The Leaving Certificate in New South Wales from 1939 to 1962

Stephen Curtis
University of Technology, Sydney
stephen.curtis-1@uts.edu.au

High Stakes examinations used to gain entry to universities have been a formal process in New South Wales since University of Sydney was founded in 1850. This paper reviews mathematics examinations used for the Leaving Certificate from the beginning of World War II in 1939 to the start of the Wyndham Scheme in 1962. Relevant examination papers were analysed to identify changes that took place during this period; furthermore reasons for these changes will be discussed.

Introduction

Mathematics is an integral part of a general education because it enhances our understanding of the world and the quality of our participation in society through number, space, movement, arrangement and chance. Over a period of time one would expect changes to occur in mathematics examinations used to gain entry to university (high stakes examinations) due to changes in the size of population, lifestyle, technology, world events and other factors. Genovese (2002) described high stakes examinations as one way a society expresses the cognitive competencies it values. He found that examinations from the early 1900s demanded deep declarative knowledge of culturally valued information and simple interrelation between facts, whereas one hundred years later students were expected to understand complex interrelations between concepts but only superficial knowledge of culturally valued information.

Universities all over the world have a formal assessment process in place for students to gain entry to tertiary studies. During the time period discussed in this paper, the high stakes examination in New South Wales was called the Leaving Certificate.

This paper is part of a much larger study analysing mathematics examinations from 1850 to 2005 and will concentrate only on the changes that have taken place in the Leaving Certificate examinations from 1939 to 1962. This particular period was chosen for a number of reasons:

- Major world upheaval and Australia entered WWII in September 1939
- The technological revolution following the first mainframe computer in 1946
- The jump in population due to post-war migration and child birth
- The Secondary Schools Board and the Board of Senior School Studies were constituted
- The Wyndham Scheme was implemented in 1962

As well as highlighting some of the changes that have taken place in the Leaving Certificate mathematics examinations during this period, a list of possible explanations will also be presented to explain the reasons for these changes.

Mathematics from the beginning

Fehr (1972) described the evolution of mathematics as growing out of the need for understanding the physical environment thus creating systems for counting and measuring called arithmetic. This led to the idealisation of sensory physical space called Euclidian

geometry and further generations of these topics led to the study of algebra. By the 14th and 15th century arithmetic was the principal study of European universities, and with the growth of algebra as a subject in universities, arithmetic was eventually taught in secondary schools and finally in primary schools. Similarly, in the early part of the last century, calculus was taught only at universities but within the last seventy years also became a secondary school subject.

Throughout the early 1900s there was a steady growth in state secondary public education, making the state government the largest single agency and an important stakeholder in education. Pressure was placed on universities by the New South Wales government to ensure that the government had an input in the curriculum and as a consequence the first Board of Examiners was set up in 1912. This Board consisted of four officers of the Department of Public Instruction and no less than four teachers from the University of Sydney. This Board was later superseded by a new body called The Board of Secondary School Studies in 1937 and included a small representation of the independent schools (Price, 1959).

In New South Wales in 1840 only three schools were involved in secondary education. However by 1915, 3500 students attended secondary school with approximately 1,000 students attempting the Leaving Certificate, and by 1939 this number had increased to about 3000 students. Post war prosperity had kept more children in schools and coupled with the post-war baby boom and migration, this number had risen to 8000 by 1955 and was expected to reach 13 000 by 1962 (Wyndham, 1957).

Educational and curriculum reforms, 1939–1962

The period between 1939 and 1962 was dominated by Australia's involvement in WWII. Economic prosperity, full employment and industrial growth and the mobilization including the conscription of young unmarried male teachers led to a demand for educational reform. Teacher training became a matter of national importance, however the State government had difficulty in meeting the demand for places in education because of the lack of adequately trained teachers.

In New South Wales the two most vital educational reforms during this period were The Youth Welfare Act of 1940 which raised the minimum school age from 14 to 15 years and the abolition of external examinations at the end of primary school. The examination system was not coping with the large number of candidates and the limited academic interest in many of them. There was a general tendency to relax the intensity of study and defer acquisition of skills to a later stage. As a consequence in 1944 the University of Sydney removed mathematics as a matriculation requirement. Between 1944 and 1951 student numbers at university doubled due to increased government funding coupled with the idealism and enthusiasm of the post-war period.

