Aligned Instructional Systems:

Shanghai

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History and background: China

Mao Zedong's death in 1976 marked the end of the Cultural Revolution. Formally the Proletariat Cultural Revolution, Mao instituted it in 1966 as a national political campaign to eliminate all bourgeois influences in China's superstructure (as opposed to the economic infrastructure). All symbols of bourgeois culture, such as music, drama, opera and novels, were under threat, and replaced with activities rooted in proletariat ideology based on a few model prototypes (OECD 2010).

Among the revolution's consequences was the closing down of conventional schools. They were replaced with schools led by political teams of workers, peasants and soldiers, and the curriculum was totally revamped to reflect the essence of class struggle. Universities were suspended, replaced by new institutions admitting only workers, peasants and soldiers regardless of their academic merit. Professors, teachers and intellectuals were sent to factories, villages and remote places to be 're-educated'. Rebuilding the education system over the past thirty-plus years has been a daunting task for the Chinese. During the 10 years of the Cultural Revolution 160 million young people did not receive a high quality education (Reed 1988).

The reconstruction of education

In 1978 schools resumed normal activities, concentrating especially on mathematics and the sciences at first. A milestone in education development was the resumption of university admissions in 1977 based on the results of entrance examinations, when many of those enrolled were mature students who had been shut out during the Cultural Revolution. At the same time, peasants were eager to build their own schools in the villages. This led to a decision in 1980 to allow local non-government financing of schools as a way of mobilizing community resources. This paved the way for a major reform and decentralization of education in 1985. There was an immediate mushrooming of schools and the target of universal primary education was achieved in just a few years.

In 1986, China enacted the *Law of Compulsory Education*, which required every child to complete nine years of formal schooling – six years of primary school and three years of junior secondary school (with some experimentation with a five + four model). In 1980 cities such as Shanghai, with their growing non-state enterprise sector, started pioneering new types of vocational schools that did not guarantee or assign jobs. This was a significant step away from the strict manpower planning that had been an integral part of the planned economy. By 1997, formal assignment of jobs to graduates disappeared from all levels of the education system, and in 1982 China established a degree system for higher education that followed the Western model more closely than previously. A *Principal Responsibility System* was also introduced during this period, which, for elementary and secondary schools at least gave much more authority to school leaders and limited the role of party officials to moral education and political activities. For higher education, however, party officials still maintained a great deal of power (Lin 1993). It was not until 1988, however, that China moved away from uniform national textbooks to experiment with some diversity in textbooks, partially to address issues of inequality among regions. Textbook diversification allowed for somewhat different interpretations of the centralized syllabuses, and there were attempts, for example in Shanghai, to create new syllabi within the centralized framework (OECD 2010).

The *Revised Law of Compulsory Education*, enacted in 2006, established differential central government subsidies to different regions of varied economic capacities. This marked the government's determination to sustain universal basic education, and hence paved the way for more energetic reforms in educational quality.

Recent developments

The emphasis in the first decade of the 21st century has been the expansion of higher education. Starting in 1998, China broke away from its long-standing policy of restricting higher education to a small percentage of the population and launched a spectacular expansion that has had immense implications for the entire education system. On the one hand, there is visible graduate unemployment, particularly in the major metropolitan areas, while on the other hand, the rapid expansion of higher education has created a new level of desire for academic studies, inducing remarkably high enrollment in academic senior secondary schools and lowering enrollment in vocational schools.

The picture would not be complete without including China's complex structure of lifelong learning, which includes full-time sabbatical study, evening spare-time programs, distance learning programs and self-study examinations. Such learning opportunities often lead to formal credentials such as certificates and diplomas, and sometimes to degrees. Those that operate these schemes range from major institutions of higher education (as their extension programs) to individual professionals and private for-profit enterprises (OECD 2010).

Shanghai

Shanghai, one of four municipalities directly under central government control, is China's financial hub and the area with its highest GDP. With a population of over 20 million people, it is China's largest city. It cannot be looked upon as typical of Chinese cities – like Hong Kong, it is at the forefront of social, economic and educational developments and has a special status within the Republic. Shanghai historically had a reputation for pioneering practices and has been given a high degree of autonomy in educational policy and practice, especially in the area of curriculum reform (Tan 2013). In 2012 Shanghai educated 1,837,800 students in 2,964 primary and secondary schools. Its government is favorably disposed toward private schools, both primary and secondary, with policies emphasizing "adequate encouragement, strong support, proper guidance, and reinforced management" (Jinjie 2012, 6). Shanghai has 148 private primary and secondary schools, comprising a little over 10% of all basic education institutions.

Almost 100% of children benefit from nine years of compulsory education and 96% go on to upper secondary school. More than 80% of its cohort goes on to tertiary education nationwide – 55,000 students took the college entrance examination (*gaokao*) in 2012. Teaching and administrative staff includes 48,900 people in primary (of whom 48,100 were full-time teachers) and 75,800 in secondary (51,800 full time teachers). The education budget in 2012 was about 70 billion yuan, or over 11 billion US dollars, 25% of which was reserved for higher education (Information Office of Shanghai Municipality 2012, Tan 2013).

The founding of the People's Republic of China in 1949 opened a new era for educational development in Shanghai. The First Five Year Plan witnessed the establishment of many new schools there. The new government adopted the education policy that mass education was for ordinary people, thus popularizing education for the working people. Especially with the promotion of work and farm study programs, vocational education witnessed a strong boost. As a result, both primary schooling and secondary education underwent a period of rapid development. By 1981, there were total 832,200 students in primary schools and 499,300 students in secondary schools in Shanghai. In compliance with the *Law of Compulsory Education* enacted in 1985, which required every child to complete nine years of formal schooling, Shanghai was among the first cities in China to achieve universal primary and secondary education. In 1980, Shanghai started pioneering new types of vocational schools, shifting from the strict manpower planning that had been an integral part of the planned economy to market oriented economy system (OECD 2010).

Innovation and Challenges: 1990s to the Present

Since the 1990s Shanghai's educational focus has shifted from quantity to quality. In recent years, facing new requirements for city development and new expectations that people place on education, Shanghai's basic education is heading toward new stage of development with emphasis on both excellent quality and equity, as enshrined in the Chinese government's policy document of 2010, *The National Guidelines for Medium-and Long-Term Educational Reform and Development 2010–2020* (Ministry of Education of the PRC, 2010). Overall the strategy up to 2020 is to develop a more student-centered and innovative education, three goals of which are to modernize, institute a learning society and build up human resources (Walker & Qian 2013). For the first time, the steps taken to formulate a national education policy included a process of open consultation with the public. It faces three major challenges: first, disparity in quality between urban and suburban schools; second, disparity in educational conditions for native Shanghai students and recent migrant students introduced by large number of migrant laborers surging into Shanghai; third, variance between schools caused by historical traditions and professional quality of principals and teachers (Jinjie 2012).

Walker and Qian (2012) question whether reforms in China have truly taken off. They believe that rather than alleviate some of the burdens on students, the reforms have actually accentuated them. They also argue that even though curriculum reforms have been in place since 2001, teaching remains much as it was before and that there is not much teaching for creativity and critical thinking. Instead of making those who run and teach in schools more confident, they posit that the reforms have been very unsettling. For example, they cite schools' attempts to get around the introduction of the inquiry based curriculum by faking documentation to show they have instituted it (Walker & Qian 2012, p. 169). Citing press reports from the *Shanghai Evening News* and the *People's Daily*, they report that some schools have resorted to two separate timetables – the public one that is full of inquiry-based learning, music, P.E., etc. and the one actually followed, which is dominated by examination-based courses (p.176). They do acknowledge that in some urban areas, this is less the case; in Shanghai, Tan (2011, 2012, 2013) would dispute Walker and Qian's thesis. She argues that current curriculum reforms, while imperfect, rest on three breakthroughs – reducing schoolwork to increase quality, strengthening basic education and raising quality through character development (Tan 2013). She stresses Shanghai's internationalism, its focus on IT and its innovative spirit, and writes that Shanghai has managed to take learning beyond examinations and into community involvement and service. Law reminds us that curriculum reform in China has to struggle with dual emphases – trying to make China more globally competitive while still ensuring that students develop a well-honed sense of patriotism to China and the PRC (Law 2014). He argues that intended changes have been undermined by students' workload and pressure to do well on examinations, "vicious" assessment cycles and the cumulative effects of socio-cultural psychology that values results above all else on the part of all stakeholders – parents, students, teachers, schools and local governments (Law 2014, 351).

The remarkable success of Shanghai in the PISA tests in 2009 and 2012 has thrust Shanghai into a position of international prominence. For all those who see Shanghai as a model for other jurisdictions there are those that denigrate its successes. Among its supporters, Zhang and Kong suggest that there are both traditional and contemporary factors at play, including high parental expectations, students' belief in the power of effort, and China's personnel selection mechanism together with the openness of Chinese education, curriculum and teaching reform, teacher training, improvement of comparatively poor schools, financial resources allocation mechanism in compulsory education, and reform of high school enrolment (Zhang & Kong, 2012).

Shanghai has recently redoubled its efforts to teach students the new knowledge and skills demanded by the 21st century global economy. It does so in the face of a traditional examinations and learning culture that emphasizes the mastery of the teacher (Tan 2013).

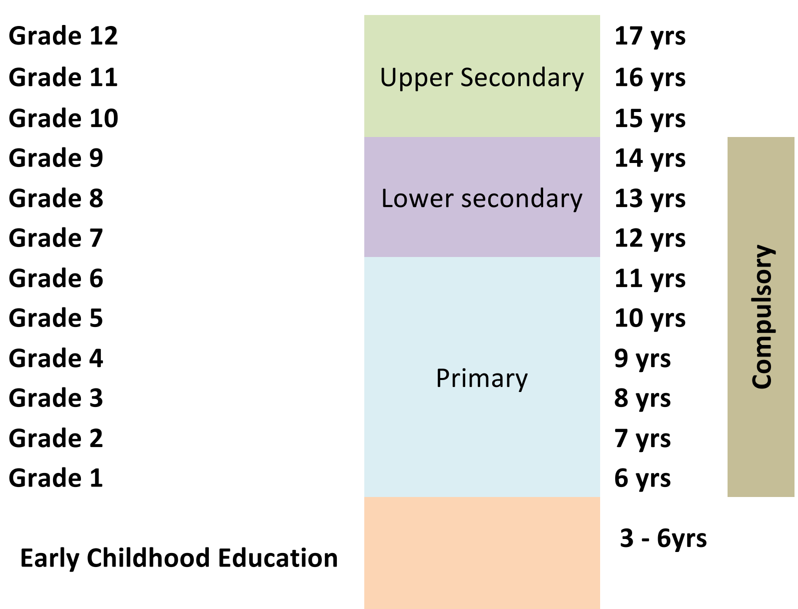
Structure of educational system

Children are required to attend six years of primary school and three years of lower secondary school. At age 15, students have the option of either leaving school or entering upper secondary programs. In order to gain a place at upper secondary, students must take a locally administered entrance exam known as *zhongkao*. Based on *zhongkao* results students enter either an academic or a vocational upper secondary school.

In upper secondary school, students take three years of classes in core and elective subjects in preparation for the nationally based university entrance exam, known as *gaokao*. Vocational schools offer coursework for two to four years in a number of occupational areas, including skills for managerial and technical personnel as well as in more traditional vocations such as agriculture.

Structure and Management of Basic Education in Shanghai
Shanghai was the first city in China to put into place and make universal the nine year compulsory education system. Shanghai follows a 5+4+3 format: five years of primary school, followed by four years of lower secondary school and three years of senior high school, which is different from the rest of China's 6+3+3. There are also schools that carry out nine years of continuous schooling, which combine primary and lower secondary schools. There are also some schools that combine lower and upper secondary schooling.

