

PRACTICAL REFLECTIONS ON TEACHING SENIOR SECONDARY MATHEMATICS IN VICTORIA AND THE PEOPLE'S REPUBLIC OF CHINA

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VCE Mathematics has now been taught in the PR China from 2003 in partnership between local Victorian schools, schools in the PR China and the VCAA. One such partnership involves the Peninsula School and schools in Nanjing and Tianjin. Similarities and differences in the senior secondary mathematics curriculum, assessment and pedagogy are considered, with illustrative examples from the experiences of teachers and students involved in the study of VCE Mathematics in PR China and the activities and materials they have used.

Background

The International Projects Unit of the VCAA coordinates delivery of Victorian Certificate of Education (VCE) programs offshore (HREF1). The VCAA model requires an offshore school to form a partnership with a well regarded Victorian school to create educational links. The teachers of both schools ensure that the course being delivered offshore is the same as the course delivered in the Victorian partner school. The VCE program in PR China offers a range of benefits whereby students in China are able to study the VCE without leaving their home country; have the opportunity to experience Victorian curriculum, teaching practice and assessment and also to access the VCE as an internationally recognised senior secondary qualification.

In 2009, the VCE is taught under licence from the VCAA to around 450 students across six schools in China:

- TEDA International School, Tianjin, China (since February 2003): offers MMCAS12, FM34, MM34, partner school The Peninsula School.
- Li Hui Li High School, Ningbo, Zhejiang Province (since January 2005): offers MMCAS34, partner school Haileybury College.
- Qingdao Number 19 High School, Shandong Province (since January 2006): offers FM34, MMCAS34, partner school Haileybury College.
- Nanjing Foreign Language School Xianlin Campus (since January 2006): offers FM34, MM34, MMCAS1-4, partner school The Peninsula School.
- Shude High School, Chengdu, Shichuan Province (since January 2006): offers FM34, MMCAS34, partner school Haileybury College.
- Wuhan Foreign Language School, Wuhan, Hubei Province (since January 2007): offers MMCAS34, partner school Haileybury College.
- Suzhou International Foreign Languages School (since January 2006): offers GM12, MMCAS12, partner school Box Hill TAFE.

VCE Specialist Mathematics Units 3 and 4 are not offered at any of these schools. Similarly, in 2008 the TEDA school in Tianjin offered the College Board's Advanced Placement (AP) Calculus AB subject (like Mathematical Methods/Mathematical Methods CAS) but not the AP Calculus BC subject (like Specialist Mathematics).

The Peninsula School and schools in Tianjin and Nanjing

Following the success and growth of its Tianjin VCE project at the TEDA International School (HREF2) which began in 2003, the Peninsula School (HREF3) has supported the

Nanjing Foreign Language School - Xianlin Campus to teach the VCE since 2007. The VCE subjects taught are ESL, Chinese, Further Mathematics, Mathematical Methods, Accounting and IT. The Peninsula School and its partner schools cater for around half of the 2009 cohort enrolled in VCE Mathematics in PR China. Figure 1 shows the location of Nanjing and Tianjin in PR China.

Nanjing

Nanjing, located on the Yangtze River, is an important cultural centre of China. It is a former imperial capital and the home of 37 universities. Major historical and archaeological sites are located throughout this metropolis. The city is built around extensive lakes and is bordered by verdant forested mountains which contrast the bustle of a vibrant city where a vast range of modern and traditional amenities are enjoyed. Nanjing is the capital of Jiangsu province, which is recognised throughout China for setting the highest standards for educational achievement in the country.



Figure 1: location of Nanjing and Tianjin in PR China

Nanjing Foreign Language School - Xianlin Campus

Nanjing Foreign Languages School Xianlin Campus (HREF4) is a private institution in a new precinct of Nanjing that contains several university campuses and high quality housing developments. The Xianlin Campus was established on 1 September 2003 as an extension of an older and famous school and accepts academically inclined students from all over China. The Parent school - Nanjing Foreign Language School, established in the 1960s, has distinguished itself over the years through winning major prizes in English language, public speaking and debating, and has numerous achievements in the Sciences and Humanities.

The Xianlin Campus, see Figure 2, is one of the finest educational facilities in China and is made up of primary, junior secondary and senior secondary sections.