The low birth-rate of the 1930s depression years as well as the raising of the minimum age for leaving school led to a shortage of primary school teachers by the 1950s (Barcan, 1988) and this in turn triggered declining standards in primary education. During the post war period with more choices available to graduates, there was a general lack of interest in teaching and the supply of university graduates was insufficient to meet the needs of secondary education. This led to lowering of standards in high schools. Despite this the Wyndham Report (1957) into secondary education recommended the extension of secondary school from 5 to 6 years and replaced the single examination system at the end

of the 11th year of schooling with two new external examinations, the School Certificate at the end of the 10th year of schooling and the Higher School Certificate at the end of 12th year. Wyndham was concerned whether the Leaving Certificate Examination conducted by the Board of Secondary School Studies should be continued, because of the steady increase in the number of candidates with the expectation that this number would reach well over 13 000 by 1965. However due to the decline in the quality of teachers the dilemma was to maintain or even raise academic standards.

During the 1930s and 1940s teachers of mathematics were concerned to increase the education value of their disciplines for the non-matriculant student. General courses were therefore devised for the so called 'appreciation movement', hence General Mathematics became a subject along with General Science and Social Studies (Price, 1959).

By 1950 there were added pressures on education brought about by an increasing school-age population, stimulated by immigration, a general rise in the birth-rate, the higher school leaving age and a consequent tendency for students to stay in school longer, because they were seeking opportunities for tertiary education. This resulted in an increased need for additional comprehensive secondary schools.To reduce this 'crisis' the Federal Court re-introduced State aid to Church and Independent schools (Smart, 1978).

The universities were also experiencing an academic crisis (Barcan, 1988), primarily a financial one but also because the quality of students declined after the post-war renaissance. This decline in standards was largely blamed on the youth and immaturity of incoming students. Murray (1957) recommended that tertiary institutions be classified into three categories - universities, institutes or colleges and boards of teacher education. Government influence increased along with government funding leading to the establishment of a large number of new universities (Murray, 1957).

Method

To critically analyse mathematics examination papers this study adopted a technique similar to the one used by Britton and Raizen in Examining the Examinations, and in another large research project conducted by The Third International Mathematics and Science Study (TIMSS) (Cochrane, 1999).

Britton and Raizen (Britton, 1996) compared a range of high stakes examinations in mathematics and science undertaken by students who were planning to enter colleges or universities in eight different countries. This extensive international study highlighted significant differences between the general structure of the examinations; style of the examinations; examination topics; performance expectations and difficulty.

A team of researchers in each of the countries used the same approach to compare the examinations, they considered:

- The number of questions in the paper and whether the examination was separated into different major parts;
- The time allowed for the complete paper, the suggested time to spend on each module;
- The type of questions e.g. multiple choice; standard short answer on various topics; descriptive; based on practical situations and physics based, etc.;
- Use of selection and alternatives.

In the other project conducted by The Third International Mathematics and Science Study (TIMSS) as part of the International Association of the Evaluation of Educational

Achievement (IAEA) across more than forty countries, four general categories were considered for analysis namely: understanding, using routine procedures, investigation and problem solving, and mathematical reasoning (Cochrane, 1999). TIMSS also considered the general structure of the examinations in more detail, such as the style of questions (e.g. multiple choice or free response items), essay and word phrase items, practical activity questions and use of diagrams, graphs and tables.

Techniques used to gather and analyse data in the above mentioned studies were adapted to collect and analyse data from Leaving Certificate papers produced ten years apart between 1939 and 1962. Having already analysed a large cross-section of data from a wide range of examination papers from 1850 to 2005, it was evident that the data collected from these particular Leaving Certificate examination papers produced for 1942, 1952 and 1962 were in fact a representative sample of all papers available for this twenty-three year period. During this period three or four separate sets of different level mathematics examination papers were produced to accommodate students with different learning abilities. This paper will only analyse mathematics papers containing entry-level calculus questions. This group was chosen because of the rapid growth of calculus as it became an important part of the syllabus. The selected papers were analysed according to the categories listed in Table 1.

Table 1: Areas of Analysis

General	Graphics	Style	Questioning descriptions
Subject level Duration of paper Number of questions	Diagrams Graphs Tables	Multiple Choice Short answer Descriptive Practical	Find, Prove, Show, Calculate, Verify, What is, Evaluate, Describe, Explain
List of Topics: basic arithmetic/algebra, linear functions, quadratic functions, harder algebra, locus, series, logarithms, financial mathematics, graphs, statistics, measurement, geometry, trigonometry, probability, practical and physical world, computing, calculus differentiation/integration, logs-exponentials-trig, projectile motion, simple harmonic motion, induction, binomial theorem, conics, matrix and determinants.			

Results

Description of examination papers

Between 1939 and 1962 mathematics was taught and examined in two parts, namely Mathematics I and Mathematics II and students had to attempt both papers. Furthermore, students taking Honours courses also had to attempt the Pass papers. Prior to 1950 there was not a clear distinction regarding the topics examined in each of the parts.By the 1950s however a clear separation had developed in that Mathematics I contained algebra and calculus while Mathematics II was predominantly geometry and trigonometry.

