House of Representatives Inquiry re 'hard and enabling sciences'.

Submission

Submission Number: 02
Date Received: 07/10/08

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Biographical note

John Ridd taught in UK for ten years, mainly as Head of Maths in large London Comprehensive schools, for six years in a secondary school and a Teachers Training College in Nigeria, and from 1970 until retirement as Head of Maths Innisfail SHS, North Queensland. He was heavily involved with the Queensland Board of Senior Secondary School Studies, Brisbane and was co-author of a series of Qld Secondary Maths texts (Oxford U P).

Background to submission

The committee may consider it relevant for me to state that my Ph D, awarded in 2004, had as its thesis title

Participation in Physics and rigorous Mathematics
and a consideration of educational, economic and political influences.

The work for that qualification was done over six years. Throughout that time, and ever since, I tutor Secondary students privately so giving me a 'finger on the pulse' of current education practices.
This Submission will not use education jargon; not because I imagine that the Members could not handle such jargon, but because it my observation that education jargon is frequently used as an exercise in obfuscation.

Introduction and apology

I apologise to the Committee for the rather messy and unpolished nature of this submission. I was not aware that the Committee was considering the crucial topic of participation in 'hard and enabling sciences' until an advert appeared in *The Australian* of 1/10/08. Because it is necessary to 'get something in' before, preferably well before, the public hearing scheduled for 16/10/08, there is very little time and I have hence had to resort to a cobbled together submission. Much of it will be directly taken from other writings of mine. However there will be joining material that is intended to link the parts together, to 'modernise' to some extent and in particular to respond to the submission by DEEWR. Please accept my apologies and please do not let the rough form of the submission cloud the fact that there are, I hope, useful facts, ideas and opinions within it.

After this introduction any material that is taken from other of my writings (thesis, submissions to Reps and Senate, copy of an E-Petition to the Queensland parliament, submission re STEM to Education Queensland, OLO articles (to lighten things up a bit – after all, just because this is a serious issue does not mean that we have to be solemn) etc) will be in standard script, all other will be in italic and bold. All and any writings that are utilised will be added at the end as Appendices that can be used as discretionary additional reading.

Tertiary enrolments in 'hard and enabling sciences'.

I was shocked to read the Submission 1 from DEEWR in that it appeared to claim that enrolments are not really declining, just wobbling about a bit. The key to their position is to be seen in their Table entitled 'Enrolments in the Enabling Sciences', which paint a highly optimistic picture. I counsel the Committee to be most cautious in accepting that data at face value. As will be seen from the following pages from my thesis it is remarkably difficult to 'sort out' what is and has been going on. In addition it is important to note that the Department decided to use the disciplines listed in the Table as being the 'enabling' subjects. That was not the original definition proposed by the former Chief Scientist Batterham who defined 'enabling' as being hard maths, Physics and Chemistry. Personally I cannot see Astronomy as being 'enabling' at all, and hence should not be included. I urge upon the Committee to consider whether the Batterham definition is a better fit with the Committees 'hard and enabling science' than that used by DEEWR.

There follows a number of early pages from the thesis. Please note the huge amount of research that had already been done by then re enrolments, the assumption from the first line that there was trouble and, most importantly, watch my struggles to disentangle the data. In the process you will, I hope, understand why I think the DEEWR presented Table has the potential inadvertently to mislead the Committee.

Excerpt from thesis

The evidence of changes in participation levels in Physics within Tertiary Physics Departments is strong and has been repeatedly demonstrated over many years. Jennings et al. (1996) showed a decline in numbers at third year level over the period 1991 - 96, a fluctuating situation in 4th year, and a decline in postgraduate numbers over the same period. A few years later de Laeter, Jennings and Putt (2000) showed that for the period 1997-1999 there were further declines in numbers in third year and fourth year and also in postgraduate studies.

The Federation of Australian Scientific and Technological Societies (Gascoigne1997 pers. com.) showed a marginal decline in first year enrolments from 1651 in 1995 to 1629 in 1996 but a far more severe decline, from 432 to 367 for second year. These figures indicate that only 22% of students studying Physics in First Year go on with the subject to second or later years.

In an examination of staffing numbers FASTS gave a decline in academic staff numbers in Australian Physics Departments from 282 in 1996 to 220 in 1997. They also state that restructuring/amalgamation were definite for James Cook, La Trobe, QUT, UNE, UWS, and Wollongong. FASTS also expresses concern for Flinders, Monash (serious 'downsizing'), Murdoch, Newcastle, Queensland (extreme staff reductions), Tasmania (pressure to amalgamate) and UTS (Physics major terminated).

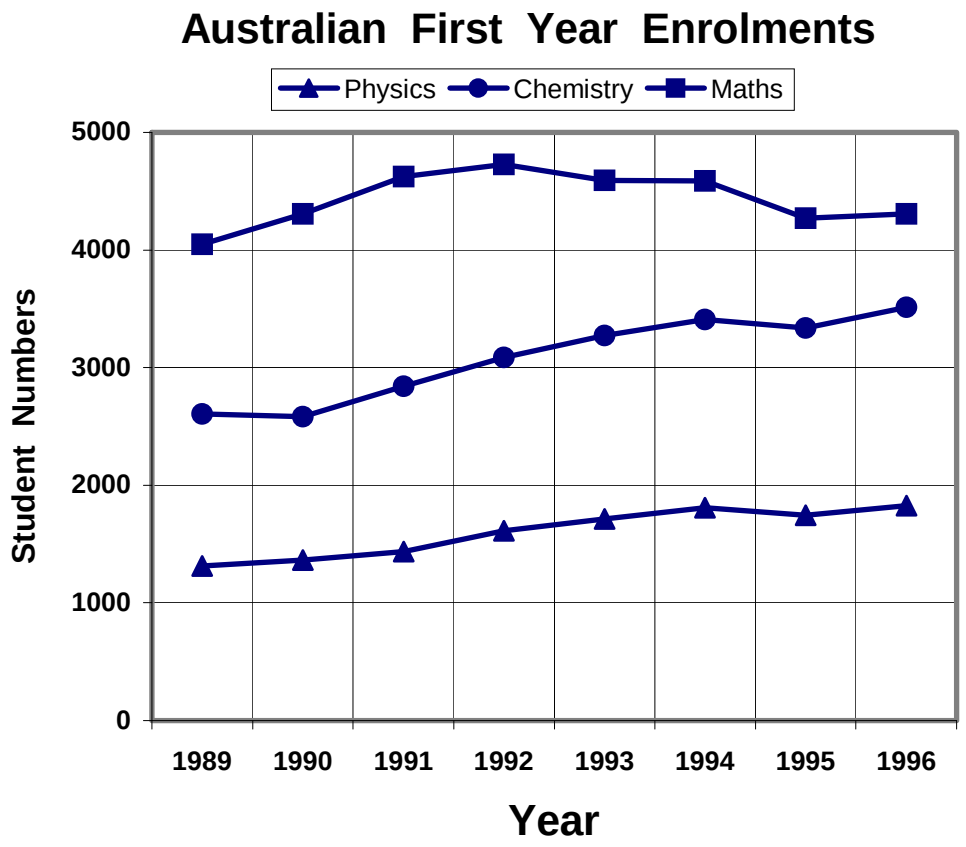
Tertiary figures for Australia are readily available from the Commonwealth Department of Education, Science and Training (DEST). However, interpretation of that data is not so readily achieved. Statistics obtained in 1996 from the Department of Employment, Education, Training and Youth (DEETYA), the predecessor of DEST, gave First Year enrolment as shown in Table 1.5, and as illustrated in Figure 1.3.

