that there are three paradigms in play. Each is questionable in its ability to deliver results.

1 Bloom's Taxonomy

This is the theory that is the "skeleton" of the curriculum. It is based on the 2 books written by Bloom and 1 book written for Bloom.

Book 1: Cognitive Domain.

- Higher Order thinking, complex reasoning, justification, etc
- Written in 1953 based on work and research from 1949 to 1952.

Book 2: Affective Domain.

- Affective objectives. Soon to be 1/3 of all our work thanks to the National Curriculum
- Written in 1963.

Book 3: Psychomotor.

- Doing skills like experiments, EEIs etc
- Written by other authors based on Bloom's ideas. About 1970.

All of these 3 books link into the basis upon which the whole system is based: Bloom's 3 areas for the education of the "whole child".

- Cognitive - 6 levels
  - This was written in 1953! How about that. We are driving education onwards into the future in a 1953 vehicle.

From his article: *"A Roof without Walls: Benjamin Bloom's Taxonomy and the Misdirection of American Education"*, Michael J Booker makes it very clear that:

"… Bloom's (cognitive) Taxonomy is a six-tiered approach to the intellectual expectations of the college classroom. It is worth reiterating the point that the Taxonomy was initially intended as a tool for college educators."

IT WAS MEANT FOR UNIVERSITIES AND HERE WE ARE, *in Queensland,* USING IT ALL THE WAY FROM PREP TO YEAR 12.

Booker then quotes Kreitzer and Madaus:

"It receives treatment in virtually every textbook in general education and in measurement for prospective teachers. " and "In short, it has become a part of the lore of educators."

BLOOM'S TAXONOMY IS NOT TO BE QUESTIONED.

IT IS "GOSPEL" WHEN IT COMES TO EDUCATION THEORY.

IT IS WORTH REITERATING THAT BLOOM'S TAXONOMY WAS MEANT FOR UNIVERSITIES.

HOW MANY TEACHERS KNOW THAT FACT?

HOW MANY EDUCATION FACULTY MEMBERS KNOW THAT FACT!

- Affective
    - Written in the early 1960's! Let us educate the student in ALL areas of thinking. The moral, the socially responsible. This particular facet of educational theory is VERY contentious. (See constructivism) So we are teaching a theory developed in the 60's. Now what type of "cultural revolution" was happening in the 1960s in USA?
- Psychomotor
    - A book never written by Bloom

A very nice critique of Bloom's taxonomy is done by Matt Deans on the Platoqld website. Why is it nice? Because it questions the dogma that is Bloom' Taxonomy. Is Mr Deans an Educational theorist? NO!

2 Outcomes Based Education:

Kevin Donnelly says in his book, "Dumbing Down":

"Australia's adoption of OBE is the reason why our education system is consistently at the centre of controversy. Since the development of the Keating Government's national statements and profiles in the early to mid-1990s, all states and territories have adopted OBE to various degrees. Internationally, only a handful of countries have attempted to implement OBE and those educational systems that outperform Australia in the TIMMS tests ignore OBE in favour of a more academic and teacher-friendly syllabus."

OBE, is the theory that drives the criteria marking system along with the affective objectives.

In a paper by Madonna Stinson (2004) at the UNESCO Expert Symposium on Arts Education 2004 – Hong Kong

"This is the opening statement of the syllabus for The Arts in the compulsory years of schooling in Queensland. This syllabus, to be fully implemented by 2006 …" and "*From 1999 to 2001 I worked full-time as a project officer on this curriculum, with particular responsibility for the development of the drama strand " and "In 1996 the Queensland Government established the Queensland School Curriculum Council (QSCC), a statutory government body, responsible directly to the Minister of Education."*

(The following statements are from someone who helped prepare a current syllabus and we should believe what she says. I know the QSCC is the precursor to the QSA. However, I would say that the leopard does not change its spots.)