Figure 2: Nanjing Foreign languages School, Xianlin Campus

The school has a student body of approximately 3400, divided into around 90 classes. As a key school in the region it enjoys strong support from the Government and the general public. Almost all of the students are boarders, and are generally very diligent, with a working day that runs from 0735 to 2100 hours, including supervised study time. In general, the students come from an affluent background with high parental expectations for achievement. For around \$ 12 000 these fee paying students can study VCE programs locally in China with the added support of their family and friends. This avoids the potential emotional turmoil of moving abroad and living in a foreign country at such a young age which can be quite difficult. When the students finish their VCE program they have the option of studying in China, or abroad in Australia or other countries such as Canada, the United States and the United Kingdom.

Curriculum

Both VCE and Chinese curricula are designed for a whole cohort of students, while attempting to cater for individual difference through some elements of choice. Both curricula encourage the consideration of different approaches to tackling problems and emphasise the importance of real-world connections to mathematics being studied. The role of modern technology is recognised, in particular as it supports a more comprehensive access to graphical perspectives on mathematical objects and their behaviour (Qi Chunxia, 2006). Basic knowledge of statistics and probability is introduced in the compulsory years mathematics curriculum in Australia. The media exposes children to statistics and probability through election campaigns, horse racing (Melbourne Cup), weekly lottery, and so forth. Due to this familiarity, Australian students tend not to have an aversion to statistics and probability as an area of mathematics, as many students in China do. However, once this aversion is overcome, with enough study the Chinese students become similarly comfortable and capable in this area as Australian students.

The VCE curriculum focuses on process while the Chinese curriculum focuses on knowledge. In China, within each province there is a prescribed supporting text for the curriculum (HREF5). While in Victoria teachers have choice between a range of possible texts and the selected text can vary from school to school, and change within a school over a period of several years. Teachers at schools in Victoria have more autonomy with respect to curriculum (Xu Xilai, 2003). Chinese students will have established a relatively complete and robust knowledge system prior to commencing their senior secondary study.

The VCE mathematics curriculum structure provides flexibility for combination of mathematics subjects, each with their own internal coherence. In Jiangsu province teaching materials are structured in two parts: the compulsory course and the elective course. The compulsory course are those topics required for each student which includes five parts. These are sets and the function concept, basic elementary functions (exponential, logarithmic and power), elementary solid geometry, elementary plane analytic geometry, elementary algorithm, statistics, probability, other elementary functions (circular/trigonometric functions), vectors in two dimensions, circular function (trigonometric identities, sine and cosine rules, sequences, inequalities). In the elective course, students can choose options according to personal interest and pathways for future development. Elective course includes: derivative, case study of statistics, introductory complex numbers, the vector in space and solid geometry, counting principles, probability, and matrices (HREF6). On balance in China there is a greater emphasis on geometry in contrast to a greater emphasis on calculus in VCE.

Assessment

In both systems daily work, attendance performance in class and homework are important, and inform decision about satisfactory completion or graduation. Final examinations make the major contribution to summative assessment. The VCE has a broader assessment regime, with both school based (coursework) and external (examination) components of the total assessment.

The conditions under which VCE examinations are taken are more flexible in that students are permitted to use a graphics calculator or CAS technology for both Further Mathematics examinations and a graphics calculator for Examination 2 of Mathematical Methods (CAS for Examination 2 of Mathematical Methods CAS).

In China, only students in Shanghai have been able to use calculators over the past several years.

In Victoria examinations questions are designed on a 'build-up' basis with students progressively rewarded for insight by economy/elegance of response. In China examination questions are designed to be comprehensive with hidden conditions, various methods required and needing insight into mathematical complexity.

Teaching and learning

VCE students move from class to class across their studies, like at university, while Chinese students undertake all of their studies in the same class. In mathematics class, VCE teachers talk less than Chinese teachers do, and students have plenty of time to practice. In an eighty minutes lesson, if the content is not difficult for students, the teacher will only speak for twenty minutes, and the remaining time is for students to practice with individual teacher assistance. More recently in China, teachers are trying to talk less in the lesson and provide more chances for students to explore. The role of teachers in class becomes more of an initiator and facilitator, with student work as the main body of study.

VCE students have plenty of time for their homework, and are expected to complete summaries themselves. They don't need to hand in homework everyday, instead teachers follow up on, and explain, some difficult problems at the beginning of the class. In China, teachers give homework everyday and require students to complete it in the same day. Teachers spend a large amount of time correcting mistakes in student homework. There are a variety of teaching approaches and contexts when teaching mathematics, both in China and in the VCE, which consider real life applications and cover different aspects of society. VCE mathematics emphasizes the development of mathematical ability and breadth of idea. Chinese mathematics focuses on the details of knowledge points that could be used to solve problems.