Table 1.5: Australian totals for First Year enrolments.

Year	1989	1990	1991	1992	1993	1994	1995	1996
Maths	4046	4306	4625	4728	4590	4586	4270	4305
Physics	1315	1365	1439	1613	1713	1810	1744	1827
Chemistry	2606	2586	2844	3088	3271	3407	3338	3511

(DEETYA, 1996)

Figure 1.3: Australian totals for First Year enrolments.



Such numbers appear to give little cause for concern, but they sit poorly with the known problems in the university Physics Departments. Confirmation of the departmental difficulties listed by FASTS earlier is contained in de Laeter, Jennings and Putt (2000). They list 'administrative changes' as having occurred at the following universities: James Cook, Central Queensland, New England, Western Sydney, Wollongong, Canberra, La Trobe, Victoria, Tasmania, Flinders, South Australia, Murdoch and Queensland University of Technology. There is also anecdotal evidence that Physics, Mathematics and possibly Chemistry Departments are also being adversely affected by the loss of 'service teaching'. That can occur when another department, being in trouble itself, takes over the teaching of those disciplines so maintaining their own staff numbers but at the expense of the Physics, Maths and Chemistry departments.

However it is now evident that the figures shown in Table 1.5 were not for 'First Year' students. In 2002, the University Statistics section of DEST stated that; 'The figures (in Table 1.5) which you thought were for first year enrolments were in fact for total enrolments (both commencing and continuing students). Also the numbers for Maths included courses coded to 090401,090402,090403,090404 and 090499'. Those subjects, named Mathematics-General, Applied Mathematics, Pure Mathematics, Statistics and Operations Research and Mathematics-Other vary both in content and rigour. The full subject definitions, by numerical code, for the years up to and including 2000, are shown in Appendix 5. (***Of the thesis)***

(So the numbers for Maths, say, are an amalgam of a number of different subjects of different levels of 'Hardness'. DEEWR data submitted to your Committee appears to suffer from this monstrous problem.)

Table 1.6 and Figure 1.4 show 'commencing' enrolments for Physics and Chemistry for the years 1989 to 2000 inclusive. Note that there are no subject subdivisions for either subject for those years.

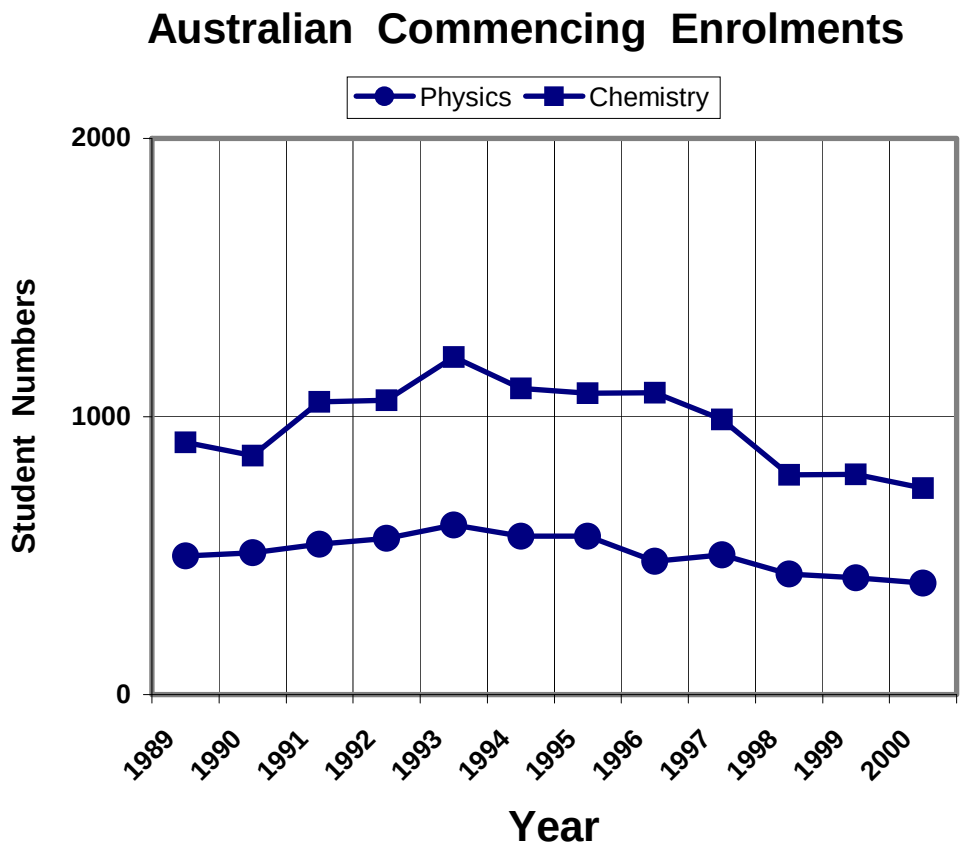
Table 1.6: Australian commencing enrolments, Physics and Chemistry 1989-2000

Field of Study	1989	1990	1991	1992	1993	1994
090502 Chemistry	907	860	1052	1059	1213	1100
090505 Physics	499	511	541	562	609	570
Field of study	1995	1996	1997	1998	1999	2000

090502 Chemistry	1084	1085	990	790	791	742
090505 Physics	569	479	503	433	419	401

(DEST, 2002)

Figure 1.4: Australian commencing enrolments, Physics and Chemistry, 1989-2000.