Shanghai school structure



School year

Chinese schools generally operate on a two-semester system, with one starting in September and the other in March.

There are two main holidays in the school year: the summer vacation and the winter vacation. The winter vacation cuts the school year in half and lasts for approximately one month, and it includes the Spring Festival which last for 15 days. The summer vacation starts at around the beginning of July and lasts approximately two months. Term times vary across the country, with some rural areas altering term times to accommodate the farming community. Shanghai's school year is 40 weeks long.

Education for Migrant Children

Shanghai's vibrant economy has meant that many migrant workers and their families live and work there. In 2006 80% of migrant children were of school age, and those who studied in Shanghai schools made up 21.4% of the entire student population at the compulsory level (Ding, 2010). Basic, that is compulsory, education from ages six to 15 is the responsibility of the recipient city and the aim is to have migrant children educated mainly within the public school system. However, there has been some reluctance on the part of local government to fund migrant workers' children's education and some parents balk at having their children educated side by side with migrant children. In 2008, the Shanghai municipal government launched a policy aimed at integrating migrant children into the education system, which has meant that many migrant children have received free compulsory education in public (around 74%) and private (around 26%) schools (Jinjie 2012).

However, migrant children who want to attend upper secondary need to do so in the province of their parents' birth, since the *gaokao* test is different from Shanghai. This means that relatively better off children of native Shanghai parents are overly represented in PISA tests, where Shanghai outscores all other nations. According to Tom Loveless of the Brookings Institute, only 36.5% of predicted numbers of 15 year olds, based on the OECD's average expected percentage, took the 2012 PISA tests (Loveless 2014). The OECD countered that the effects of the system of returning migrant children to their home districts were not significant, although Andreas Schleicher admitted to a House of Commons Education Select Committee in England in early 2014 that only 73% of Shanghai's 15 year olds were represented in the PISA tests, compared with around 90% for OECD countries (W. Stewart 2014) However, this assertion has been vehemently rebutted by Zhang Minxuan (2013). At the time of this writing the controversy continues.

Policy, aims and vision

Shanghai's school system reflects the overall educational aims and objectives of Chinese government policy, which include:

- abandoning the system of "key schools" for a small elite; this was replaced by an inclusive system in which all students are expected to perform at high levels
- raising standards and pay for teachers
- moving from the system of rote learning, and emphasizing more on gaining deeper understanding, thinking critically and applying knowledge to solve new problems
- greater curricular choice for students
- more latitude for local authorities, such as Shanghai, to decide examination content.

There is greater focus on the following aspects:

- provision of content and support for student learning
- teaching and teachers
- school facilities
- systemic strategies.

Shanghai's basic education system aims to reinforce *quality* and *equity*. However, the education system faces the challenges of:

- disparity in quality between urban and suburban schools
- disparity in educational conditions for native Shanghai students and recent migrant students
- variation between schools caused by historical traditions
- variations in the professional quality of principals and teachers (OECD 2010).

Twenty First Century Skills

Since 1988 Shanghai has undergone large-scale curriculum reform with the aim of transforming students from passive recipients of knowledge to active participants in learning, so as to improve their capacity for creativity and self-development and to fully achieve their potential. Schools are encouraged to develop their own curricular materials to fit with their local conditions. The new curriculum has three components: basic curriculum – for all students; enriched curriculum – based on elective subjects; and inquiry-based curriculum – mainly implemented through extra-curricular activities (see also Curriculum Overview). Students engage in all kinds of extracurricular activities in sports and the arts, where they are expected to learn organization and leadership. Students are also assigned teamwork activities. Visiting rural villages or deprived social groups gives them experience of social or service learning. All these activities are coordinated by the municipal education authority (OECD 2010).

Overall, the curriculum reform involves broadening students' learning experiences, enhancing the relevance of subjects by relating them to broader human and social issues, and concentrating on the development of capability rather than accumulation of information and knowledge (OECD 2010). Since 2008, a new, inquiry-based curriculum has been implemented throughout the city, which, with teacher support and guidance, asks students to identify research topics based on their experiences. It is hoped that through independent learning and exploration, students can learn to learn, to think creatively and critically, to participate in social life and to promote social welfare. These reforms are reflected in pedagogical as well as assessment reforms. Although not referred to specifically as such, the aim of these reforms fits with the twenty first century skills agenda and aims at the implementation of these skills, strategies and attitudes (OECD 2010).

Pedagogy and Assessment

Curricular reform has been accompanied by developments in teacher education and professional development. Shanghai was the first district in China to require continuous professional development (CPD) for teachers. Every teacher is expected to engage in 240 hours of professional development within five years. A web-based platform was constructed and implemented since 2008 to share best practices of curriculum design, development and implementation. The website contains resources for curriculum development and learning, success stories of curriculum implementation, and research papers on teaching and learning (OECD 2010).

According to Vivien Stewart (2014), Shanghai does not have an overarching framework for measuring 21st century skills but is using PISA-type tests of problem-solving as a way to shift schools in the direction of modern skills and pedagogy.

In Shanghai's (as in Singapore) mathematics classrooms, teachers ask students to work on problems at the board, not expecting all students to get the right answer. The purpose is that the effort of those at the board will help other students understand the problem and develop their broader mathematical understanding, rather than to focus on getting the right answer (Boix-Mansilla & Jackson 2011, in Saavedra & Orfen 2012).

Since 1985, Shanghai has produced integrated examination papers that cross disciplinary boundaries and test students' capacity to apply their knowledge to real-life problems. Sometimes examination questions provide students with information not covered in the syllabuses in order to test their abilities in applying what they know to new problems (OECD 2010). Shanghai education experts believe that training students to transfer their knowledge and skills to real problems contributed to their 2009 PISA success (Saavedra & Orfen 2012).

Teachers use IT to develop and share best practices. In Shanghai student teachers use *Teaching and Learning e-Portfolios* to develop their pedagogical, content and experience-based understanding. A professional development program was introduced in 2008 to support teacher learning of 21st century competencies, placing an emphasis on schools becoming "cultures of thinking for teachers" where teachers have time to observe other teachers' classrooms regularly. Teacher observations have long been a common practice in Shanghai and borrowing effective lessons is considered a form of creativity (Saavedra & Orfen 2012, 21).

Shanghai's high performance in PISA 2009 and 2012 would appear to show that students are now exposed to a much broader knowledge base and are trained to integrate their knowledge and tackle real-life problems and to make open-ended explorations. However, according to the OECD (2010), educators are critical of the quality of the education system in that the dictates of the examination system leave little room for students' learning on their own and autonomy in their study. However, assessment has changed dramatically from the traditional Chinese focus on learning by rote and rehashing what they had learned at examinations.

Governance

Shanghai has provincial status and is made up of 16 districts and one county. The Chinese Ministry of Education (MoE) retains central authority over key areas such as formulating policy and establishing the national curriculum. However, some responsibilities have devolved to localities, such as the ability to develop provincial curricula and course materials (Lam 2010). This complements Shanghai's traditional autonomy.

The Shanghai Municipal Education Commission (SMEC) is the main governing body for education in the province. Its main functions are maintaining internal structures and personnel management in accordance with overall PRC government legislation.

Some of its main functions in the primary and secondary arenas are:

- to implement laws, regulations, rules and policies of education
- to study and draw out the drafts of local laws, regulations and policies of educational work as well as organize and implement relevant local laws, regulations and policies
- to research, propose and promulgate the educational development and reform strategy for Shanghai and compile development plans and annual plans of various types and levels of education according to the overall planning of economic and social development of Shanghai
- to guide and coordinate the implementation of educational planning and programs
- to conduct overall planning and macro management of pre-school education, basic education, higher education, vocational and technical education, lifelong education, etc.
- to carry out overall planning, coordination and direction of the education system, school-running system and comprehensive reform of education and teaching as well as coordinate and manage the work of central ministries and commissions concerning universities in Shanghai
- to boost balanced development of compulsory education, provide rural areas and outer suburbs with more and better public educational resources as well as promote fairness in education
- to direct the development and reform of employment-oriented vocational education, compile professional catalogues, teaching guidance documents and teaching evaluation criteria of secondary vocational education as well as guide the teaching material improvement and vocational guidance of secondary vocational education
- to guide and promote the construction of a learning society, take charge of life-long education, manage all kinds of non-academic education and direct the work of eliminating illiteracy
- to formulate the demands of setting, relevant standards and basic teaching requirements of various secondary, primary and pre-primary schools together with relevant departments, organize the compilation, examination and confirmation of the unified textbooks of middle and elementary schools as well as draw out the planning of educational technology equipment and the supporting standards; to organize the work of educational supervision and assessment

- to guide ideological and political work, moral education, sports, health and art education as well as national defense education of schools at all levels in Shanghai
- to direct the development and construction of the scientific and technological innovation platform of institutions of higher education
- to conduct macro-management of teacher qualification
- to guide and coordinate the organization and implementation of the employment system of professional technical positions involved in education (Shanghai Municipal Government 2010).

In other words, much of the education system in Shanghai is highly centralized.

Decentralizing at District/County Level

There are, however, some aspects of decentralization. The Commission has delegated power to districts and county in the following aspects:

- the approval of establishment, annulment, and modification of private secondary vocational schools, primary and secondary schools, and kindergartens
- the formulation and implementation of continuing education for teachers from junior high schools, primary schools, and kindergartens
- the appraisal of professional titles for teachers in kindergartens, primary, and secondary schools
- the enrolment, registration, and daily instruction of regular high schools, professional high schools, senior and junior high schools for adults
- the annual inspection and appraisal of experimental or model senior high schools under different administrative bodies are carried out at the district/county levels according to the requirement set by the municipal education commission (Shanghai Municipal Government 2010).
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Textbooks

In the late 1980s the State Education Commission loosened its grip over school textbooks and instituted the *One Guide Multiple Textbooks* policy, which offers more choice of primary and secondary school textbooks. In 1988 Shanghai established the *Curriculum and Teaching Material Reform Commission for Primary and Secondary Schools*, which is a fundamental part of the city's comprehensive curriculum reform. Since that time, Shanghai has allowed some diversity in textbook and teaching material selection (Jinjie 2012).

Accountability

Shanghai values quality in education and has systems of quality assurance in the managerial sense, with no shortage of performance indicators and appraisal mechanisms. The education system is basically transparent which means that parents have some influence on schools, both through their choice of schools and through the media, which report frequently on education-based issues. Parents receive constant feedback from their children's schools, often through technological means. Principals and teachers therefore must balance administrative accountability, client accountability and professional accountability. The Chinese Ministry of Education has recently (2012) accentuated principal accountability by adding five items into their professional standards: prevention of increasing the difficulty of the curriculum; decreasing the time students study; discouraging undue emphasis on academic performance; preventing teachers from offering paid-for tutorials; and preventing promotion of commercial goods and services to students (Law 2014).

Each school has a three year development plan and must produce yearly implementation plans. The municipal government sends in inspectors to ensure that schools carry out these plans and schools also self-appraise. Each school reports back to the supervisory office every term about its targets for school conditions, management and school quality (Tan 2013). In regard to the teacher management target, schools are assessed on the "teaching-research system for lesson preparation, lesson delivery, lesson appraisal, system for student school work inspection, system for teaching quality assurance" (Tan 2013 p 102). Schools are held accountable for how well they carry out the second phase of educational reform, which features nurturing students' innovative spirit, practical ability and character development as well as examination preparation (Tan 2013).