"The QSCC adopted an 'outcomes' approach, ***an adaptation of the model developed By William Spady (1993)"*** (my emphasis)

"All materials address means of making crosscurricular links by embedding literacy, numeracy, lifeskills, and a futures perspective into learning activities."

It is VERY CLEAR that in Queensland we are working with a modified Outcomes Based Education model based on the work by William Spady. It is very clear from the state syllabuses AND the NEW NATIONAL CURRIUCLUM that we are embarking upon a National TRIAL of OBE with all the crosscurricular links and affective objectives. It is also built on Bloom's 3 books:

Cognitive: Science Understanding

Psychomotor: Science Inquiry Skills

Affective: Science as a human Endeavour

Who is William Spady?

From the dissertation in 2011 "William G. Spady, Agent of Change: An Oral History" by John Anthony Hader, *we* start to get a picture. The relevant sections for Queensland are provided and it gives an idea of how close we in Queensland came to implementing a full OBE system**.**

"Spady worked with a group of women from the Northern Territory in the early 2000s who were interested in transformational OBE, and during the first trip to work with them, Spady did some consulting with the Catholic schools in Queensland. The word about Spady and OBE spread throughout the Catholic schools in the country, and he was invited to Perth in Western Australia and Queensland to present to Catholic teachers. In 2003, Spady met the Director of the Catholic schools in Queensland who invited him to present at a faculty development event. Spady recalled the presentation:

"They had 5,000 teachers all come to this basketball stadium. I was the major speaker…That was probably the biggest audience I ever addressed…It was a good experience for me. It was a challenging experience…I put out ideas that they certainly weren't all familiar with, but I always tried to make this appealing and understandable, and [that's] what really matters when you try to do this sort of thing." (W.G. Spady, interview, June 15, 2010)

The Catholic teachers —fell in love with Spady's five —Cs (conscious, creative, collaborative, competent, and compassionate), the adjectives used to describe the qualitative attributes of the role performer labels in transformational OBE. The teachers wanted to build an outcome framework around Spady's five —Cs because —it just captured their sense of both the moral and the intellectual agenda of what education should be about. Spady traveled the east coast of Australia in Queensland from town to town, introducing the five —Cs to the administration in Catholic school after Catholic school.

The 5 Cs matches with and compliment Bloom's "Affective Objectives" for the "whole child".

In 2005, he also met with a commission in Queensland who were seriously looking at —redefining learning systems statewide, and they were interested in transformational OBE. At an unofficial meeting, the commission and Spady built a —compelling and interesting role performer framework around the five —Cs for their school systems. The commission continued to move OBE forward; however, according to Spady, politics proved to be a stumbling block:

"Everything is governed by politics. Whenever you have an election and a new regime comes in, then they want to clean house. It doesn't matter what you're doing. It doesn't matter how good anything is. They all just feel compelled to have to just do their shtick. That's what happened in Queensland. Just as we were really building momentum all over the place, there was a new election, and some labor guy got appointed to be the Minister of Education." (W.G. Spady, interview, June 15, 2010)

According to Spady:

"The closest connections I had were in Queensland "

It made him return to Australia and South Africa again and again in hopes of transforming educational systems that were time-bound and rigid.

Spady's work still affects the Catholic schools in Queensland."

I would argue that ALL schools are still affected by Spady.

But also the Lutherans were involved. From The Lutheran Education Australia vision: LifElong quAlities for Learners
"We acknowledge the support and insights provided by Mike Middleton (Australia) and Dr William Spady (USA), the latter working with us on six occasions to help in the understanding of lifelong qualities and their development …".

The church groups have a say on the QSA board. So does the QTU and it also agrees with the current paradigm. The department is represented on the board and it too agrees with the paradigm. Will anything change?

Did OBE ever work?

Not in WA. South Africa has abandoned OBE. What about the good old USA?

From Outcomes Based Education? Rethinking the provision of compulsory education in Western Australia, Richard G. Berlach and Keith McNaught write:

The impossibility of translating OBE theory into practice is precisely what the 46th Illinois School District found when in December 2000, the School Board approved the hiring of William Spady to advise District 46 in the Strategic Design Process. After working with the process for a number of years, the District decided to abandon Spady's "controversial beliefs" (p.2) as practically unworkable. The following is taken from a record of meetings.