For Chemistry, the rise in enrolment observable in the period 1989 to 1993 is much more than offset by the decline from 1993 to 2000. For the whole period 1989 to 2000 enrolments declined by 18%, the decline from the 1993 peak to 2000 is 39%.

For Physics there was also a rise in enrolments between 1989 and 1993 followed by a marked decline from 1993 to 2000. The decline over the whole period was 20%. The drop from the 1993 peak to 2000 was 34%.

From 2001 the definitions for the various Physics, Chemistry and Mathematics 'subjects' used by DEST were altered. The definitions for 2001 are also given in full in Appendix 5. ***(This definitional change may perhaps be the reason that DEEWR data starts at that year.)***

Table 1.7 shows the commencing enrolments, based on the new subject definitions, for 2001. Note that Chemistry is now subdivided, Physics is not.

Table 1.7: Australian commencing enrolments in Physics and Chemistry 2001

Field of Study	2001
010500 Chemical Sciences	347
010501 Organic Chemistry	13
010503 Inorganic Chemistry	7
010599 Chemical Sciences not elsewhere classified	216
Total Chemistry	583
010301 Physics	346

(DEST, 2002)

If it is assumed that the Chemistry 'Total' can legitimately be compared with the single subject Chemistry for the earlier period, the enrolment decline continued. For the period 1993 to 2001 the decline was 36% and from the 1993 peak a remarkable 52%. The Physics (still a single subject) decline also continued. From 1989 to 2001 numbers fell by 31% and from the 1993 peak by 43%. The close association between Mathematics and the physical sciences makes an examination of Tertiary enrolments of interest. Table 1.8 shows those enrolments for the period 1989 to 2000.

Table 1.8: Australian commencing enrolments in Mathematics 1989-2000

Field of Study	1989	1990	1991	1992	1993	1994
090401 Maths-General	702	793	921	785	797	842
090402 Applied Maths	196	191	141	212	270	236
090403 Pure Maths	55	53	35	42	42	30
090404 Stats & Op. Res.	268	271	324	313	324	303
090499 Maths-Other	259	300	306	285	213	160
Total Maths	1480	1608	1727	1637	1646	1571
Field of Study	1995	1996	1997	1998	1999	2000
090401 Maths-General	668	577	643	552	556	595
090402 Applied Maths	231	268	241	174	148	132
090403 Pure Maths	46	26	36	29	21	21
090404 Stats & Op. Res	320	324	287	257	324	311
090499 Maths-Other	162	191	178	224	192	148
Total Maths	1427	1386	1385	1229	1241	1207

(DEST, 2002)

As for both Chemistry and Physics, total enrolments in Mathematics increased for a few years, reaching a peak in 1991, two years earlier than the peaks for Physics and Chemistry. From that peak there was a major decline in total enrolments. For the whole period 1989 to 2000 the decline was 18%; the decline from the 1991 peak to 2000 being 30%. Because of the multiple Maths 'types' for those years it is possible to examine the numbers in rather greater detail. Over the whole period 1989 to 2000 090401 Maths - General declined by 15%, 090402 Applied Maths by 33% and 090403 Pure Maths by 62%. Pure Maths started from a low base and by 2000 had become almost negligible. 090404 Statistics and Operations Research behaved abnormally, showing an increase of 16%. The catch-all definition 090499 Maths - Other declined by 43% but that decline was highly uneven as the figures for the years 1997, 1998, 1999 and 2000 show very clearly. Table 1.9 shows the enrolment data for 2001, i.e. subsequent to definitional changes.

Table 1.9: Australian commencing enrolments in Mathematics 2001

Field of Study	2001
010100 Mathematical Sciences	465
010101 Mathematics	224
010103 Statistics	171
010199 Mathematical Sciences not elsewhere classified	170
Total Mathematics	1027

(DEST, 2002)

The Physics data shown in Tables 1.6 and 1.7, when considered in conjunction with detailed Third year enrolment data by de Laeter (de Laeter et al 2000) are confusing. De Laeter examined Third Year enrolments in all Australian universities, confirming the data with each relevant Departmental Head. That data is tabulated against the DEST data in Table 1.10.

Table 1.10: Commencing and Third year Physics enrolments.

Date	1992	1993	1994	1995	1996	1997	1998	1999
Commencing	562	609	570	569	479	503		
Third Year			615	616	591	540	567	548

(DEST 2002. de Laeter et al 2000)

The interpretative difficulty is clear. In 1992 a total of 562 students 'commenced' Physics. It is assumed by DEST that most of those students would have been in First Year; such an assumption is reasonable. Two years later, in 1994, when the 1992 entrants would have been in their third year at university there were 615 students studying 3rd Year Physics. That pattern, that the number of Third year students taking Physics is greater than the number who took (presumably) first year Physics two years earlier is evident in five out of the six years. That pattern is so counter intuitive as well as contrary to observation that it has to be assumed that a simple comparison of the data is inappropriate.

(You can see, I hope, why I look at simplistic data and start asking questions such as what year? How much of a year? Level of difficulty from heavy weight to what school students would unhesitatingly describe as 'vegie'?)

Information from the Planning and Statistics section of the Resources Office at James Cook University (Clark 2002 pers.com.) makes it clear that DEST aggregates data from the various Australian universities and that the data is given in EFTSU (equivalent full time student units). Hence, for example, for 1997, the 503 is not the number of students that were studying Physics in the First Year, but the sum of all the full time equivalents of all students who were studying any Physics in First Year.