> Dealing with the wider environment is seen as an integral part of professional responsibilities, and this sense of accountability is built into programs of teacher preparation, teachers' continuing professional development and training for school leadership. Hence, accountability is not regarded as a separate machinery to assure quality (OECD 2010, p. 108).

Setting standards

As elaborated above, education management in Shanghai is carried out through the *Two Tier Government, Two Tier Management* system. Under this framework, Shanghai's municipal government and education commission are responsible for policy making, supervision, monitoring and evaluating of schools' performance. Local governments at the district/county level are responsible for the implementation of school reform and development. Education planning has been carried out through a series of five year plans dating back to the inception of the PRC. During the Ninth Five Year Plan (from 1996) the government called for a re-orientation of teacher training from an examinations orientation to an all around quality education system (Walker & Qian 2013). In The Tenth Five Year Plan period that started in 2001, Shanghai tried to establish closer ties among educational institutions, government, and society by means of transforming government functions, streamlining administration, delegating power, and improving service packages (Jinjie 2012).

Tan (2013) characterizes the system as “decentralized centralism” (p. 92). Shanghai has more leeway in setting educational standards and instituting curriculum reform than most of China, but its policies must still support the central government’s educational ideology. So while schools have some leeway to localize some of their curriculum offer, that leeway does not extend to the foundational (compulsory) examination courses that the municipal government controls (see above).

Teacher training

National teacher training policies

During the Cultural Revolution educated people were often sent to rural villages, where they became teachers, even though they were unqualified and paid very little. Many of these rural teachers were retrained in the 1980s, which led to them returning to the cities in search of better pay and conditions. Rural schools are still less well supplied with teachers than urban ones (OECD 2010).

Teaching is a respected profession in China although teachers’ salaries are not very high on the mainland. Some *Normal* universities in the rural west of China have instituted a free teacher-education plan where students sign contracts promising to become teachers after graduation. If they do not go into teaching they are required to return the tuition fees and living expenses.

Teachers are able to supplement their incomes by taking on additional work both in school and outside it. Teachers’ initial training is more subject-based than it is in the US and teachers have to undergo more subject training than their US counterparts before being accepted onto a teacher training program (Tan 2013).

The system in which Chinese teachers teach is formalized and structured. Ong characterizes China’s education reforms as “opportunistically combined with the socialist state’s aspirations to produce self-reliant but state-dominant professionals” (quoted in Tan 2013, 84). They interact with their subject colleagues far more than in the US, primarily through study groups where all of the teachers of that subject meet together and create very detailed lesson plans that they all will follow. These lesson plans are used to document teachers’ performance and it is not unusual for a lesson to be observed by the school principal as well as district education officials, especially if the teacher is being considered for a promotion or for an award. This emphasis on planning means that teachers spend a great deal of time in lesson planning and practice. In exchange, teachers teach far fewer hours than their US counterparts, perhaps only 12 to 15 classes per week; teachers spend almost as much time preparing as teaching (Tan 2013). Class sizes, however, are much bigger than in the US; the Shanghai Municipal Education

Commission stipulates that class size should be fewer than 40, with an average class size of 35. However, some schools that accept the accompanying children of rural workers/ migrant workers are permitted to increase the class size appropriately, if they have any difficulties.

The study groups are governed by local and regional "teaching and research offices" (教研室), which are in turn supervised by a parallel office in the provincial or municipal education department. Ultimately they report to the Basic Education Department within the Ministry of Education. That department is responsible for curriculum development, textbooks, pedagogy and school management for all of China.

Observation is not limited to principals and other authority figures. It is commonplace for teachers to be observed by peers or by less experienced teachers who they might be officially mentoring. Sometimes teachers carry out public lessons for large groups of teachers to observe and comment on, which is regarded as invaluable professional development both for the person teaching and for those commenting.

Chinese teachers are classified into four hierarchical grades according to their years of service and standard of performance; district education bureaus decide how many teachers of each grade will teach in individual schools (Salleh & Tan 2013). The grades are:

- Third-grade or novice teachers
- Second-grade teachers who have at least three to five years of service and are internally evaluated by their schools
- First-grade teachers who have at least five years of service and are both internally evaluated at the school level and externally evaluated at the district level
- Senior-grade teachers who have at least five years of service and, like first-grade teachers are both internally and externally evaluated.

Aside from these, excellent teachers can receive honorary titles of *gugan* (backbone) and *teji* (special-grade). The former are experienced teachers of at least Second-grade (about 30% of the workforce; the latter are recognized for their outstanding teaching and leadership. They have generally taught for many years and are known for their successful and innovative practices and initiatives.

In order to pass from one grade to the next, teachers need to prove that they have contributed something tangible to the teaching community – mentoring new teachers, writing for publication, winning prizes. Tan (2013) argues that Shanghai teachers are encouraged to compete and that school-based professional development is both a vehicle for growth and a disciplinary mechanism. Teachers' pay has three components: a job allowance; a workload allowance; and performance bonuses. The first is standardized, the second depends on the school and the third is generated from the teacher's appraisal, in which teachers are judged on their "morality, ability, diligence, results and honesty" (Tan 2013, 209).

Pre-service and in-service teacher training in Shanghai

In 2001 the Shanghai Municipal Government overhauled its teacher training requirement, with an eye to improving the overall quality of teachers throughout the system. As a result, many more teachers than in the past have a bachelor's or higher degree and teachers are required to have a teaching certificate, which is differentiated depending on what level and what subject the person teaches. The current requirements for a teaching certificate stipulate that: kindergarten and primary school teachers much have graduated from, at minimum, teacher training schools; junior high school teachers must have a degree from a teaching training college; and senior high school teachers must have a university degree. Shanghai was the first Chinese district to require that all teachers undergo continuous professional development (CPD) of at least 240 hours within a five year period. Senior teachers are expected to participate in 540 hours of CPD within a five year period (Jinjie 2012).

There are five main forms of in-service teacher training in Shanghai. Subject teachers participate in teaching and research groups (TRG), in which they carry out action research aimed at improving the quality of pedagogy. Classroom groups (CG) are grade-based and try to foster cooperation among teachers of various disciplines and strengthen horizontal links among teachers. CG allows teachers to coordinate the content of their lessons so that they can provide complementary and reinforcing topics (Zhou, 2005 cited in Zhang & Kong 2011). Both group types feature joint lesson planning.

China's system of control over its teachers extends to the way they teach. This can be seen as quality assurance and a reinforcement of professional development. If nothing else, it guarantees that teachers have a set structure in which to develop their own and others' teaching and learning.

Teaching is systematized on three levels:

- at school level, teaching study groups allow teachers to work with their peers on a regular basis
- at district/county level, the Education Bureau maintains a "teaching study office" that oversees each subject area
- at municipal level, the Education Commission maintains a "teaching study office" that oversees the district/county level office's work.

Each of these levels is overseen by the Basic Education Department in the Ministry of Education. Shanghai provides web-based curriculum, pedagogy and research resources for its teachers in order to encourage the sharing of good practice. District officials generate concrete measures for schools to implement and from those plans schools produce school-based training programs. The plans are judged through quantitative measures through specific achievement targets and numbers of credits achieved. Teachers who fail to complete the required credits could be putting their pay and promotion possibilities in jeopardy (Tan 2013). Tan uses this system as an example of “decentralization taking place in the midst of continued central power, enforced through central legislation, regulations and a reward and punishment system (141).”

Mentoring is at the heart of the system, both one to one and in groups; all schools have comprehensive one to one programs in which mentors and mentees discuss teaching materials, actual lessons, teaching methods, planning and setting and marking assignments (Salleh & Tan 2013). Shanghai has also set up teaching studios, where an expert teacher will mentor a group of about 10 teachers for a year. This includes both observation and research (Tan 2013). Salleh and Tan (2013) identify both strengths and weaknesses in Shanghai’s mentoring programs. Strengths include a standardized national mentoring framework that complements Chinese cultural values of respect for authority and conformity and that makes all participants take the process very seriously. Teachers are highly motivated to maintain good relationships among themselves and to take collective responsibility for the quality of teaching. They see the multiple layers of teacher development as a good vehicle for passing on sound pedagogical practices through mentoring, teacher-research groups and the tradition of public lessons. Teacher collaboration is also critical – Shanghai teachers routinely share their lesson plans with each other and collaborate in developing them. Teaching research groups generally meet once a week for 40 minutes. This leads to the last strength about which they write – a focus on classroom teaching. New teachers have multiple opportunities to observe and discuss others’ classroom practice and reflect on that practice both through teacher-research groups and their own action research.

Salleh and Tan do point out two major weaknesses: performativity and the inability of novice teachers to question/disagree with their mentors and senior teachers. The former resides in the emphasis on examinations results and their monitoring by the Shanghai authorities. While Shanghai teachers see this as less of an imposition that Western teachers might – they believe that standardized tests are more objective than other measures – Salleh and Tan posit that this leads to an undue emphasis on instrumental education rather than on education’s intrinsic value. They use as an example of this the downplaying of all non-examined subjects. And because of culturally ingrained respect for experts, hierarchy and experience, new teachers are reluctant to question the authority of their mentors or to bring in innovative practices that they have discovered (Salleh & Tan 2013).

Teaching style

While trying to move away from undue examination preparation, the emphasis in Shanghai classrooms remains text-based, with an emphasis on mastering content. Tan argues that this is one of the reasons why syllabuses in Shanghai are pitched at a higher level than those in the US, Europe and Australia (Tan 2013, 37). Teachers stress memorization *with* understanding and they deliberately employ difficult questions even for simple content so that even the most capable students are challenged and have to employ problem solving techniques. Tan likens this to a chess game – there are many fundamental rules that need to be memorized but in order to play the game successfully you have to anticipate your opponent’s moves and find solutions to multiple problems.

Shanghai's Curriculum

Shanghai has been at the forefront of education reform in China, often being the first area to pilot and/or implement curricular and systems change. It has been engaged in serious curriculum reform since 1988. In the first phase, students were for the first time able to select some of their courses based on personal interest. Textbooks became more varied to support the changes. In the second phase (from 1998) the aim was for students to become less passive as learners in order to foster creativity, problem solving and self-development. Natural sciences were integrated with humanities. Traditional subject disciplines were re-organized into eight learning domains: language and literature; mathematics; natural science; social sciences; technology; arts; physical education; and practical skills (OECD 2010). Schools were given more flexibility to design their own teaching materials to complement the national curriculum. Weak schools received a lot of government support to improve their standards through infrastructure management and help with implementing curriculum, improving pedagogy and teacher quality (Tan 2013).

The curriculum introduced to support this new emphasis on student-centered learning has three components: a basic, compulsory, curriculum; an enriched, mainly elective, curriculum; and an inquiry based, extra-curricular, curriculum. As part of the last element, students conduct research the aims of which are to help them 'learn to learn', think critically and creatively, do community service and promote social welfare. According to Jinjie (2012) one of the most significant changes to the Shanghai curriculum in its second reform phase was returning class time to students, that is, the promotion of student participation and in-class activities at the expense of teachers' lecturing. Jinjie goes on to argue that primary and secondary schools in Shanghai have strengthened their emphasis on students' development, with more varied teaching and learning activities, and an increased emphasis on practical skills. The new curriculum was implemented city-wide in 2008. Shanghai's plan for educational reform and development for 2020 calls for an increase in school-based curricula as well as a credit system at the senior secondary level to make learning more individualized and flexible (OECD 2010).