Note, in Table 2 entry-level calculus courses are shown on bold.

Table 2: Summary of all mathematics examination papers

Year	Description of Subject				
Leaving	with Calculus			without Calculus	
1932			**Maths I & Maths II Honours**	Maths I & Maths II Pass	Mathematics
1942			**Maths I & Maths II Honours**	Maths I & Maths II Pass	Mathematics
1952		Maths I & Maths II Honours	**Maths I & Maths II Pass**	General Maths	
1962	Maths I & Maths II Honours	Maths I & Maths II Pass	**Maths III Pass**	General Maths	

Duration of examination paper

Throughout the period 1939–1962 even though each individual examination paper was three hours long, the total time to complete the Leaving Certificate was generally much longer (Table 3). The Pass course included Mathematics I and Mathematics II a total of six hours, while the Honours course also included the Pass course making it a total of twelve hours.

Table 3: Duration of examination

Year	Subject	Duration (hours)
1942	Maths I & II Pass Maths I & II Honours	3 + 3 = 6 3 + 3 = 6Total = **12**
1952	Maths I & II Pass	3 + 3 = **6**
1962	Maths III	**3**

Impact of Calculus

Before 1942 only a small section of the Mathematics II Honours paper contained elementary calculus questions (Table 4). During the next 10 years a second paper was introduced at the expense of a non-calculus paper. After 1962 three sets of mathematics papers contained questions on calculus.

By 1962 calculus had been gradually increasing in content to include almost 50% of the examination for university entrance. Geometry had slipped from 40% to less than 5% by 1960. Table 4 also shows the change in emphasis in other areas: trigonometry, quadratic functions, harder algebra and logarithms.

Table 4: Relative percentage of topics tested

Year	Quad Fns	Harder Algebra	Series	Logs	**Geom**	Trig	**Calc**	Logs Exp	Binom Theorem
1942	0	10	3	0	**40**	25	**8**	7	3
1952	5	5	5	5	**34**	25	**16**	0	2
1962	8	0	5	6	**3**	16	**46**	5	5

Questioning methods

Table 5 shows the usage of the most commonly used questioning methods in the Leaving Certificate mathematics papers relative to each other for each of the years. To summarise the results values have been rounded off to the nearest 5%. A number of other questioning descriptions were also used during this period, however in relative terms they had little impact on the style of the examination papers.

Table 5: Relative percentage of commonly used questioning methods

Year	Find	Prove	Show	Calculate	Verify	What If
1942	20	60	20			
1952	40	50	10			
1962	40		25	10	5	20

Discussion

Growth of Calculus

Between 1939 and 1962 the number of questions examining topics such as basic arithmetic and algebra, quadratic functions, series, logarithms, and the binomial theorem had remained relatively constant. However topics such as geometry and trigonometry (to some extent) significantly reduced in number and even disappeared from the examinations with calculus replacing them.

The style of the entry-level calculus questions have remained constant, because the topics examined generally remained unchanged and continued to be based on the gradient function; rules for differentiation; equations of tangents; maximum and minimum turning points. This suggests that the entry-level calculus syllabus taught in secondary schools had not altered during this time period. However the percentage of the calculus content as well as the number of individual papers that contain calculus questions had increased significantly due to the introduction of additional calculus based topics. According to (Douglas, 1986) in his introduction to *Step Towards a Lean and Lively Calculus*:

> Calculus is central to the mathematical sciences, is fundamental to the study of all sciences and engineering, and belongs to the core undergraduate mathematics curriculum for all students. The rapid development of modern physical science coincided with the invention of the calculus and this symbiotic intermingling grew to include engineering and eventually the biological and social sciences.

He further stated that calculus has stood the test of time and continues to be the foundation and wellspring of most modern mathematics courses.

In New South Wales the expansion of calculus grew 'hand in hand' with the boom in technology following the post war period. The development in USA of the first mainframe computer in 1946, led to the rapid world wide growth in computer usage. Apart from scientific and engineering areas, economics and business studies also became more technically oriented because of the inevitable introduction of computing technology into almost every business sector from hospitality through to medicine, hence there was a need for further calculus to taught in schools.

Questioning methods

The school curriculum prior to WWII was largely controlled by the State Government, the Board of Examiners and the University of Sydney ((Price, 1959). However after WWII parents, teachers, the business community and community groups were showing interest in curriculum reforms based on cultural, personal, vocational, social and economic changes in the community (Brady & Kennedy, 1999).

Consequently mathematics examination papers produced from 1939 to 1952 largely requested students to express their declarative knowledge because the majority of the questions asked the students to 'find', 'prove' or 'show'. By 1962 questions were more varied with additional terminology such as 'calculate', 'verify' and 'what if' replacing the more conventional term - 'prove'. The style of the examination changed by asking the students to think about 'what if' and provide logical reasoning for solutions.