The Third Year data however, is not in EFTSU units, but the number of students studying Physics at that level i.e. considered to be 'majoring' in Physics. Although it is difficult to estimate the EFTSU equivalent of the de Laeter et al.(2000) numbers such an estimate does enable a more valid comparison of First and Third Year data. If it is assumed that the 'Third Year' students are spending approximately one third to one half of their time on Physics, the EFTSU equivalent of 548 would be in the range 180-270. A change from 503 commencing student unit in 1997 to rather less than half that number of student units in 1999 at Third Year level is credible.

The data sets, because of the fact that they are based on consistent data collection systems over time, are a reliable indicator of trends that have occurred. What the data sets cannot do is indicate how many students are taking *any* Physics in First Year or the amount of Physics taught by Physics *Departments*. That total number must be very much larger than the EFTSU number. An examination of detailed data shows that 'mainstream' Physics subjects are normally rated as being 0.125 EFTSU, but

some other non 'mainstream' Physics components within other subjects are rated as low as 0.03 EFTSU. The numbers enrolled in some of those low EFTSU rated subjects is often high, frequently much higher than the numbers enrolled in 'mainstream' subjects. Any attempt to estimate the number of students studying some Physics in their first year at university must inevitably have very large error bars, but there cannot be fewer than 4000 and it is probable that twice that number are involved to a greater or lesser extent.

Whilst there are obvious definitional problems in making judgements about 'standards', it is reasonable to suppose that a large percentage of students studying First Year Physics at Universities are studying only at a 'Foundation' or basic level.

(So the number of students taking 'Hard Maths' or Physics and probably Chemistry is not shown in generalised data such as that used by DEEWR because it may be subsumed into a general overall number. I am unconvinced that the DEEWR data as shown in the table tells the Committee very much at all in respect of tertiary enrolments in 'hard and enabling sciences.)

(Entry into Tertiary courses is normally by people who have just left Years 11/12. Consequently it is essential to look at what is happening in those Years)

Secondary enrolments in 'Hard and Enabling Science'

(There is a vast amount of data showing the enrolment problems in Years 11/12. There is no point in covering that area in as much detail as for Tertiary enrolments but a small sample of data from Queensland is both relevant and indicative. For further data see complete thesis attached to this submission)

Excerpt from thesis.

(In Queensland Maths C is generally considered to be the 'hardest'. The Tables and graphs below show the number of students who did the full two year course in Maths C and importantly the numbers per school)

Table 1.23: Maths C student enrolments (4semesters), number of schools and mean enrolment per school. Queensland 1992-2001.

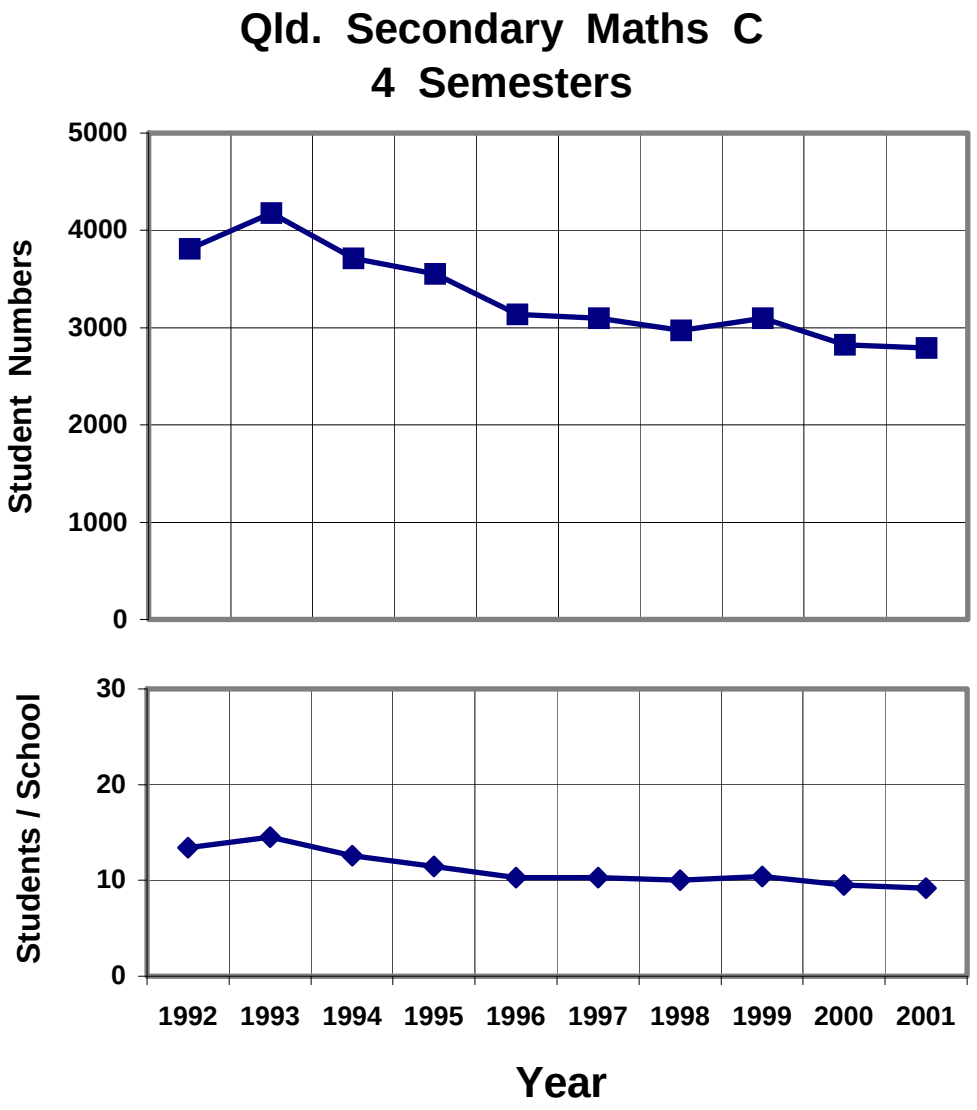
	1992	1993	1994	1995	1996
Student number	3813	4176	3712	3553	3134
School number	284	288	295	N/A	303
Students/school	13.4	14.5	12.6		10.3
	1997	1998	1999	2000	2001
Student number	3100	2971	3098	2824	2788
School number	301	297	299	298	302
Student/school	10.3	10.0	10.4	9.5	9.2

(QBSSSS data)

(Clearly the situation deteriorated dramatically. The 27% decline in absolute numbers is bad enough especially bearing in mind the rapid rise in population, but far more serious is the decline in numbers/school. Schools staff/pupil ratios are strict so it follows that schools experience difficulty in staffing the subject. There was a clear medium to long term threat to the existence of the subject)

(A quick look at the most recent data indicates that in the years 2001-2007 the enrolments increased slightly to 2792. However the number of schools increased to 314 so the crucial enrolment /school ratio worsened even further to 8.9. Clearly the problem for the schools is very serious indeed. I also note that the number of schools offering Physics was 371. Hence there must be a net 57 schools in which students are taking Physics but are unable to take the somewhat allied subject Maths C. That is most undesirable).