PISA 2009 outcomes, which featured reading skills, showed that Shanghai students excel in the skills of generalizing, comprehension and memory, self-regulation, memory and elaboration. Compared with OECD countries, Shanghai's test takers read more for pleasure and enjoyment (OECD 2010). PISA 2012 featured mathematics, in which Shanghai's test takers – who ranked first globally – excelled in translating problems into a form that is amenable to mathematical treatment (formulating), employing mathematical concepts, facts, procedures, and reasoning, and interpreting problems (although in the last category test-takers did comparatively worse than in the other two) (OECD 2013b). In the new for 2012 PISA tests of problem solving, Shanghai's students again did very well, although not as well as in the main tests of mathematics, reading and science. Test takers were by and large able to solve problems that measured the acquisition of knowledge as well as the utilization of knowledge and on items that referred to both static and interactive problem situations (OECD 2014). These results seem to bear out claims for the success of its curriculum reforms.

Curriculum structure

Primary students in Shanghai have lessons in eight major domains: language and literature (including Chinese and English); mathematics; natural sciences (including nature); social sciences (including conduct and society, geography, history and political thought); arts (including song and dance and art); technology; sports and fitness and integrated practice (including social practice and community service (Tan 2013).

The school day in Shanghai for lower and upper secondary students is broken up into 40 minute periods (see charts below). Students in every grade should have a 15-20 minute meeting with homeroom teachers each day in which current affairs are discussed once a week. Moral Education lessons are given monthly. At least 40 minutes daily are reserved for physical and eye exercises and physical education (PE) activities; additional PE activities are encouraged. Research based, exploring, discovering type subjects, practical activities, IT and themes based lessons can be spread throughout the year or taught in blocks. Other concepts, such as national unity, safety, mental health, “adolescence education”, drugs, AIDs, etc. must be covered. Schools hold lectures to raise students’ overall awareness of the practical use of knowledge and skills and each school has to have a weekly activity on science, technology and the arts (personal correspondence with Ministry of Education staff member).

2010 Lower Secondary Curriculum Plan
(translated from the Chinese by K. Carruthers, IOE)

Subject/Lessons per week		Grade 6	Grade 7	Grade 8	Grade 9
Fundamental subjects[1]	Chinese	4	4	4	4
	Mathematics	4	4	4	5
	English	4	4	4	4
	Thoughts and virtues/Morals	1	1	2	2
	Science	2	3		
	Physics			2	2
	Chemistry				2
	Life science (or biology)			2	1
	Geography	2	2		
	History		2	2	
	Society				2
	Music	1	1		
	Painting and drawing	1	1		
	Arts			2	2
	P.E.	3	3	3	3
	Labor technologies	2	1	2	
	IT	2			
	Lessons per week	**26**	**26**	**27**	**27**
Extended subjects	Academic subjects and activities (inc. P.E.)	5	5	4	4
	Themes seminar or class based activities	1	1	1	1
	Community service/field work	2 weeks per year: compulsory and can be a block of lessons or individual lessons			
	Lessons per week	**6**	**6**	**5**	**5**
Research based/Exploring/discovering type of subjects		2	2	2	2
Morning or lunch meeting		15-20 minutes per day			
Physical exercise and eye exercise		40 minutes per day			

[1] Schools must guarantee that extended subjects and research-based subjects will be taught, with fundamental subjects not exceeding a total of 27 lessons per week.

Lessons per week	**34**	**34**	**34**	**34**

2010 Upper Secondary Curriculum Plan
(translated from the Chinese by Katharine Carruthers, IOE)

Subject/lessons per week		Grade 10	Grade 11	Grade 12
Fundamental subjects[2]	Chinese	3	3	3
	Mathematics	3	3	3
	English	3	3	3
	Physics	2	2	
	Chemistry	2	2	
	Life science (or biology)		3	
	Science			2
	Thoughts and politics	2	2	2
	History	2	2	
	Geography	3		
	Society			2
	Arts	1	1	1
	P.E.	3	3	3
	Labor technologies	1	2	
	IT	2		
	Lessons per week	**27**	**26**	**19**
Extended subjects	Subjects and activities (inc P.E.)	5	6	13
	Themes education or activity as a class unit	1	1	1
	Community service/Field work	Two weeks per year		
	Lessons per week	**6**	**7**	**14**
Research based subjects		2	2	2
Morning meeting or lunch meeting		15-20 minutes per day		
Physical exercise and eye exercise		40 minutes per day		
Lessons per week		**35**	**35**	**35**

[2] Schools must guarantee that extended subjects and research-based subjects will be taught, with fundamental subjects not exceeding a total of 27 lessons per week.

Language of instruction

Most schools deliver classes only in Chinese.

Assessment Overview

China, in general, and Shanghai in particular, has moved to adopt more learner-centered curricula and assessments. Assessment for learning has been introduced in order to aid students' understanding of the world around them. This is at the heart of the inquiry based learning element that includes students as active participants. Passive knowledge, memorization and mechanical drilling are all discouraged and assessment is being used to foster student developments. The MoE used the 2011 curriculum standards to encourage schools to use assessment to inform teaching and to institute teacher learning communities around assessment issues (Law 2014). Techniques include dialogic teaching and learning, group work, debates, and more room for student talk. Teachers are reminded to look beyond students' examination preparation to develop moral qualities, citizenship, learning to learn, social interaction and cooperation as well as participation in sport, health and aesthetics (Tan 2012). Teachers are supposed to record progress in a growth record booklet that identifies students' talents in such areas as ICT, English, arts and sports (Shanghai Municipal Education Commission 2006 as cited in Tan 2012).

The *Curricular Plan for Ordinary Primary and Secondary Schools in Shanghai* (Shanghai Municipal Education Commission no date) stresses that students need to develop innovative spirits and real-life abilities. To meet the needs of a global, knowledge-based economy, students should participate in student-led pedagogy and assessments as a way of gaining new knowledge and learning how to solve problems. The growth record booklet for every student includes student self-assessment. However, on the whole the preferred method of assessment in China is summative rather than formative, pencil and paper rather than performance tasks such as presentations (Tan 2013). Standardized assessment is seen as more fair and objective than other assessments.

Public Examinations

There are two national entrance examinations for Chinese students called *zhongkao* and *gaokao*. At the end of Grade 9, all students take the *zhongkao*, which is a summative assessment of the previous nine years of education, as well as an entrance examination into senior high school. The examinations are locally administered and their content differs somewhat across localities. Assessing students in six domains – Chinese (150 marks), mathematics (150 marks), English (150 marks), combined physics and chemistry (150 marks) and physical fitness (30 marks), the *zhongkao* determines whether a student will attend a selective senior high school or upper secondary program or if s/he will go on to an ordinary high school or a vocational program. Because there is some inequality of education resources among the districts it is possible for students who have the same results in different districts being assigned to upper secondary programs of different quality.

And after three years of senior high school students take the *gaokao*, or university entrance examination. In Shanghai the municipal education commission writes the examinations for those students who have a Shanghai *hukou* (right of residency), consisting of Chinese (150 marks), mathematics (150 marks) and English (150 marks) plus one subject of the student's choice for 150 marks including physics, chemistry, biology, politics, history or geography (Tan 2013). About 80% senior high school graduates go on to some form of tertiary education (Sharma 2011). Like the *zhongkao, gaokao* results determine a student's future, in this case what caliber of university he or she will attend. Students must also take the School Standard Examination, at upper secondary, consists of examinations in 10 subjects taken over a three year period consisting of Chinese, mathematics, English, physics, chemistry, life sciences, IT, geography, history and ideology and politics. These are primarily paper and pencil tests, except IT which is an on-line assessment. English language includes a listening and speaking element and the sciences include an applied element. Unlike the *zhongkao* and *gaokao*, standard examinations are graded and norm-referenced (Tan 2013). While it sometimes happens that students who have not attended highly selective lower secondary schools go on to selective upper secondary schools, this is unusual, so a child's fate is decided fairly early on (Tan 2013).

In September 2014 a new reform of *gaokao* in Shanghai was launched and will be fully implemented by 2017. This is intended to have a significant change of the entrance examinations and enrollment system and to improve some of the perceived inequalities in the current system (Gaokao.com 2014, in Chinese).

In addition to these national examinations, students in Shanghai take local examinations at primary, lower and upper secondary school. Each district sets its own papers; there are also tests that are based on sampling of about 30% of students that are aimed to assess teaching quality in which neither the subject nor the sample is know beforehand. Interestingly, these tests also ask about students' sleeping and reading habits, whether or not they have additional tutoring, which are their favorite subjects, etc. in order to get the message across to schools that they are educating the whole child, not just offering examination preparation (Tan 2013).

Although, as seen in the section on curriculum reform, Shanghai is trying to break out of the examinations-oriented straitjacket, examinations have been the focus of attention in China since the time of the first civil service examinations stretching back to the seventh century. So despite reform efforts, teaching and learning, especially in secondary schools, are predominantly determined by the examination syllabi, and school activities are very much oriented towards exam preparation. As the time gets closer to examinations, non-examined subjects such as music, art and physical education are removed from the timetable. Additional examination preparation classes are laid on and students study for many hours each day, including weekends.

Over the last twenty years, national policy has tried to move away from this examination orientation, but largely unsuccessfully. Examination pressure remains a major concern to educators, parents and policy makers. It is generally believed that an undue emphasis on examination preparation undermines young people's general development, but there have been few effective solutions to the problem on offer.

The Ministry of Education issued a major policy document in 2001 that called for the following changes:

- to move away from pure knowledge transmission towards fostering learning attitudes and values
- to move away from discipline-based knowledge, towards more comprehensive and balanced learning experiences
- to move away from pure "bookish" knowledge and to improve relevance and interest in the content of a curriculum
- to move away from repetitive and mechanistic rote learning towards increased student participation, real-life experience, capacity in communications and teamwork, and ability to acquire new knowledge and to analyze and solve problems
- to de-emphasize the screening and selective functions of assessments and instead to emphasize their formative and constructive functions
- to move away from centralization, so as to leave room for adaptation to local relevance and local needs (Ministry of Education, Shanghai 2001).

Shanghai has opted to modify the mode and contents of examinations so they serve the purpose of curriculum and pedagogy reform. Since 1985 Shanghai has had the responsibility of overseeing the university entrance examinations within its jurisdiction. It has put a great deal of effort into modifying the examinations so that they complement curricular and pedagogical changes. The examinations follow a three + X pattern of the three core subjects (Chinese, English and mathematics) plus the X of any other subject(s), depending on the receiving institution. That component can be a paper and pencil test, an oral examination or a practical skills test and may test one or more subjects. The OECD gives the example of interdisciplinary papers that test students' ability to solve real-life problems as well as questions that require students to show knowledge, understanding and skills not on the examination syllabus. There are no longer multiple choice questions in Shanghai's public examinations (OECD 2010).

International Analysis[3]

PISA 2012	Score	Rank	Point difference highest (95%)/ lowest (5%) achievers	Below level 2 (basic skills for life and work)	Levels 5 & 6 (top performers)
Mathematical	613	1st of 65	330 points	4%	55%

[3] PISA has a mean score of 500 and a standard deviation of 100.

Literacy			OECD = 302	OECD = 23%	OECD = 13%
Reading	570	1st of 65	259 OECD = 310	3% OECD = 18%	25% OECD = 8%
Scientific Literacy	580	1st of 65	269 OECD = 304	3% OECD = 18%	27% OECD = 8%
Problem Solving	536	6th of 44		11%	18%

China does not participate as a separate country in PISA[4]. Instead the jurisdictions of Hong Kong, Macau and Shanghai participate separately. Shanghai participated in 2009 and 2012. The points differences between Shanghai's highest and lowest achievers, which the OECD uses as a measure of educational equity, that is the lower the point difference, the closer educational opportunities are for all students, is lower than the OECD average. Shanghai had the highest proportion of 'all-rounders' in the 2009 assessments – 14.6% of its test takers had scores at level 5 or 6 in all three subjects (compared with the OECD average of 4.1%). Between 2009 and 2012, mathematics performance in PISA increased by 13 points, reading increased by 14 points and science increased by 5 points[5]. In the 2012 problem solving test 98% of top performers were also top performers in mathematics; the other subjects were just over 70% (OECD 2014, OECD. 2013a, OECD 2013b). Shanghai did not participate in PIRLS or TIMSS in 2011.