"Proven results should be our guide in planning for the future of our schools. Unfortunately, we have found little evidence of positive results from affective outcome-based programs like Dr. Spady's. States that have implemented them, such as Pennsylvania, New York, Minnesota, Oregon and Ohio, have largely abandoned them and are returning to strong academic standards-based curriculums… The real issue with the Strategic Design Process centers on the process itself. The types of questions asked lead to defined outcomes (goals) that are vague, fuzzy, and difficult to implement and measure... At the May 7th [2002] School Board Meeting, the Board discontinued the use of William Spady as a consultant to the district. (Watch District 46 Schools Home Page).

From our near neighbour PNG an article by REGINALD RENAGI: **Outcomes-based education is failing PNG.**

"THE SO-CALLED education reforms in the form of 'outcomes-based education' (or OBE) have failed to meet PNG's expectations.

OBE focuses on measuring student performance (outcomes) whereas traditional education focuses on the resources available to the student. In practice, OBE discourages direct instruction of facts, and therein lies great controversy.

In the past two years, despite public uproar, the PNG government has stuck with OBE and not listened to people's pleas for a better and more affordable education system."

Will the same happen here?

3 Constructivism:

This is the theory(?) where EEIs and ERTs come from.

From the article: CONSTRUCTIVISM IN SCIENCE AND MATHEMATICS EDUCATION by Michael R. Matthews

"Constructivism is undoubtedly a major theoretical influence in contemporary science and mathematics education. Some would say it is the major influence. In its post-modernist and deconstructionist form, it is a significant influence in literary, artistic, history and religious education. Constructivism seemingly fits in with, and supports, a range of multicultural, feminist and broadly reformist programmes in education. Although constructivism began as a theory of learning, it has progressively expanded its dominion, becoming a theory of teaching, a theory of education, a theory of the origin of ideas, and a theory of both personal knowledge and scientific knowledge. Indeed constructivism has become education's version of the 'grand unified theory'.

Although there have been some critics of constructivism (Suchting 1992, Matthews 1993, Phillips 1995, Osborne 1996), and some urging caution in its adoption (Millar 1989, Solomon 1993), few would dispute Peter Fensham's claim that 'The most conspicuous psychological influence on curriculum thinking in science since 1980 has been the constructivist view of learning' (Fensham 1992, p. 801).

One prominent constructivist, Richard White, has said 'although the research on alternative conceptions has sparked interest in content, it has not yielded clear advice about how to teach different topics' (Fensham, Gunstone and White, 1994, p. 255). ***Given the necessity for any science programme to teach the content of science this is a serious failure.*** (my emphasis)

In his final paragraph

Given the influence of constructivism on education reform, teacher education, curriculum development and pedagogy, it is important to be clear about just what are, and are not, the epistemological commitments of constructivism. And what relationship these commitments have, if any, to classroom practice. ***The history of education is littered with 'ideas that seemed good at the time', but whose enactment caused educational and cultural havoc. Constructivism has all the earmarks of being such an idea.*** (my emphasis)

From a book: **The Content of Science: A Constructivist Approach to its Teaching and Learning** (Fensham, Gunstone and White, 1994), the Postscipt by Peter Fensham provides an interesting parallel to where we are at the moment:

"*Elsewhere I have argued that science educators are now potentially a very influential group in determining how the knowledge of worth in science education is determined."*

I believe that we science educators are doing just that through this inquiry.

Other Points.

The QSA stated in their submission:

"The system is consistent within itself and across time. An independent review conducted in 2011 by US assessment expert Dr Scott Marion and two senior experts from the Victorian and South Australian qualifications authorities found that Queensland's current procedures for ensuring both the within year and year-to-year comparability were strong overall."