Figure 1.9: Maths C student numbers (4 semesters) and number/school,



(The situation in both Maths C and Physics is poor. However with the exception of male participation the numbers in Chemistry were stable and provided a sound source of students for tertiary courses in Chemistry or chemically based disciplines. It is noticeable that the science most closely allied to mathematics – Physics – is badly affected, that is an understandable correlation.)

Possible influences on participation.

Excerpt from submission to House Inquiry into 'enabling sciences, physics, maths and chemistry. (2004)

(The attention of the 2008 Committee is drawn to the fact that the definition of 'enabling' was as defined by Batterham, not as defined by DEEWR)

In the language of economics there are two possible influences on enrolments in physics and rigorous maths: demand side and supply side. It is probable that a real and/or perceived lack of employment affects student decision-making. Some enrolment data from Canada tends to support a thesis that demand side factors are highly significant. However there is evidence from both USA and Germany that supply side factors are also significant, In USA Zadeh (1997) states that *"despite the rising demand for computer science graduates, the number of undergraduate*

degrees in computer science (U.S.) had dropped 43% from 42,000 in 1986 to 24,000 in 1994". Zadeh suggests fewer students are willing to do courses in which "hard work is required". So for US Computer studies the fall in enrolments cannot be explained in terms of demand side factors. The problem must be mainly supply side driven.

Zadehs remarks for computer science in the US despite unmet demand are re-emphasised by Hahlen for the German experience. Firstly referring to IT he states that *'It is ours as well as the Federal Government's understanding that a significant demand for highly specialised IT experts can be expected and that the demand cannot be met solely by future graduates. That is the reason for the recent approval of a further 1000 residency permits for foreign IT specialists, so called greencards.'* Secondly, with reference to engineering, he comments that *'concerns that a lack of academically trained engineering specialists are definitely justified, in particular for the central disciplines mechanical and electrical engineering.*' (Hahlen, 2001). As for the US it is evident that supply side problems exist, demand side considerations alone cannot explain the difficulties raised by Zadeh and Hahlen.

(This opinion in respect to serious supply side issues was also mention by the Engineering Deans – quoted below)

Excerpt from Submission to Senate (2007)

Declines in enrolments and standards in upper secondary school rigorous Maths and the associated numerical Sciences have inevitably led to serious problems in enrolments at tertiary level. Whilst it is possible – as has been suggested in some quarters – to argue that those tertiary problems are a consequence of lack of demand, i.e. employment opportunities, it is clearly not in the case of Engineering. In January 2006, Professor Archie Johnston, President of the Australian Council of Engineering Deans, referring to the feeble condition of engineering enrolments by domestic as opposed to overseas students at a time of high demand for engineers was quoted in *The Australian* as saying *'the biggest hurdle is the mathematics; the demand for mathematics(in schools) has plummeted'*. He went on to remark that university training in engineering demanded a solid preparation in mathematics at school. To put it in quasi economic terms, the declines in enrolments cannot be put down entirely to a weak demand side; some of it must be driven by a problem in the supply side.

Excerpt from House Inquiry (2004)

It is hard to envisage any actions that may be taken by and within governmental, industrial and educational institutions that will change the *demand* side of the equation. However there may well be governmental and educational actions that might affect the *supply* side. Hence there is a greater likelihood that an examination of the supply side might produce results that could point the way towards useful actions that *could* be taken by governments and education institutions. Consequently this submission concentrates on supply side possibilities.

(The crucial stage is the interface between Years 10 and 11. It is at that stage that the students choose to take – or not take – the 'hard maths and enabling sciences'. The next part of this submission deals with the importance of lower secondary schooling)

Importance of lower secondary schooling

Excerpt from submission to Senate Inquiry into 'standards of school education', (2007)

It is intuitively obvious that the education experiences in Years 8/9/10 must be a prime determinant of each student's selection of subjects to be studied in Years 11/12 and success in those subjects. However it is not necessary to depend on an intuitive feeling (no matter how blindingly obvious it may be); there is good research to support that intuitive feeling, especially for 'physical' i.e. numerical Science. The influence of student's previous experience in Years 9/10 on subsequent participation in physical Science was examined by Ainley as long ago as 1993. Emphasising the importance of prior experience he concluded that *'as a generalisation, participation in a physical science type course is most strongly shaped by earlier achievement in numeracy, an interest in investigative activities and gender……among males, the influence of earlier achievement on physical science participation is independent of, and much stronger than socio-economic status.'* (Ainley 1993).

There is also solid evidence that lower secondary performance has an effect on results at the end of secondary education. The most usual measure of the 'result' of secondary education is the Equivalent National Tertiary Entrance Rank (ENTER) result, (called TES or OP et al in various jurisdictions). A Longitudinal Survey of Australian Youth (LSAYR 22, 2001) showed that numeracy/literacy *in Year 9* was by far the biggest determinant of final student performance. Furthermore the effect of numeracy was greater than the effect of literacy in every State. (This issue will be re-visited in the section on 'males') There is currently a rather excited 'discussion' over the relativity of 'Private' v "Public' schools. In that context it should be noted that 'school type' was a very minor determinant, almost negligible. 'Individual school' a much larger determinant – though still small compared to literacy/numeracy in lower secondary schooling.