Detailed analysis of curriculum

In this section, the following key areas of the Shanghai curriculum have been analyzed: primary language, mathematics and general science, and secondary language, mathematics, biology, chemistry, physics, history and vocational education. The areas of the analysis are:

- Orientation – the aims, goals and rationale for the subject/content area
- Coherence and Clarity – the extent to which the curricula contain clear and specific goals for each grade and whether the suggested learning activities and pedagogical materials support those goals
- Scope – the scope of material coverage, the number or amount of items or goals in the curriculum versus the depth of mastery proposed of each one
- Levels of Difficulty – to what extent the curricula items can be judged to be at the appropriate levels of difficulty. An appropriate level of difficulty should be defined as one that builds sequentially on prior and existing knowledge and presents an achievable challenge to the average student

[4] According to the OECD *Why doesn't the whole of the People's Republic of China participate in PISA?* (http://www.oecd.org/pisa/aboutpisa/pisafaq.htm) Shanghai, Hong Kong and Macao joined PISA, while the Chinese national ministry was not yet ready to do so. The PISA Governing Board accepts such participation in anticipation of fuller participation of a country. The national ministry has carried out piloting of PISA in several provinces in previous cycles as preparation for fuller participation of China. For PISA 2015 China is participating at the national level, through an increasing number of provinces, which is a further step towards realistic results for China as a whole.
[5] As a rule of thumb, the OECD equates 40 points with one academic year.

- Integration – how the different subjects within each grade of the curriculum is internally aligned
- Progression – how smoothly and coherently the learning goals and proposed content of a given curriculum in a given subject progress from one grade level to the next
- Key competencies – the level of development of a number of key competencies in the current curriculum and textbooks (such as problem solving, teamwork, self-learning, creativity, critical thinking competencies).

In the Shanghai education system, Grades 1 – 5 are primary; Grades 6-9 lower secondary and 10-12 upper secondary.

Primary: Chinese language

Orientation:
Language is an important communicative tool. The aims of the curriculum are to master the culture, to know the language, and appreciate its instrumental, humanistic and aesthetic aspects.

The purpose of the curriculum is to provide a channel for language learning that can keep pace with the society, improve the quality of students' attainment, inform children's cultural knowledge and train their problem solving ability and their research ability.

Coherence and Clarity:

The following examines the content and requirements of the curriculum as set out for the six years of primary and the three years of junior high education, comprising the compulsory stages of schooling.

The headings used in the mother tongue curriculum are: recognition, reading, writing, oral communication and comprehensive study. Recognition is the section of the curriculum where characters are taught; comprehensive study "trains children in collectivism", by setting community based writing and reading tasks.

The requirements of the curriculum are set out for adjacent Grades: 1-2; 3-5; 6-9, creating larger units of time in which competencies are to be built. These are expressed as a series of tasks or goals to be completed, often expressed in terms of number, for example:

- recognize 2,000 characters by the end of Grade 2
- recite 60 old poems between Grades 1-2
- read 250 words a minute between Grades 3-5
- have read 1 million words in their home reading in Grades 3-5.

Scope:

The scope of the curriculum is partly defined by the need to memorize ever increasing numbers of characters, and memorize an increasing number of texts, but also to develop reading fluency, and the habit of reading at home. From Grade 3-5 onwards, increasing mention is made of active response to texts as well as word level comprehension. A range of genres is mentioned in Grades 6-9, and across the grades, student are expected to familiarize themselves with classic works as well as reading more difficult works in modern Chinese. The range of texts is provided by text books.

Levels of demand:
Levels of demand for reading and character recognition escalate faster than for writing. Character recognition begins with learning *Pinyin*, a phonetic system for representing the sounds of Chinese in writing. The writing curriculum moves from writing from everyday experience, to acquiring a "common style" through imitation of existing sources. The move from word to text is paced relatively slowly, with building the lexicon still part of the writing curriculum in Grades 8-9. Levels of demand in oral communication are in comparison least extensive in their description and focus on listening and concentrating on summarizing the main ideas in others' speech or in voicing ideas boldly and fluently. Children are expected to be able to deliver a two minute, then a three to five minute, then a 10 minute speech in successive grade groupings. There is very little differentiation in the curriculum according to ability.

Progression:
Progression is expressed by adding to the scale of tasks, and the range of texts to be read or written.

Assessment:
Assessment is part of routine teacher practice, with more formal assessments taking place at mid and end of term. These forms of assessment are summative rather than formative.
It was not clear from the available documents if these are set by the teachers individually or by the city.

Key competencies:
There is stress on enjoying reading and tasks are set for how much reading should go on at home. Students are expected to develop good study habits, to raise questions and think actively, as part of the reading curriculum. The comprehensive study element includes team-work.

Integration
The mother tongue curriculum in Shanghai relies more extensively on memorization than have the other curricula examined in this study. The importance of learning characters, and the skill set required to do this obviously dominate how the curriculum is approached.

Primary: Mathematics

This report is based on working with a native speaker from the un-translated documents available outlining the Shanghai regional primary and secondary mathematics curriculum standards. Some of the information below, for example about assessment, is based on additional sources such as articles or personal communication.

Orientation:
The document includes general aims for the curriculum, then general aims for the primary phase. Later more specific aims for mathematics are included and these roughly concern the following:

- to provide children with the mathematical knowledge and skills to live in society and learn in the future and enabling them to think mathematically and solve problems in mathematics
- to provide children with opportunities to apply mathematics to everyday problems and use abstract mathematics
- for children to understand the importance of mathematics in society and to develop confidence in relation to mathematics

Coherence and Clarity:
Goals are given for overall phase (that is lower primary and upper primary) rather than by individual grade. There is some additional information which includes possible activities and examples, but this is quite brief compared to some other countries. It is possible that more detail is included in textbooks.

Scope:
Content is given for lower primary (Grades 1 and 2) and for upper primary (Grades 3-5). For each of these, content is broken down into three categories (with the first being the largest):

- basic content that is essential for all students
- expanded or more advanced content to be used selectively depending on the personal development of individuals
- content that is research focused and encourages exploration, with emphasis on processes and experience.

Knowledge and skills at each phase are in five domains[6]:
- Numbers and calculation
- Equations and algebra
- Graphics and Geometry
- Data processing and probability and statistics

These headings are the same for lower and upper primary. The number of class hours is given for each (a class hour is actually about 45 minutes) and this indicates that, at lower primary especially, the vast majority of time is spent on number. In addition to domains for knowledge

[6] work associated with measuring seems to be listed partly under numbers and calculations and partly under graphics and geometry

and skills, there are also two sections on process and method – see section on key competencies below.

For Grades 1-2 (basic content), 138 class hours are to be spent on numbers and calculations. At this stage children work with numbers under a hundred, including counting objects, comparing and ordering and recognizing and writing numbers. They understand the meaning of addition and subtraction, add and subtract mentally with numbers under 20, use written methods for addition and subtraction including with two-digit numbers and carry out multiple calculations involving addition and subtraction. Students progress to understanding, reading, writing and comparing larger numbers under 10000 and carrying out written calculations for addition and subtraction. They add numbers under 100 mentally. In grades 1-2 students are introduced to multiplication and division. They memorize single-digit multiplication facts and use these to obtain division facts. They can derive multiplication facts using repeated addition. They are introduced to division by sharing out of objects and understand the idea of a remainder. Students also work with Chinese money and with time, including hours minutes and seconds. They apply these skills to everyday life. They should acquire the habit of checking calculations.

At Grades 1-2 (basic content), two class hours are to be spent on equations and algebra. This is about the use of letters and other symbols to represent unknowns, including solving simple equations with unknowns (for example 3+□+7) and using letters to express the commutative property for addition (a+b=b+a). Graphics and geometry at Grades 1-2 (basic content) are given 18 class hours. Students work with and get to know the names of simple 2D and 3D shapes such as rectangles, squares, triangles and spheres. They use standard metric units such as cm and m for measuring length and measure length using rulers. They know that the angles of squares and rectangles are right angles. At Grades 1-2 (basic content) 12 class hours are to be spent on data processing and probability and statistics. At this stage, students categorize objects and develop familiarity with simple bar charts, first formed from objects and progressing to abstract charts and tables.

The expanded content for Grades 1-2 includes six class hours to be spent on number and algebra and four class hours to be spent on graphics and geometry. Suggested activities for number and algebra include using inequality symbols in algebraic expressions, continuing and finding the rule for number sequences (the example given is 1,4,7,10...) and exploring 3 by 3 magic squares. The graphics and geometry expanded content includes observing 3D shapes from different angles, understanding line symmetry and using shapes to make figures.

Under the research / practice heading, the class hours are not specified. Suggested content includes learning about the origin of numbers and of the multiplication table and the history of mathematical symbols. Children should also use numbers to calculate and measure, use statistics in everyday life and work with word problems / story problems.

For Grades 3-5 (basic content) 185 class hours are specified for number and calculations. Children work with natural numbers up to a billion, with the focus on reading and writing numbers up to 10,000. They round decimals and read, write, understand and compare decimals up to three places. They work with fractions, including adding and subtracting fractions with the same denominator. Students know the relationship between fractions and decimals and add and subtract decimals up to two places using mental and written methods. They use diagrams to aid their understanding of the relationship between fractions and decimals. Students in Grades 3-5 multiply and divide natural numbers, including mental multiplication of two digit by one digit numbers and related division calculations and written multiplication of two digit by two or three digit numbers and related mental calculations. Students learn how to use electronic calculators. They understand the meaning of multiplication and division and the relationship between them and use them to solve everyday problems. They extend their understanding of multiplication and division of natural numbers to start to explore ways to multiply and divide decimals. They understand the effect of moving the decimal point and become aware of recurring decimals through division. Students carry out multiple calculations involving all four operations and use brackets for the order of operations. Students work with positive and negative whole numbers through real life examples such as temperature and use number lines to represent and compare positive and negative integers. Students extend their use of metric units to include units of mass such as g and kg and understand the relationship between units. They use mass in everyday contexts including estimation. They work with time, including centuries, years, months and days and work with the Chinese lunar calendar.

At Grades 3-5 (basic content) 45 class hours are to be spent on equations and algebra. Students use letters to represent relationships in measures or number, for example using the formula for the area of a square. They use letters to represent unknowns and solve simple equations. They use equations to solve word problems. Graphics and geometry (basic content) occupies 80 class hours at this level. Students extend their use of units of length to include mm and km. They can draw circles using compasses and use related terminology such as radius and diameter. They measure angles in degrees using protractors and draw rectangles and squares with a ruler and protractor. Students work with a wider range of shapes, for example isosceles and equilateral triangles, parallelogram and trapezium. Students understand the meanings of area and perimeter and calculate the perimeter of triangles, squares and rectangles. They calculate the area of triangles and a range of quadrilaterals, first by counting squares and moving gradually towards use of formulae. Students are introduced to the volume of cubes and cuboids using standard metric units and work with liters and milliliters and with surface area. Students apply their growing understanding of geometry to solve practical problems. At Grades 3-5 (basic content) 28 class hours are to be spent on data processing and probability and statistics. Students use a range of methods for collecting and representing data, including bar charts and frequency charts. They relate these to everyday situations. They are introduced to the idea of mean and calculate this using a calculator. Students are introduced to probability, mostly in relation to everyday events.