This trend was brought about by social changes such as the development of multicultural society; changing attitudes towards work; the changing status of woman; the increase of leisure time; the changing market for job skills and the increasing demand for 'further' education (Hagan, 1977). People were now encouraged to think more and to question rather than readily accept statements and comments made by the "better educated" members of society (Genovese, 2002).

Length of examinations

Entry-level calculus papers varied greatly in content from 1942 through to 1962. Whereas students in 1942 had to attempt four sets of three hour examinations, totalling 12 hours, by 1952 this was reduced to 6 hours and by 1962 this was replaced by the Mathematics III paper, covering similar topics in a single session of just 3 hours. Student numbers attempting the Leaving Certificate quadrupled during this period (Wyndham, 1957). The post war baby boom of a more affluent society and the massive influx of European and United Kingdom migrants also contributed significantly to increased numbers staying in school for their Leaving Certificate. This placed a tremendous burden on schools, the education system and the Leaving Certificate and a substantial cost and time savings could be achieved by producing fewer examination papers.

Conclusions

From 1939 to 1962 external factors such as Australia's entry in World War II in September 1939 and the subsequent national mobilisation in 1942 restricted university enrolments. These events had a significant impact on the education system. Changes to the examinations were reflected in the appearance, content and style of the mathematics papers used for the Leaving Certificate. Following WWII with the start of the technological

revolution in 1946 and the large increase in population due to post-war migration and child birth led to further changes in the Australian way of life, its social structure and values.

Many teachers were arguing to bring curriculum assessment and reporting into line with classroom practices (Withers, 1941). The Vernon report found that between 1947 and 1961 the proportion of the workforce in the professional and technical and other 'white collar' functions expanded (Marginson, 1997). This in turn was reflected in the growth of the more academic calculus content. Social changes discussed earlier in the section on 'Discussion of Findings' led educators to consider different methods of assessment. According to (Nuttall, 1986)

> Two practical, political, pressure points remain. Universities and tertiary institutions have not quite disabused themselves of the idea that they should determine senior secondary curriculum through control of its assessments

The curriculum was also substantially affected by education becoming a social and political issue with the appointment of Dr Wyndham as Director General of Education in 1952. He was initially given the task to completely review the education system in New South Wales and make recommendations for improvements to be implemented. Changes to the curriculum were also influenced by the geography and politics of our region as well as the need for understanding of the different languages and cultures of our neighbours in the Pacific Rim (Beare, 1989). Furthermore there was a reorientation of thinking by both the educational and wider community towards the emergence of new trends, such as decreasing the emphasis on restrictive subject specialization and the need for vocational training, hence the justification for less rigorous and more practically oriented courses (Nuttall, 1986). Other issues such as why so many students fail in their university studies, especially in their first year (Wyndham, 1957) have yet to be investigated.

References

Barcan, A. (1988). *Two Centuries of Education in New South Wales*. Sydney: New South Wales University Press.

Beare, H. (1989). The curriculum for the 1990s: A new package or a new spirit? Melbourne: The Australian College of Education.

Brady, L., & Kennedy, K. (1999). *Curriculum Construction*. Sydney: Prentice Hall.

Britton, E. D., Raizen, S.A. (Ed.). (1996). *Examining the Examinations*. Boston: Kluwer Academic Publishers.

Cochrane, D. (1999). A Wake-Up Call for U.S. Educators: TIMSS. *Policy Forum, v2*(n1 Spring).

Douglas, R. G. (1986). *Towards a Lean and Lively Calculus*. Washington D.C.: The Mathematical Association of America.

Fehr, H. F. (1972). Why Mathematics should be Taught in a Contemporary Setting. *Australian Mathematics Teacher, 28*(3), 79-91.

Genovese, J. E. C. (2002). Cognitive Skills Valued by Educators: Historical Content Analysis of Testing in Ohio. *The Journal of Educational Research, 96*(2), 101-114.

Hagan, J. S. (1977). *Second Interim Report of the Working Party for the Establishment of an Education Commission*. Sydney.

Marginson, S. (1997). *Educating Australia*. Melbourne: Cambridge University Press.

Nuttall, D., L. (Ed.). (1986). *Assessing Educational Achievement*. London: The Farmer Press.

Price, A. G. (Ed.). (1959). *The Humanities in Australia: A Survey with special reference to the Universities*. Sydney: Angus and Robertson.

Smart, D. (1978). *Federal Aid to Australian Schools*. St. Lucia: University of Queensland Press.

Withers, G. (1941). *From Marks to Profiles and 'Records of Achievement'*. Geelong: Deakin University.

Wyndham, H. S. (1957). *Report of the Committee Appointed to Survey Secondary Education in New South Wales*. Sydney.