There is yet further confirming evidence of the importance of earlier education from both UK and US. Alison Wolf, professor of Education at the University of London's Institute of Education, repeatedly emphasises the importance of lower secondary education. (Wolf 2002). One of the outcomes of a UK longitudinal study that followed students born in 1958 and 1970 demonstrated that, when all other variables including formal education are controlled, basic skills showed up as vital determinants of a persons future life. *'(the study) underscores the enormous importance, in modern societies, of basic academic skills. Poor literacy and poor numeracy – especially the latter – have a devastating effect on people's chances of well-paid and stable employment'*. Wolf also reports on another longitudinal survey in the US for students who were in their final year of high school in 1972 and 1980. It examined '*whether (language and maths) skills, as measured by these tests, affect future earnings over and above the effects of any formal qualifications……It seems that they do'* Furthermore *'it again seems to be mathematical skills which matter most'*.

This firm establishment of the importance of lower secondary schooling, together with the fact that students make almost irreversible decisions in respect of subject choice at the end of that time, makes an examination of the situation at Year 10 exit essential.

Standards in lower secondary school

(I will present this in a highly informal manner – extracts from articles on Online Opinion. However the informality in no way reduces the standard of research on which the items are based Firstly from 'Wadderloader, maths and science teaching' (2005))

Those of us with eyes to see and ears to hear have been enduring the smug mantra, "Today's youth is the best educated ever" for years now. Wadderloader rubbish.

The latest blow to any remnant belief in the excellence of education in Australia lies in the recently released *Trends in International Maths and Science Study* (TIMSS). It shows that Australian students in Years 4 and 8 are mathematically weakening relative to other countries. Not only are we not in the first division with countries such as Hong Kong or Singapore, we are now sliding down the second division and have been overtaken by Hungary and England. What little data there is for physics indicates that Australian students in Year 8 are below the international average. **(In particular the percentage of students reaching the 'Advanced' level in Maths is 43% in Singapore, a pitiful 7% in Australia and a scandalous 3% in Queensland)**

The mess we - or to be precise our youth - are in has not happened overnight, it takes time and a perverse sort of skill. So who has shown that skill? It is facile but unjust to blame the classroom teachers. Responsibility rests with the institutional power groups that lie behind and determine what happens in the classroom. Fundamental problems lie in:

- The various Boards of Study that are responsible for all syllabi and assessment systems;
- poor teacher training within university education faculties;
- trendy state education departments; and
- teacher unions who oppose verifiable assessments of student outcomes.

Collectively those groups are the four horsemen of the educational apocalypse or as I call them, "The Education Establishment".

University and upper secondary student enrolments in rigorous maths and physics have declined in all state jurisdictions. There is strong evidence from Australia and elsewhere that the declines are not entirely due to lack of job opportunities, hence there must be problems on the supply side. For example there is a shortage of engineers especially power engineers, but engineering faculties struggle to maintain reasonable enrolments without an unacceptable drop in standards.

Maths standards up to the end of Year 10 are known to be highly variable and frequently weak. Algebra, "the language of higher mathematics" and "a gatekeeper to educational opportunity" is particularly poor - a consequence of the fact that the subject is held in near derision by "The Education Establishment". Syllabi for both maths and science up to Year 10 are long on fashionable educational theory, short on content and are pitched at a low academic level. Numerical science in Years 8, 9 and 10 is almost non-existent.

The feeble condition of maths and physical science in lower secondary schooling is often covered up by staggeringly complex, unreliable and virtually meaningless assessment systems up to and including Year 10. It is certainly true that (in Queensland at least) lower secondary school education costs many hundreds of millions of dollars annually. For that investment the taxpayers, the parents and the students receive, in toto, an unknown amount of variable educational experiences with unknown and unreliable outcomes, which are of unknown value as a preparation or a predictor for success at later studies. There is a total data vacuum about student performance in all schools up to Year 10.

Queensland the "Smart State"? Wadderloader.

Much more accurate would be: "Vacuum State". Now that really would be an eye catching number plate!

All those syllabus and assessment problems to Year 10 can be sheeted home to the various State Boards of Study - which is why I put them as the first and worst horseman. Their syllabi and assessment systems are ill defined and student outcomes are unreliable and lack validity.

Moreover, for upper secondary school many syllabi in maths, physics and chemistry are vague and provide little idea of what content material and concepts are required learning. It is quite possible for

students from neighbouring schools to be following two completely different courses. The implications for tertiary faculties are serious. Assessment systems are essentially non-numerate, depend heavily on items that may or may not be the students' own work and over emphasise English. A recent Parliamentary inquiry into the education of boys recommended that:

Assessment procedures for maths and sciences must, as a first requirement, provide information about students' knowledge, skills and achievement on the subject, and not be a de facto examination of students' English comprehension.

Boys from lower socio-economic backgrounds are frequently weaker in literacy than girls of similar background and are much weaker in English than mathematics. Hence making maths and the physical sciences a "de facto test of English comprehension" is socially and sexually discriminatory.

Any improvement in participation and performance in the enabling sciences is dependent on dramatic improvements in the standards of maths and numerical science in lower secondary schooling and the construction of syllabi that ensure that outcomes are reliable, validated and defined. Those improvements will not emanate from within "The Education Establishment". Only parliaments can produce the improvements that are urgently needed. As a start they should take a club to the various Boards of Study (under whatever name). It is impossible to overstate how influential those institutions are - for good or evil. Certainly they are much more significant than either teacher unions or the public versus private debate because they determine everything in all subjects in all years and in all schools without exception.

(Then from 'Strong on the critical and weak on the thinking'. (2006))

Most of us know the apocryphal story of a proud mother watching a march-past that involved her son. "Oh look", she cried, "my Johnny is the only one in step".

The present debate about education is rather like that: the "Education Establishment" think they are the only one in step, it sees education in our schools today as being the best ever. A plethora of others - historians, geographers, mathematicians, english specialists, physicists, chemists, biologists and so on - think there are serious problems with what is happening to our children; they are all marching out of step - together. It is interesting to look at the remarks of a few of these disparate, intelligent and thoughtful out of steppers.