The expanded content for Grades 3-5 includes 26 hours on number and algebra, 15 hours on graphics and geometry and seven hours on data processing and probability and statistics. Under number and algebra, extended work includes use of letters to show different ways of calculating, starting to solve equations using trial and improvement and inverse operations and dealing with problems involving decimals and calculations related to the calendar. Extended work on graphics and geometry includes exploring the relationship between the area and perimeter of rectangles and working on problems related to mass and volume. The extended content for data processing and probability and statistics includes more work on probability related to games.

Under the practice and research heading at Grades 3-5, for which class hours are not specified, suggested activities include problems related to exchanging money into foreign currencies, learning more about the history of mathematics in China and carrying out probability experiments, including using a computer.

Overall the content is similar to other countries at primary level (though with perhaps more and earlier algebra – see below). The inclusion of items related to the history of mathematics is relatively rare at primary level.

Levels of demand:
Content is specified for upper and lower primary rather than by grade, though progression between the two primary phases is clear. Expectations are generally quite high compared with other countries, especially for algebra and to some extent for number and geometry, less so for data processing. Extended content is specified for some students, although most of the content is specified as being for all students.

Progression:
This is unclear given that the curriculum is not specified by grade level (though a model of the curriculum is offered early on related to rings on the top of a bucket – is this the same as the spiral curriculum?) Text books doubtless make progression between grades clearer.

Assessment:
There are no national exams for primary schools, though schools generally write their own tests for the end of Grade 5. Selective secondary schools also set entrance exams for primary students applying for entrance.

Key competencies:
Process and method are seen as two strands which are:

- process and experience, including interpreting mathematics from everyday situations, for example, reading statistics from tables

- method acquisition and development of aptitude, which concerns selecting effective methods, being flexible in choice of methods, observing, analyzing, summarizing, making judgments, giving reasons and explaining.

There are numerous mentions of problem solving throughout, including encouragement for students to explore a range of ways of approaching the same problem.

Primary: Science

The curriculum for Natural Science for the primary Grades 1-5 is set out in a single document covering the general orientation and philosophy behind the curriculum, aims and objectives, curriculum content and requirements, and suggestions and exemplar materials to support for planning, teaching and assessment.

Orientation:
The introduction to the curriculum emphasizes the promotion of scientific literacy and the need to take account of the characteristics of early learning and development through building on children's experiences and interest in the natural world around them.

Priority is given to the development of children's love of nature and interest in exploring their environment, their knowledge of science related to the world around them and their thinking skills. It is suggested this should include developing positive attitudes to science, an understanding of the relationship between science and society and an ability to apply scientific skills and knowledge in solving problems in everyday life. There is a strong focus on scientific inquiry and children solving problems through experience.

The overall philosophy set out for the science curriculum also highlights the importance of giving attention to learning processes that provide a foundation for lifelong learning. Consistent with this perspective, the importance of building an assessment system that is multidimensional and involves a range of assessment approaches is underlined.

In the design ideas offered it is emphasized that fostering scientific inquiry should be reflected in all areas of the curriculum and in assessment. Fostering scientific inquiry is seen not only as an aim of the curriculum but a key feature of curriculum content and approaches to teaching and learning.

Coherence and Clarity:
The curriculum framework sets out aims, objectives and requirements concerning curriculum content for the two stages of primary education: Grades 1-2 and Grades 3-5.

The overall aims reflect the curriculum rationale and philosophy with a strong emphasis on promoting positive *attitudes* (for example curiosity, respect for evidence, respect for the living environment) and developing *skills of inquiry* (for example experiencing and learning about methods of inquiry) and on the *application of knowledge and methods* to everyday life.

Objectives are set out in broad terms in relation to the three dimensions of:

- Attitudes including: attitudes to science, scientific attitudes and awareness of the nature of science

- Knowledge related to: Living things, the Physical World, Earth and Space incorporating Health and Hygiene, the application of science to solve problems in society and the work of scientists and their impact on human activity.
- Scientific inquiry including a range of skills and processes associated with planning, carrying out and reporting inquiry.

Curriculum content, suggested teaching, learning and assessment approaches are consistent with the curriculum rationale and aims. For example the advice on teaching materials and approaches underlines the need to focus not only on knowledge, but also on attitudes, skills and values. There is an emphasis on problem solving, cooperative learning and the development of a democratic classroom environment. A variety of approaches to assessment are advocated with evidence related to the development of attitudes, skills and knowledge to be recorded in a file for each student. The guidance suggests that setting out the objectives for the two primary phases, across grades, allows some scope for teacher interpretation.

Scope:
As indicated above the objectives for *Attitudes* for both primary stages underline the need to foster and maintain curiosity. There is a strong emphasis on developing love and respect for nature and an appreciation of relationships between humans and the environment. Building confidence in raising questions and undertaking inquiry is highlighted in Grades 1 and 2. In Grades 3-5, reference is made to fostering cooperation with others and respect for evidence and the opinions of peers. Developing an appreciation of links between science and everyday life (both positive and negative dimensions) and awareness of current scientific issues are key objectives across all primary grades.

The *Knowledge* objectives make reference to a range of content as follows:

- *Living things* – the diversity of living things, life processes and in the later grades relationships between living things and the environment, inheritance and variation
- *Physical world* – materials, states of matter, forces and energy
- *Earth and Space* – features of the Earth, day and night, seasons and weather, movement of the Earth and Moon, human exploration of the Universe, influence of human activity on the Earth.

The following themes are also integrated into the curriculum objectives and content:

- Health and Hygiene – personal and public health
- Scientists and their work and impact on human activity, applications of science to solve problems in society

The objectives for *Scientific Inquiry* for both stages of primary education incorporate a range of skills and processes associated with scientific inquiry including: questioning, observing, measuring, selecting resources, recording and interpreting outcomes, communication with peers. In Grades 3-5 research using second hand sources (for example the library or the internet) and model making are included. There are also objectives linked to developing an understanding of the nature of science, for example, to know that the outcome of scientific inquiry can be tested through experiment or that questioning plays a key role in scientific inquiry.

Level of demand

The objectives are expressed in fairly broad terms, however, the content requirements for the two phases of primary education provides some further indication of the expected scope at each phase and associated level of demand to support planning, teaching and assessment.

The level of demand is appropriate in that the attitudes, skills and knowledge set out in the curriculum build on children's experiences of the world around them as emphasized in the guidance on implementation. A range of attitudes and skills are promoted across all Grades, with a strong emphasis on applications of science and human interactions with the environment. There are indications of progression across the two phases of primary education building on their growing experience both in and outside school. It is difficult to judge the level of conceptual demand but this seems appropriate and broadly in line with many other jurisdictions.

Progression:

The objectives content and requirements for attitudes, knowledge and scientific inquiry for each phase of primary education are set out in tables side by side so that features of progression can be readily identified both in terms of depth and range of content.

In relation to *attitudes*, progression is evident in the greater focus on cooperation with others, respect for evidence, increasing recognition of the nature of science and of links between science, society and everyday life.

Progression in the objectives for *scientific inquiry* is indicated, for example, in the greater reference to use of measuring equipment, more formal approaches to data presentation and analysis and the importance of communication and evaluation with peers.

There are indications of progression in terms of *knowledge* in both scope and depth. In the earlier grades reference is made to children observing, identifying, recording and discussing phenomena and events. In the later grades the requirements incorporate more formal procedures associated, for example, with designing an experiment, collecting and recording data or measuring or the application of skills, attitudes and knowledge in making models. Some concepts are introduced in Grades 3-5 such as microorganism, interdependence, and gravity.

Assessment:

The curriculum document sets out assessment principles and the content and methods of assessment. Both formative and summative methods are considered and the importance of feedback to students is underlined.

The principles highlight the need for assessment to cover all dimensions of the curriculum, attitudes, knowledge and inquiry. They emphasize the need to employ a variety of methods of assessment appropriate to the objectives, and to involve not just teachers, but parents, children and professional bodies in assessment processes. It is suggested that a file is kept for each student, incorporating different forms of evidence for assessment.

The overview of the assessment system suggests that students take a graduation examination at the end of primary school set by the local education department. As in other jurisdictions there is a strong emphasis on the assessment of home language and mathematics but much more limited attention to science in the primary age phase.

Key competencies:
There is no specific section in the science curriculum focusing explicitly on key competencies, however references to problem solving, team-work and critical thinking skills are included throughout the curriculum document. More generally the promotion of positive attitudes and skills in science is emphasized. More limited explicit attention is given to creativity or self - learning.

Secondary: Chinese language

Orientation:
The mother tongue of many of Shanghai's students is the Shanghai dialect of Chinese. Increasingly requirements to have studied *wen yan wen (文言文）* are being introduced. *Wen yang wen* is the classical form of Chinese, and has gradually been introduced over the last five year, a period where the teaching of English has been reduced in importance, and may be seen as a strategy to reinforce students' notion of Chinese heritage and culture. While the value of English in final assessment has dropped from 150 to 80 points, that of Chinese has risen from 150 to 180 points. A clear policy covers both primary and secondary phases. This stresses that Chinese language is the vehicle for both communication and culture, and is both instrumental and important in expressing a student's humanity and social integration.

As a core subject in secondary education, home language instruction is described as the foundation for language and literature, but also as vital for the underpinning of other subjects. The study of Chinese should cultivate aesthetics, but also act as a channel for both understanding and learning in the wider curriculum, and gaining access to other cultures. The emphasis in the program of study is at the macro level: little is spelled out in detail (for example, choice of texts) and there is not an undue emphasis on correctness or indeed calligraphy. Students must understand classical and cursive symbols, but there is not the emphasis on penmanship found, for example, in Japan. However in the Standards issued by the Ministry of Education there are very specific targets for vocabulary acquisition.

Coherence and Clarity:
Detailed specifications are available at each grade. *Wen yang wen*, with an accompanying emphasis on traditional values, is introduced from Grades 6 to 9. Learning aims are expressed

in a qualitative rather that performance outcome manner. At the outset of the primary phase there are eight goals specified:

- Students should love the language, have the right attitude, demonstrate enthusiasm.
- They should love the Chinese culture, together with the culture of the wider world. Students should develop a value system, to support patriotism and socialism.
- Students are to use language correctly, creatively and to support innovation.
- They should be able to read modern Chinese independently and appreciate literature.
- They should be able to use the dictionary, and be familiar with *Wen yang wen*.
- They should be able to record and express feelings, and to write in a particular genre.
- They should be able to use oral communication appropriately.
- They should be able to understand on-line materials, and to research independently

By the end of lower secondary there remain similar qualitative aspirations, but more specific benchmarks also emerge, not only for school based work, but for home based and recreational language use:

- To have command of 3,500 characters, and be able to understand modern Chinese literature. Students should be able to evaluate and compare texts.
- Students should be able to use dictionaries, and understand simple passages in *wen yang wen*. They should be able to select their own recreational reading.
- Students should be able to observe and contemplate life, and be able to use language to express feelings. They should be able to write common, functional language.
- Respect must be shown for other speakers. Students should be able to listen, summarize, present and engage in a debate.
- Students should be able to engage in research, and make use of ICT to search for and obtain information.

Scope:
By Grade 10 the requirements of the program of study quite clearly identify a confident use of language, and independent engagement with literature, both classical and modern. There is a strong emphasis on how this integrates with wider social skills. The specifications cover not only a school curriculum, but what is expected of young people in their leisure time. Students are required to be able to:

- Summarize and compare literary texts, and independently identify the features and themes of complex articles. They should demonstrate an awareness of the social implications of literature, and be able to identify and show empathy. They should be familiar with the major elements and tradition of *wen yang wen*, and read such texts in their own leisure time. They should respect their national traditions.