Mathematics education in China put emphasis on logical reasoning proof, calculating and the conscientious feature of thinking. Because of the strong emphasis on deduction and proof, many Chinese students feel that it is difficult to study mathematics. Each topic begins with the concept and definition, only after a period of study, can they gradually find the ingenious point of the definition. To some extent, this kind of mode is not good for cultivating student's interest in mathematics, and only the students who finish introductory study can set up a firm foundation for their further study. (Xu Xilai, 2003). VCE mathematics teaching has a 'spiral' basis. First is the basic concept, and then property, and then its application. High school education in Australia pays attention to students' development in all aspects. Realistic demands are a key consideration of education. VCE mathematics teaching is close to the society and emphasizes thinking creatively, the ability to handle information, and to solve problems innovatively. Generally speaking, students are skilful in obtaining information from the real world, but have difficulty to dealing with some pure mathematics questions. For example, consider the idea of a monotone (strictly) increasing function. In VCE Mathematics, students would likely use a graphical approach and/or the sign of the derivative to show that a function is increasing over an interval. Chinese mathematics requires students to be familiar with the algebraic approach to prove it according to the function. That is, given the function $y = f(x)$ with its natural domain, then f is increasing over a given interval if, for any x_1 and x_2 in this interval such that $x_1 < x_2$ then $f(x_1) < f(x_2)$.

Concluding remarks

The authors of this paper have, between them, worked with Australian students, Chinese students in Australia, and Chinese students undertaking local and VCE mathematics studies in PR China. The students undertaking the VCE program in Nanjing China typically study English as a Second Language, Chinese, IT and Accounting as well as Further Mathematics (Number patterns, Geometry and trigonometry and Graphs and relations modules) and/or Mathematical Methods, but not Specialist Mathematics. The authors have observed that their Chinese students find the local mathematics curriculum more demanding than these VCE Mathematics studies. However, they also find the VCE emphasis on formulation, modeling and interpretation, with its higher level on language demand challenging. Aspects of the English language such as the use of the definite and indefinite articles, and prepositions cause difficulty for Chinese students in grasping mathematical concepts such as the words 'to' and 'from'. For example, the true bearing from 'point A' to 'point B' can be easily confused with the true bearing from 'point B' to 'point A'. A similar case occurs when referring to angles such as 'elevation' and 'depression' – Chinese

students do not readily relate these words with the simple concept of 'up' and 'down'.

Australian students are inclined to experiment with technology such as a graphics calculator to tackle a problem, even if mathematics is not their strength. However Chinese students who are not strong in mathematics do not show such interest in availing themselves of the technology for this purpose. Many of the Chinese students undertook concurrent study of Further Mathematics and Mathematical Methods, and have reported from subsequent study at Australian universities that this was an advantageous combination, providing a thorough understanding from both statistical and probability perspectives of the normal distribution. The Chinese authors note that: "VCE mathematics is close to daily life, nimble in method, and emphasises its application" and "students can bring their initiative and creation into full play if they wish". They also note that Chinese mathematics has a strong logical system, which values mathematical theory. Students have strong cultural expectations of diligence placed on them to develop a firm foundation and proficient ability in calculating and reasoning. With more collaborative work and joint research in mathematics education, educators and students in Australia and China could enjoy the benefits of both approaches more fully.

References

Qi Chunxia (2006) The Characteristics of Australian mathematics Curriculum and its Implication to China. *Comparative Education Review*. (7)_82

Xu Xilai (2003) Comparing mathematics education in China and Australia. *Basic Education Review*. (6)_38

Websites

HREF1: <http://www.vcaa.vic.edu.au/schooladmin/international/index.html>, International Projects for Schools and Educators, Victorian Curriculum and Assessment Authority

HREF2: <http://www.tedainternationalschool.net/> TEDA International School, Tianjin.

HREF3: <http://www.tps.vic.edu.au/>, The Peninsula School, Victoria

HREF4: <http://www.e-jobfair.com/070115/njxl.htm>, Nanjing Foreign Language School, Xianlin Campus, E-Jobfair

HREF5: <http://math.cersp.com/CourseStandard/HEDU/200609/390.html>

HREF6: <http://www.shulihua.net/Html/Article/Shuxue/672.html>