A recent out-of-step comment by geographer Professor Lidstone of QUT stated that "high school students are not presented with the fundamentals of geography, such as the formation of mountains or glaciers or the science behind issues such as the rain-fall cycle". He criticised the syllabi produced by the Boards of Study (the action arm of the in step Education Establishment) by stating that "integrated social studies doesn't do history well, it doesn't do geography well, it doesn't do citizenship-type things well. It quickly becomes a hodgepodge."
The number of out-of-step critics of how history is taught is substantial, many of them grumbling that it is now simply just a selection of disjointed bits and pieces. Of course history up to Year 10 exit is caught up in the so called integrated social studies referred to by Professor Lidstone.

The decline in the standard of mathematics is undoubted. In particular the standard of the great mathematical tool that is algebra is weak. Those in-steppers of the Education Establishment who doubt that statement should examine the first chapters of a Year 11 Maths B text in Queensland. They are overwhelmingly dealing with material that used to be handled in the lower secondary years.

The consequences of feeble maths in Years 8, 9 and 10 are shocking. That weakness inevitably causes a massive gap between Years 10 and 11. Even the hyper in step Queensland Studies Authority has managed to recognise that fact - albeit 20 years too late.

Enrolments in the most rigorous mathematics in Years 11 and 12 are down. Out-of-step Professor Archie Johnston, President of the Australian Council of Engineering Deans, referring to the feeble condition of engineering enrolments by domestic as opposed to overseas students at a time of high demand for engineers, stated (*The Australian,* January 11, 2006) that "the biggest hurdle is the mathematics; the demand for mathematics (in schools) has plummeted", and remarked that university training in engineering demanded a solid preparation in mathematics at school.

The problems in English are so well known as to require no further comment here except to remark that there are clearly many out-of-step people here as well.

The plight of the numerical sciences, with poor enrolments allied to and related to the non numerate condition of science up to the end of Year 10, is another discipline area that has many out of step critics. Senior science teacher Marko Voykovic, co-founder of education lobby group PLATO described science

these days as being "sand pit science". He contends that the foundations of science are not being put in place and that syllabi fail to provide content.

One of the most candid, knowledgeable and authoritative out-of-step critics of the syllabus-curriculum issue that lies at the heart of the so called education debate is Brother Michael Green, the Principal of St. Augustine's College, Cairns. He stated (*Cairns Post*, October 4, 2005) that the current education system is a flawed and discredited fad that is failing students and that the move away from a clear syllabus has meant that Queensland's curriculum has "degenerated into a confused and confusing morass where students are missing out on the basics they need". He commented on weakness in grammar, syntax, shocking habits in the setting out of arithmetic and the lack of general knowledge of basic history, geography and world events.

Brother Green also spoke with palpable sadness and anger of the fact that Queensland once led the Commonwealth in early and middle year learning but is now selling young people short. This tragic decline is a part of the overall collapse that has taken place in Queensland education over the last few years.

Another aspects of that decline was dealt with by me in a previous *On Line Opinion* article, "Floating gently on a waft of edudribble", that emphasised the fact Queensland once led the way in reliable assessment systems but has degenerated into a floppy unreliable mess. So this died-in-the-wool ex public system teacher and the principal of a Catholic school experience the same emotions. We are both out of step because we both recognise the awful damage being done to children.

The in-step Education Establishment claim that through the various Boards' syllabi they are encouraging students to think, to be critical and sceptical. Sadly for them there are out-of-steppers who think that current syllabi fail totally to do that. A recent editorial in *The Skeptic* magazine (Spring 2006 edition) emphasised the obvious idea that critical thought - scepticism - must be based on verifiable evidence. Enabling people to think critically "is not made easier by the fatuous notions pervading far too many of our education systems, luxuriating under the rubric of 'postmodernist theory'. Ostensibly aimed at fostering critical thinking, it does no such thing, being strong on the critical and weak on the thinking. By holding inter alia, that truth and facts are relative concepts, it fosters the belief that all opinions are equally worthy."

Those statements are the antithesis of material oozing from that super de luxe in-step body the Queensland Studies Authority who state in a maths syllabus "making explicit the fact that knowledge is historically, socially and culturally constructed". So pi and the exponential function are, for in-step "thinkers" historical, social and cultural constructs. Give me strength.

The QSA is essentially no different to the other Boards of Study. They are all powerful in that they determine the syllabi-assessments in every subject for every school. They are the militant wing of the in-step Education Establishment.

However sooner or later it will dawn on the various governments and oppositions that there are far more people who are out-of-step than are there are in the in-step Establishment. At that point parliamentary action will be taken to bring some sort of sanity to the Boards of Study syllabi-curriculum and associated assessment structures.

Personally I find the idea of direct government interference in such matters abhorrent. However the in-steppers have failed our children in spades and desperate situations call for desperate remedies.

But it would be preferable if Boards would reform themselves. Come on The Education Establishment.

Break step.

(I will proffer a small amount of additional evidence re condition of maths and science in lower secondary school. The origin of the work was my thesis but the quotation itself is from the House of Reps Inquiry. The quotations are from school Principals in response to request from me. Their confidentiality was guaranteed, hence the candour)

Excerpt from submission to the House of Representatives Inquiry (2004)

> Relevant, freely made, comments by principals (coded SGOV - Government, SIND - Independent, SCAT - Catholic) were:

"The abolition of the accreditation and monitoring process at Years 9 & 10 has increased the gap between Years 9/10 and 11 & 12" (SIND Mackay)

"Of greater concern is the apparent 'jump' from Year 10 Maths to Year 11 Maths A/B/C" (SGOV Sunshine Coast)

"Standards of work should be moderated at Years 6 or 7 and at Years 9/10 in at least English and Maths."(SGOV Toowoomba)

"The erosion of standards in Years 9 & 10 has been an ongoing process – even in literacy/numeracy areas." (SIND Peninsula)

"This is of concern for this school (i.e. comparability in Maths/Science) as we draw many students from another school for Years 11 & 12." (SGOV Wide Bay)

"Year 10 certificates are near worthless these days. The desirability of moderating Year 10 results is questionable and almost pointless. One area of concern is however the algebraic skills of Senior students, especially average learners. (SGOV Mackay)

"The pendulum seems to have swung too far, and students may well have been disadvantaged by impoverished courses and false confidence in their achievement levels." (SIND Brisbane South)

"Having an external motivator such as a <u>State</u> wide <u>test</u> and/or certificate would help enormously. Maybe the 'wheel' is turning again." (SIND Sunshine Coast)

"Please also highlight the lack of <u>assessment continuity</u> from 8/9/10 – 11/12 in Maths. Students would be better served if the <u>same structure</u> flowed from Junior – Senior." (SGOV South Coast)

Matters raised by principals without the stimulus of questions were teacher quality and interaction. Some comments were:

"Quality of teacher graduates a concern – do not have basic literacy and numeracy skills – especially primary teachers." (SGOV district unknown).This quotation is obviously from a 1-10 or 1-12 school.