It would benefit the committee to ask:

Who chose these experts? QSA?
How long did they take to review the entire set of procedures covering all of the work of the QSA? 1 day?
Maybe ½ a day to listen to the QSA and ½ a day to review the data?
Who provided the data? QSA?

There are 3 paradigms that need to be questioned as to their efficacy in primary and secondary schools.

1. **Bloom's Taxonomy: teaching and learning and affective objectives**
2. **OBE: criteria based marking and affective objectives**
3. **Constructivism: EEIs, ERTs, teaching and learning**

In closing this first part I want to share this factual story: today I received an exam from a friend who recently taught at a prestigious Private School in Melbourne.
It is a grade 10 science exam.
It is a semester exam.
There are 40 multi-choice questions each worth one mark
There are 9 short answer questions each worth between 1 to 4 marks
There are 2 extended answer questions worth 15 marks in total
No criteria
Just good old marks and percentages.

How would I change the system?

The following is based on my readings of

1. David Hestenes (USA): Force Concept Inventory (FCI)
2. Eric Mazur (USA): Harvard. Use of FCI
3. Paul G Hewitt (USA): Conceptual Physics
4. Lillian McDermott (USA): Inquiry Physics
5. Joe Wolfe (AUS): Physicist, UNSW. Physclips
6. Carl Wieman (USA): Learning Goals
7. Les Kirkup (AUS): Measurements in science

Also on conversations with

1. Peter Ridd (AUS): Physicist JCU
2. Matt Deans: Mathematician UQ
3. Igor Bray (AUS): Physicist, Curtin University
4. A relative, with a PhD in Inorganic Chemistry, who taught chemistry at a Queensland University for many years
5. A colleague whose sister is a Professor of English at a NSW university
6. Colleagues
7. The following quote:

Rhonda Farkota who argues that successfully mastering higher-order skills first requires being taught the basics in a structured, systematic way:

"It is generally accepted that a student-directed approach is more suitable when it comes to the employment and cultivation of higher order skills where reasoning and reflection are required. However, for the acquisition of basic mathematical skills, the research clearly shows that teacher-directed learning is better suited. Needless to say, these basic skills must be firmly in place before students can approach problem-solving questions with any degree of competence."

A suggested 2 year program

Year 11				Year 12			
Semester 1 Thermal, nuclear and electrical physics	Term 1	***Exam***	10%	Semester 3 Gravity and electro-magnetism	Term 1	***Exam***	15%
		Prac Test	5%			***Prac Test***	5%
	Term 2	***Exam***	20%		Term 2	***Exam***	25%
		Prac Test	5%			***Prac Test***	5%
Report			40%	Report			50%
Semester 2 Linear motion and waves	Term 3	***Exam***	20%	Semester 4 Revolutions in modern physics.	Term 3	***Exam***	30%
		Prac Test	10%			***EEI***	10%
	Term 4	***Exam***	20%		**Submission**		90%
		EEI	10%		Term 4	***ERT***	10%
Report			60%				
	Submission		100%		**Final**		100%
				Report			
Exams in total			70%	Exams in total	Exams in total		70%
Experiments in total	Prac tests		20%	Experiments in total	Prac tests		10%
	EEI		10%		EEI		10%
				Written Assignments	ERT		10%

Teaching and assessing would come under headings.

1. Conceptual Understanding
2. Mathematical Understanding

. We have nothing to do with the affective objectives or Science as a Human Endeavour

<u>Exams:</u>

Year 11: Semester 1

1. Conceptual Understanding questions at what teachers call a C level.
    a. 5-10 per exam
    b. Use of marks
2. Mathematical Understanding questions again at what teachers call a C level
    a. 5-10 per exam
    b. Use of marks

Why?

For as I long as I have been teaching science and maths, what result a student has in semester 1 is generally what they end up with in grade 12.

Why?

After 10 years of a general education students end up with a set of habits of thought that is very difficult to break. No matter how dedicated the teacher and no matter how good the curriculum and no matter how good the assessment, students still don't get science or maths after 2 years of specialised instruction. Ask any University Science or Maths lecturer about 1st year students.