- Confidently use differing genres to convey feeling, maintain an argument, engage in narration, and express independent opinions. They should be able to write clearly in functional Chinese prose.
- Listen carefully, respecting the speaker, and demonstrate that they can grasp key points from what they hear. They should form a habit of listening to, for example, broadcasts, and be able to analyze and summarize complex media such as audio visual material.
- Cultivate an aesthetic sensibility, and develop independent thinking skills.

At this level students are banded in to three sets, based on teachers' assessment, categorized as basic, expanded, and inquiry based, indicating that such students are research capable. No criteria for this process of selection were available to this study, but clearly the research band represents a very high level of language awareness and use.

Levels of demand:
The standards of mother tongue usage are set by the Ministry of Education. Teaching and learning are supported by text books that also come from official sources, and so amplify and illustrate these standards. The standards are expressed in qualitative terms, accompanied by teacher assessment. It is not clear how this is moderated across schools, but the specifications, in so far as may be quantified, indicate a high level of expectation. The requirement that students from Grades 6 – 9 should acquire command of and confidence with between 2,500 and 3,500 characters is an indication of reading and writing expectation, difficult to compare with other writing systems, particularly at this level of specificity. Students are also expected to be able to master *kaishu* (formal) and *xingshu* (cursive) versions of the script, and to read both modern and *wen yang wen* texts. They are expected to have a reading and understanding speed of no less than 300 characters a minute, which is on the high side. They must also demonstrate that they can memorize and use 150 characters of the ancient *wen yan wen* script. After school and social reading should include classics, including western classics, to a minimum of 200,000 words but the texts are not specified. They should also read newspapers and periodicals representing 400,000 words, and be able to write summaries of their reading. Students are expected to memorize and recite passages to a total of 10,000 words. This is highly specific, and represents a much higher level of required reading and recitation that in other comparable systems.

A study by Lia, Leib and Pacea, *Reading subskill differences between students in Shanghai-China and the US: evidence from PISA 2009* concluded:

> In summary, compared to the overwhelmingly test-oriented practices in China, reading instruction in the US is more diversified and less influenced by tests. And compared to Shanghai-Chinese students who spend considerable time on drills and rote memorization to prepare for tests, US students have more opportunities to develop critical-thinking skills. In the PISA 2009 reading test, for tasks in the accessing and retrieving subscale and tasks in the integrating and interpreting subscale, readers use content primarily from within the text, whereas for tasks in the reflecting and evaluating subscale, readers draw primarily on knowledge outside the text and relate that

> knowledge to the text (OECD, 2009)...... it is found that compared to Shanghai-Chinese students, US students had relative strengths in reading non-continuous texts but relative weaknesses in reading continuous texts. Also, US students had relative weaknesses in the subskill of integrating and interpreting compared to Shanghai-Chinese students.

By Grade 9 students are expected to identify themes and opinions, understand written and rhetorical structures, analyze key statements, and make use of keywords to improve their own communication skills. They are also expected to be able to identify the key features of a genre, a requirement not always specified in other systems. Students must also demonstrate that they can make use of IT to further explore and deepen understanding.

Despite this apparent emphasis on rote learning, the standards for writing indicate that the study of home language should seek to promote independence of thinking, with students encouraged to use a wide range of words, vividly, to express their own feelings. They should keep personal diaries, and be able to express and exchange ideas. The standards specify two specific genres, a general, and a functional, including letters, reports and minutes.

Required listening skills include listening to the radio and making judgments on what they have heard. When speaking, students should be able to express their thoughts and feelings clearly and at an appropriate volume. They should be able to make a ten minute presentation, and engage in debate politely. Comprehension should include an integrated study. Students should be able to undertake topical research including conducting interviews, and investigations, and contribute to a class newspaper. They should be able to make use of the internet, and join school communities. Again, after school reading is required, and students are expected to identify themes and produce a summary.

Progression:
There are two progression examinations *zhongkao* and *gaokao*. Students start their nine-year compulsory education at six. Students stay at elementary schools for five years and junior high school for four years. At the end of Grade 9, all students take *zhongkao*, a summative assessment of the nine-year compulsory education, and entrance examination to senior high school, key senior high school, ordinary senior high school or vocational school. At the end of three-year senior high school study, students take *gaokao*, which gives entrance to universities. The results of *gaokao* decide whether senior high school graduates go to key university, ordinary university, college, or other high education institutes. Home language plays a key part in each of these assessments.

Assessment:
The *gaokao* is a two and a half hour examination, at age 17-18 for college entrance. It is of an exacting and concentrated nature. In the examination studied, a mix of language and literature, an initial comprehension question involves a longish, technical passage, academic in nature. Six questions require a précis, a multiple choice question on complex interpretation, word meaning in context, nuance of meaning, and questions on the functions of structure, and an evaluation of the author's standpoint.

This is followed by a passage of more literary/flowery prose, again in modern Chinese. There is a question around the central motif of the passage (in the case examined, that of sunshine), and a question around the interpretation of the theme of the passage. This is followed by a true or false set of questions. The final three questions are searching, an appreciation of the sentiment, an appreciation of the contrast between the emotional and narrative aspects of the piece, and a compositional, stylistic analysis.

There follows a stretching question that requires the candidates to memorize a poem from the classical *wen yang wen* tradition. They are then set a form of Cloze procedure, completing the textural gaps from memory. This is followed by an unseen passage from the classical period, whereby candidates must demonstrate an understanding of words, theme, some multiple choice, and analyze feeling and emotions resulting from a reading of the piece. Two more questions involve *wen yang wen* texts, one concerning genre in classical poems, and the other on the understanding of vocabulary and rhetorical structures of a classical prose text.

The final question requires a piece of creative writing, 800 words, a reflective piece on *déjà vu* or catharsis in modern Chinese literature. Given the time constraint this is a very stretching examination.

Key competencies:
The key competencies of reading, writing listening and speaking are all present, though reading and writing predominate. There is an emphasis on accuracy in the writing of the Chinese script, a growing emphasis on classical traditions, and a requirement to memorize passages. There is an emphasis on literature, and on language giving a strong social function. There is a great deal of stress on the requirements for, in particular, reading to be undertaken outside of school.

Secondary: Mathematics

This report is based on discussions with a native speaker related to the National Curriculum Standard document and various articles related to the mathematics curriculum in Shanghai post 2004 (Wang et al, 2012; Lim, 2007; National Numeracy, 2013).

Orientation:
The mathematics "National Curriculum Standard" (2004) aims to provide students with a good foundation of mathematical skills that they can apply to everyday life, to stimulate their interests and enlighten their thought and at the same time develop positive attitudes towards mathematics. Wang et al (2012) report that this last goal was given a new emphasis in the 2004 reforms, which aimed to present students as active learners. The aims are the same as for primary mathematics, that is:

- To provide children with the mathematical knowledge and skills to live in society and learn in the future and enabling them to think mathematically and solve problems in mathematics.

- To provide children with opportunities to apply mathematics to everyday problems and use abstract mathematics.
- For children to understand the importance of mathematics in society and to develop confidence in relation to mathematics.

These goals are further elaborated in a set of objectives for each grade band (Junior secondary, 6-9, and Senior secondary, 10-12). These briefly indicate the content knowledge and skills (which is detailed elsewhere), then in more detail the mathematical processes and competencies, attitude and values to be fostered. The attitudes and value section is aligned with that in other curricula, although with enjoyment is treated as stemming from students' appreciation that mathematics is a part of human culture, and its relationship with everyday life, social and cultural development. The mathematical processes and competencies section is more developed than in other curricula, setting out a progression between grade bands (Canada, Ontario had progression in competencies but to a lesser extent). There is an unusual explicit emphasis on changing students' conceptual understanding of topics as they meet new mathematical ideas, for example during Grade 6-9 the concept of handling 2-D and 3-D objects becomes geometric reasoning (about figures) and in Grades 10-12 this becomes spatial 'imagining' concerning abstract relations in co-ordinate geometry. The goals of appreciating mathematics and changing conceptual understanding are in evidence throughout the curriculum, usually integrated in the content.

Coherence and Clarity:
The secondary curriculum is presented in three grade bands 6-7, 8-9 and 10-12. There are broadly five content strands in the Basic curriculum: Number and Calculation, Equations and Algebra, Graphics and Geometry, Functions and Analysis (Grade 8 onwards), Data processing and Probability. The Number and Calculation strand stops for Grade 8-9 but returns at Grade 10-12 with complex numbers. In each band, each strand contains one to six broad objectives, with subheadings and comments related to the mathematical skills and knowledge, the suggested number of hours of study, and occasionally examples. There are some indications of how the material is to be approached, for example exploring graphs and right angled triangles using dynamic geometry software (DIMA) or through investigation and these seem to be new additions.

The curriculum distinguishes between Basic and Extended content. At Grades 6-9 all the material is taught to all students; however only Basic content is examined for graduation and it is expected that some students will not work further on the Extended material (for example, in practice classes or home tuition). There are two kinds of extended materials, in Part I (broadening applications, throughout Grades 6-9) and Part II (deepening, Grade 9 only). Students who expect to continue to high school will study all the extended material in preparation for the z*hongkao* entrance examination to Senior High school.

At Grades 10-12, the Basic curriculum (18 credits) is taught to all students in grades 10 and 11, and it forms the content of the Grade 11 graduating examination (*Hui Kao*). To qualify for university, all students must complete a further 6 to 10 credits spanning the different parts of the Extended curriculum. Part I Extended units are studied in Grade 10, chosen from a range of relatively self-contained mathematics applications such as matrices; Part II Extension material is studied in Grades 11-12 when the students have divided into Arts/ Social Science and Science/Engineering streams. Both these streams follow the same Basic content, but there are two distinct extended courses, each worth three credits. These are Course A for the Arts/ Social Science stream, concerned with applications of mathematics in the arts, decision making and statistics, and course B for the science/Engineering stream extending the pure mathematics curriculum. Both streams must also choose at least one credit from courses C (modeling with mathematics) and D (historical and modern mathematics). This breadth of offering and limited freedom matches the initial goals of fostering core skills alongside aptitude and interest. Overall though the curriculum is strongly bound together by the significant common content and the compulsory inclusion throughout senior high of courses addressing the nature, history and uses of mathematics as well as content.

In addition to the mathematical content strands there is a mathematics Research and Practice strand throughout the secondary curriculum. This is taught through the one-hour per week given to combined studies course or the content lessons.

Lim (2007) explains that mathematics teachers are not required to follow the curriculum document strictly; instead they are encouraged to expand and explore further mathematical content as needed. The new curriculum content is compatible with the traditional emphasis on concept variation, in depth practice varying the examples and methods. Schools must offer all extended material that offers more depth in order to prepare students for university entrance examination. It is not clear whether it is students or schools who choose what to teach/study among the units of the part I, C and D courses.

Scope:
In the basic curriculum, the four strands are weighted as follows in terms of suggested lesson time, showing a progressive move from number and calculation towards algebra, functions and proof. In the later grades the geometry and function strands are increasingly algebraic, providing abstract contexts in which to practice symbolic reasoning and problem solving. There is no differential or integral calculus in either the basic or extended curriculum, for any stream, as this is deferred to university. Unusually there is no explicit pre-calculus either, with no mention of rates of change, gradients or numerical approximations to area.