"I believe that Maths teaching (and to a lesser extent, Science) is of less quality than it should be across the whole state." (SGOV Bris/Ipswich)

"Problem is largely one of teacher competence in the junior school." (SGOV Mount Gravatt)

"Often the quality of the programs and students' results is in direct proportion to the quality of the Head of Department in charge.". (SGOV Northern)

"Attracting and holding on to suitable Maths Science teachers should be of the highest priority by all employing authorities." (SGOV Toowoomba)

"While a consideration of the possibility of lack of comparability of standards at Year 10 is important, I suggest that the bigger issue is the lack of real teacher talk/dialogue at Years 8/9/10. No one gets to see what others are doing anymore, with the possible result that in –class teaching and learning at Years 9 & 10 is being professionally stultified."

(SIND Brisbane South)

It is crucial that the Committee does not make the mistake of thinking that the problems in Queensland are unique. They are not. For example the new mathematics syllabus for the Years up to Year 10 in NSW has an assessment 'system' (using the word very loosely) that is staggeringly complex, time consuming, non numerate and depends ultimately on something called an 'on-balance judgement'. There is no system that provides for State wide comparability and there is no apparent system that ensures any validity in the wider context. Furthermore the syllabus, on the first page, under a heading 'what is different?' states that:

There is a significant reduction in the number of outcomes from the current Mathematics 9-10 syllabus (1996) and the Mathematics Years 7-8 Syllabus outcomes (1999).

The Committee may find the content of that statement a matter of concern. They may also find the nonchalant, casual, manner of it's stating of even greater concern.

Summary and suggestion

- Enrolments at tertiary level in 'hard' maths and physics are down, a fact that is obscured by the use of statistical data that does not distinguish between the 'standard' or difficulty of two or more subjects called maths.
- The definition of 'Enabling Sciences' used by DEEWR does not chime with the excellent idea of 'hard and enabling sciences' used by your Committee.
- The inclusion of Biological Sciences in 'enabling science' gives the misleading impression that all is well. The inclusion of Astronomy compounds the problem.
- Enrolments in Years 11/12 in hard maths and the numerical science physics declined seriously in the 1990s and are now bumping along at a low level with no real sign of improvement.
- The poor enrolments in 'hard and enabling sciences' cannot possibly be ascribed entirely to demand side factors. Hence there must be supply side issues. Those issues lie within the school systems.
- Decision to take/not take hard and enabling science is made at the end of Year 10. A decision *not* to take a subject in Year 11 is almost always irreversible.
- Consequently the condition of maths and numerical science in lower secondary school is a crucial determinant of participation in 'hard and enabling' subjects.
- Australian student performances on TIMSS tests are weak. In particular the performance of the more gifted third of the population is very poor in comparison to the high flying Singapore. The percentage of Singaporean students that reach 'Advanced' level is six ***times*** the Australian percentage. Those are the very children that are most likely to go on to do 'hard and enabling sciences' in Years 11/12 and in tertiary education. We should hang our heads in shame.
- Lower school science is generally non numerate and is in that sense pre-Newtonian. It has been described as sand pit science.
- Every week whilst tutoring I help Year 11 and 12 students using old *Year 8 and 9 textbooks.* That indicates how far down we have sunk. The weakness in Year8/9 algebra in particular is a shocking problem that permeates all 'hard and enabling sciences' in Years 11/12. There are times when I could weep with rage at what has happened to these students.
- All syllabuses and assessment systems are produced by the various State Boards of Study. That statement applies to all subjects in all Years in all schools of all types.

- Boards of Study and university education faculties tend to be dominated by post modernist 'knowledge is culturally constructed' dogma. Such attitudes (I decline to use the word 'thinking') have strong and worrying similarities to pre Renaissance beliefs and are essentially anti science. (See STEM Appendix part B paragraph 1.2)
- The power of the various Boards is total. They will not make the radical changes needed to improve the standards of the hard enabling sciences because they are totally unable to see that there is a problem.
- The key is the subject syllabi and associated assessment systems. They need to be reconstructed so that the student outcomes are **Reliable, Validated and Defined.** All other issues are second order of importance at most.
- Minima 'essential learnings' are useless at best. They will do nothing whatsoever to raise the standards of the more gifted third of the students.
- I am a great admirer of democracy. I remain convinced that sooner or later the various Parliaments of Australia will exert their ultimate authority over the Boards – which are, after all creations of those Parliaments. I have been calling for Parliamentary action for several years now. I always refer to 'Parliament' not 'Government' because this is not a party political issue at all. I draw your attention to my E-Petition on this issue which calls for a major Inquiry into standards etc in Queensland. (See E-Petition Appendix)

- **I urge the Committee to institute an Inquiry with similar terms of reference to the one that 'died' before the last but one election and was not restarted. That was: "*Inquiry into participation in the enabling sciences, physics, mathematics and chemistry*". However it is worth noting that participation is inevitably linked to standards. Hence may I be so bold as to suggest that the words "*and standards*" be inserted after the word "participation"?**

Notes re the Appendices.

(1) J. Ridd thesis in full.

(2) E-Petition to Queensland Parliament asking for an Inquiry into education in the State. **This gives a good idea as to the issues that should be considered by any Inquiry into 'Hard and enabling sciences'.**

(3) Submission to House of Representatives (2004)

(4) Submission to Senate (2007)

(5) OLO article 'Wadderloader….'

(6) OLO article 'Strong on the critical ….'

(7) STEM discussion paper response for Education Queensland. Much of this is of no value to the Committee, but Part B sections 1.1, 1.2 and 1.3 may be of interest and, perhaps, amusement!