Why?

From the article: CONSTRUCTIVISM IN SCIENCE AND MATHEMATICS EDUCATION by Michael R. Matthews(my emphasis shown)

"Many science educators are interested in finding out how, on constructivist principles, one teaches a body of ***scientific knowledge that is in large part abstract*** *(depending on notions such as velocity, acceleration, force, gene),* ***that is removed from experience*** *(propositions about atomic structure, cellular processes, astronomic events),* ***that has no connection with prior conceptions*** *(ideas of viruses, antibodies, molten core, evolution, electromagnetic radiation),* ***and that is alien to common-sense,*** *and in conflict with everyday experience, expectations and concepts? Teaching a body of knowledge involves not just teaching the concepts, but also the method, and something of the methodology or theory of method. "*

What politicians are asking of me is no simple task. This is a hard gig. I can throw every known ism at teenagers to try and help them understand science and maths and they still do not get "IT". Remember that they have come from 10 years of general education INTO a specialised subject. That requires a big intellectual jump.

From The Physics Teacher, Vol. 30, March 1992, 141-158 an article on the ***Force Concept Inventory*** by David Hestenes, Malcolm Wells, and Gregg Swackhamer states:

"Since the students have evidently not learned the most basic Newtonian concepts, they must have failed to comprehend most of the material in the course. They have been forced to cope with the subject by rote memorization of isolated fragments and by carrying out meaningless tasks. No wonder so many are repelled! The few who are successful have become so by their own devices, the course and the teacher having supplied only the opportunity and perhaps inspiration."
A harsh critique of teachers, the system and of the students entering university but I say it is correct. So what do we do?

Teach by direct, explicit instruction for as long as is necessary each and every lesson until the end of year 12.
If students can show a willingness and maturity to be allowed to undertake peer discussion and the like as suggested by Mazur then that is up to the teacher. Today I had 2 year 12 boys discuss with me a vector problem. I solved the problem the same way as they had and got the same wrong answer (deliberately of course!). I then gave them a hint as to where we went wrong. They then proceeded to argue and discuss together, with me listening, until they eventually got the right answer and both had an AH HA moment in a short period of time. No one should have said that constructivism is THE

way to teach. It is one of many tools in the teacher's tool box and should be applied at the appropriate time. Only after the basics are thoroughly understood

The old saying: "when the student is ready the teacher is prepared and when the teacher is ready the student is prepared" holds true to this day.

However, the main teaching strategy is explicit teaching. I am the teacher and I will decide what happens and when. I am not a facilitator.

Explicit teaching over the course of 2 terms, reinforcing day after day the learning objectives we,

the science and maths community of Queensland (Not Finland or any other foreign country like Canberra)

determine to be

1. the important conceptual skills objectives (see Paul G Hewitt: Conceptual Physics) and
2. the important mathematical skills objectives (talk to Matt Deans and Peter Ridd)

that will lead students to reorganising their thinking.

Currently a student entering grade 11 physics/maths is EXPECTED to learn and know how to solve multistep, complex reasoning, higher order thinking problems and understand conceptual ideas that are usually beyond their ability right from the beginning to get an A. The good students get it and the average student will do their best to struggle through for 2 years. They don't have time and are not given time to learn the skills needed for this new specialised subject.

Give every student the TIME to develop these skills to a basic C-level so that they KNOW how to

1. think about and solve simple conceptual problems.
2. think about and solve CORRECTLY simple mathematical problems.

They have been explicitly taught how to do this problem solving over 6 months.

If the student struggles in term 1, the teacher will obviously see this on the student's exam and can then help that student in the next term. The student KNOWS that the next term there will be similar problems needing similar skills and can work WITH the teacher on their weakness. Both have time to work on the necessary skills deficiencies. Also they can work together on the literacy requirements that go with problem solving. (from the Professor of English. They are appalled at the level of competence students have when entering University)

Year 11: Semester 2

1. Conceptual Understanding questions at what teachers call a B level.
2. Mathematical Understanding questions again at what teachers call a B level.

Why?

After 6 months of learning the basics, take students to the next level of conceptual and mathematical understanding. This would be simple multi-step problems and more difficult conceptual problems.

Again we are able to see after one term HOW the students are handling the conceptual and mathematical demands. The following term, term 4, allows the students and teacher to work together on these deficiencies.

The learning goals MUST BE VERY SPECIFIC. (Wieman)

Educators will immediately say that this disadvantages the top students. WRONG. They get a better grasp of the CONCEPTS. They may actually start to UNDERSTAND what they are learning.

As an anecdotal story: A person I know who was an OP1, Junior Dux and Senior Dux, University medal winner with a GPA of 7 in applied physics, told me that they did not really understand their school or university work. They did what the teacher/lecturer told them to do and it worked. They did not really understand the concepts.

All of this work on conceptual and mathematical reasoning could/should be provided in a textbook. How could it work?

See Serway and Faughn: College Physics 4th Edition. Also see Paul G Hewitt: Conceptual Physics: The High School Program.

By the end of year 11 students should now have a good idea of concepts and mathematics to a B standard.

Why should they?

Repetition. How do people achieve mastery of a musical instrument? Repetition. How do people become good at a sport? Repetition. Both music and sport have levels at which a person can participate BUT you do not get to the next level unless you have practised and practised. And that practice is conducted with a teacher or coach that gives explicit instructions on what to do. You cannot change a way of thinking unless you give a student time to digest the instructions and to practise the instructions and then try them for themselves.

Year 12: Semester 3 and Semester 4

1. Conceptual Understanding questions at what teachers call an A level.
2. Mathematical Understanding questions again at what teachers call an A level.

Students have 3 terms / 9 months to learn the higher level conceptual and mathematical skills!

Throughout the Year 12 course Exams are worth more as the year goes on so that:

1. Students are NOT PENALISED to a large extent for not understanding the work first time
2. Students are rewarded for ongoing effort
3. Students can not slack off as the year progresses if they want to succeed

Prac Tests

Students do small Prac tests based on one or two experiments they have done during the term and are to be tested on their conceptual and mathematical understanding.

Teachers could use McDermott's Physics by Inquiry.

Use the experiments developed at seniorphysics.com if you want. These were mainly developed by Queensland teachers. An example being Alan Whyborn's new, innovative experiments.

Based on Les Kirkup's work, ALL Queensland students WOULD have a thorough knowledge of some basic error analysis in experiments.

The concepts to be covered are given in detail not the type of experiment. Teacher creativity?

Eg: Year 11

Semester 1: Linear relationships and relative error
Semester 2: Inverse relationships and percentage error

Match the appropriate mathematical and conceptual skills to the curriculum.

Several Prac tests based on in class experiments are assessed BEFORE the students do an EEI. The skills to use equipment, get data, analyse data have been explicitly taught BEFORE the students do an EEI They are assessed in class under exam conditions. This is done to make the students aware that the in-class experiments mean something. They are not there for play or time wasting. They could make the difference between a VHA and a HA.

EEI

The EEI is an experiment that the students do in class and they only need write up the results, discussion and conclusion AND NOTHING ELSE! These sections will cover conceptual and mathematical concepts. Students do not get to choose their own experiment. Teachers choose but give a small range suited to the local equipment and facilities and teacher experience. At most it is 2 weeks in class. Overall length is 600 words.

If a student wants to do their own research there are a number of National competitions they can enter. They could link up with universities if they are very good. There are many other options.

ERT

Term 4 in grade 12 is such a short tem why not have the students learn how to write an ERT. Learning to write is NOT a bad concept to learn in Physics. The overall word length is 600 words.

The basics of this Physics program could be easily adapted to Chemistry and Biology and Senior Mathematics.

I could flesh out each section further if so desired.

Thank you again for the opportunity to provide a point of view to such an important subject.

Ian Pink
Monday, 13 May 2013