Grade band	**Number and Calculation:**	**Equations and Algebra,**	**Graphics and Geometry**	**Functions and Analysis**	**Data processing, statistics and Probability**
6-7	40%	23%	37%	-	Integrated in other strands
8-9	-	23%	49%	17%	12%
10-12	4%	27%	28%	29%	11%

The content is as follows (please note that unless otherwise stated, the numbers in brackets refer to the number of lessons on each topic):

Grade 6-7

Number and Calculation:

Rational numbers (85 lessons of around 45 minutes); divisibility including hcf, lcm; positive and negative, proper and improper fractions, relationship with decimals, and operations with different denominators. Percentage and ratio, simple problems and use in real life situations; rational numbers as subset of the real numbers, ordering, place on number line, calculations including the four operations and squaring. Be able to use in complex calculations, using a calculator to solve more complex calculation problems.

Real numbers (13); square roots, real numbers including concept of irrational numbers, calculations, scientific notation.

Equations and algebra:

- Solving Linear equations and inequalities (25); systems of simultaneous linear equations with two and three variables; modeling in problem solving contexts, solving inequalities in one variable.
- Manipulating polynomial and algebraic fraction expressions (54 hours) with numeric or parametric coefficients, identities, factorizing, simplifying, zero and negative exponents.

Graphics and geometry:

- Circle and sector (5), circumference and area, chords, arc length and area of a sector.
- Constructions (7): line segment, angle, constructing the midpoint, difference and product of line segments geometrically, angle bisectors, adding angles geometrically, complementary and supplementary angles.
- Rectangular solids (7) extending knowledge of rectangles in plane. Identifying edges, plane surfaces, parallel and perpendicular. 2-D drawings of solids.
- Transformation geometry (14); translation, reflection, rotation, symmetry including the co-ordinate system.
- Angles between a transversal and parallel lines (12) and related geometric problems, constructing a perpendicular, exploring the relationship with dynamic geometry software.
- Triangles (20) ; understand, prove and reason about triangle properties involving side lengths, altitudes, angles, congruence, identifying congruent and isosceles triangles.

Data handling content is to be combined with previous work: probability within the study of fractions, algebraic symbols can stand for probabilities, bar and pie charts in geometry, weighted means in number problems.

Extended content includes studying games and puzzles, drawing points from co-ordinates, the difference between equations and identities, rearranging formulae, classic proofs such as root 2 being irrational, Chinese history of discovering π.

The scope of the number and geometric work in these grades is similar to that in other jurisdictions, with the difference that mastery is expected in the Shanghai curriculum so that none of the material appears again in later grades. The formal probability is more restricted and depends on teachers' decisions about how to include it in other topics. The algebraic content is notably more demanding. Algebraic fractions, for example, would often not be met until one or two grades later and possibly not by all students.

Grades 8-9

Equations and algebra:

- Quadratic equations with one unknown (10); factorizing to find roots, quadratic formula. Conditions on coefficients for equations to have 0, 1, 2 real roots.
- Irrational expressions (such as those involving $\sqrt{x}$): (14) concept and properties of irrational expressions, simplifying expressions, fractional exponents.
- Algebraic equations (21) including algebraic fractional equations, irrational equations, quadratics in two unknowns; solving problems by forming such equations.
- Rearranging and simplifying equations. Simultaneous equations with one quadratic and one linear.

Graphics and geometry;

- Reasoning and geometric proof (26); logical propositions, examples of proof, converses, proofs involving angles in parallel lines, equal segments, proofs and applications of Pythagoras theorem and Pythagorean triples for right-angled triangles, links between number and geometry. Proofs involving angle and perpendicular bisectors. Loci with circles and bisectors.
- Quadrilaterals (25); polygons and angle sum, properties of parallelograms, square and rhombi; related geometric problems and proofs. Vectors in space: addition and subtraction, parallel, inverse, zero vectors, the triangle inequality. Isosceles trapezia.
- Similar triangles (22) ; constructing enlargements, parallel segment theorem, identifying similar and equilateral triangles; area and scale factors and applications to perimeter and altitude, center of gravity; use in practical problems. Scalar multiples of vectors, connection with scale factor of similar triangles. Linear vector expressions.
- Circles and regular polygons (14); chord, arc, central angle, figures formed by intersections of lines and/or circles; constructing regular triangle, square, hexagon.
- Right angles triangles (10); interior angles, side lengths ratios including sine, cosine, tangent and cotangent, solving problems with this and Pythagoras theorem.

Function and analysis

- Proportionality (12): concept of functions and inverse functions, plotting graphs of functions, understanding the effect of changing coefficients.
- Linear functions (13), graphs and other representations (tables, graphs, algebra).
- Quadratic functions (9), use software to understand quadratic graphs, sketch, characteristics of graph from equation (maxima, intercepts, symmetries).

Data handling

- Probability (8): understanding the concept of probabilities in classic and realistic problems including simple geometric models.
- Statistics (15) ; data handling, extract information from a table, bar charts and pie charts using algebra and geometry content. Interpreting frequency and frequency polygons. Measures of tendency and spread, including median, mode, range, variance and standard deviation used to solve statistics problems.

Extended content

- Part I (Grade 8 only) includes: the algebraic relationship between roots, powers, and absolute value, factorizing and the remainder theorem, (12); Chinese and Greek history of Pythagorean theorem and triples (7) ; the nature of mathematical thinking (through examples and revision): using symbols to replace numbers, relationships between geometry, algebra and functions, applying mathematics to everyday life (16).

- Part 2 (for those who will continue to high school): further work on quadratic functions, equations and graphs, relationship between coefficient and roots (14); further work on circles, exterior angle tangent theorem, common tangent of two circles, circle theorems involving angles at circumference and chords; 4-point circle (15) .
- Research and application to real life is to be combined in previous work including collecting data, work with maps and scales.

As in Grades 6-7 there is relatively little probability and statistics in the curriculum. There is also relatively little work on proportionality and recognizing situations that would be modeled by multiplicative relations (12 hours within Functions and Analysis), and this follows after work on ratios and percentages rather than being concurrent as in many curricula. The concept of proportionality is, however, concurrent with studying scale and enlargement at the same grades.

Manipulation of irrational algebraic expressions is unusual at this age, as is the simplification of algebraic fractions. These are further indications that algebraic fluency is developed more strongly in the curriculum. The Geometry curriculum is also demanding: the theorems and trigonometric content are fairly standard but the scope of the work on derivation and proof is unusually broad. The basic and the extended curriculum both explicitly address the nature of deductive mathematical reasoning.

<u>Grade 10-12</u>

Equations and algebra includes:

- Set theory (12), inequalities, fractional, absolute value and quadratic (14),
- Systems of linear equation, matrices and determinants (in two and three unknowns) (8)
- Algorithms in number theory (10)
- Sequences, arithmetic and geometric progressions, limits, proof by induction (18).

Functions and Analysis includes:

- Functions : meaning and set language, composition, maximum and minimum value, even and odd functions, monotonic (16)
- Logarithms and exponential functions; graphs, curves, varied methods of solving equations, examples including population, disease spread (20)
- Trigonometric functions for any angle (20); radian measure, unit circle, trigonometric ratios including secant and cosecant, related formulae, identities and their derivations, use in problems, vector scalar product, double angle formulae and their derivation, using a calculator, sine and cosine rules.
- Periodic functions (12); use software to explore the properties of trigonometric functions and graphs, functions of the form $A\sin(\omega t + \varphi)$, period and frequency; solve quadratic trigonometric equations using identities.

Graphics and Geometry:

- Vectors in 2-D plane (8): ratio theorem, co-ordinate notation. Vectors: modulus, angle between vectors.
- Vector equations in the plane and relationship with co-ordinate equations (14)
- Curves; understand the equations of circles, parabolas, ellipses and hyperbolae (18)
- Graphics in space (15); understanding the relationships and language between 2-D and 3-D space; skew lines
- Studying simple solids: cylinder, cones, spheres (10).

Data processing, statistics and probability:

- Permutations and combinations, binomial theorem (14)
- Probability (12); random events and probabilities, equally likely outcomes, sample space, empirical probabilities.

Number and calculation

- Complex numbers (10); four operations and the Argand diagram. Complex roots of quadratic equations.

Extended content for Grade 10 and 11: part I. Students going to university take 1-5 credits (15-75 hours) from this part.

- Logic (15); language and propositions, inductive and deductive reasoning.
- Counting principles such as inclusion-exclusion and pigeonhole principles (8).
- Inequalities including methods of proof and inequalities of Cauchy and Bernouili (8).
- Complex numbers, operations in trigonometric and exponential forms (15).
- Quadratic equations in 2 unknowns (15); co-ordinate geometry, using vectors to understand translations and rotations to express conics in standard form.
- Matrices and transformations (15); linear matrix algebra, use in 2-D transformation geometry. Number theory (15); Euclidean algorithm, prime numbers and factorization, Diophantine equations, Goldbach's conjecture.
- Graph theory (8); trees and graphs, minimum connector problems and applications.

Extended content part II, for Grades 11 and 12:

- Arts and Social science (A course, 3 credits) is based around applications to everyday life and the arts: statistics and probability in life (10); examples, misconceptions; simple linear programming (10); graphs and linear inequalities; introduction to decision mathematics: optimization and search methods (10) such as bisection; mathematics music, art, social research (8); projections and perspective drawing (10).
- Science and Engineering (B course, 3 credits) includes more applications of mathematical reasoning to spatial and everyday contexts: applying the trigonometric half-angle formulae (8), trigonometric formulae for angle sum and difference; statistics and probability (15) including the probabilities of independent events, conditional probabilities, random variables, uniform and binomial, distributions, linear regression; parametric equations (8), polar co-ordinates, conic sections and polar equations; space and vectors (16) in 3-D co-ordinate system, vector equations and theorems related to lines and planes in space, distance and angle between skew lines.

The C course covers mathematical modeling tools in a range of contexts (each a five-hour unit) and is intended for students going to university. The contexts/tools are:

- Modeling with functions (exponential, log etc) in relation to price, sports, economics examples
- Modeling with linear programming in contexts of resource allocation, distribution, transportation
- Modeling with number sequences, for example mortgages, population growths, investment and interest
- Modeling with probability, for example lottery, card games, birthday
- Modeling with statistics, for example school assessment models, market research.

The D course gives an overview of historical and modern mathematical activity with units on mathematics in ancient China and Greece, the geometric roots of the calculus, 19th and 20th century developments of mathematics, and the achievements of modern China.
The curriculum ensures a spread of mathematical study, with the concepts from basic mathematical content being explored repeatedly through varied examples, historical perspectives and applications in real-life contexts. The most unusual feature is that there is no calculus of graphs in the course, and no pre-calculus. However, analysis is introduced since limits of sequences are studied by all. Instead there is a very strong emphasis on representations of curves and space using mathematical visualization, Cartesian equations and vectors: the distance between two skew lines, for example, which is in basic content could be university level mathematics elsewhere. It is also unusual to expect so much algebraic fluency with absolute value equations and inequalities. The notable feature of this curriculum is how much algebraic/geometric work is included for all students.

Levels of demand:
The greater scope of the curriculum is made possible by the assumption of algebraic fluency and abstract reasoning skills. The complexity of examples and their level of difficulty is higher

than in many other countries. For example in Grades 8-9 students are expected to determine the number of roots of the quadratic equation $x^2 + m(x+1) + x = 0$ depending on the value of the parameter m. The solution itself is not complex (one root if m=1, two otherwise) but the framing of the reasoning and the confidence with symbolic variables is demanding.

Curriculum examples such as this suggest that teachers aim for deep learning by setting multistage problems. The z*hongkao* assessment does not include such a high level of abstract reasoning, but the NCSL (2013) classroom study noted a regular emphasis on the range of different methods and approaches that could be used to solve questions posed.

Progression:
The curriculum is coherent in its progression, and the breadth of abstract applications ensures a constant practice of algebraic and numeric skills. The pace of introducing these new applications must be fast and it is clear from the division into basic and extended content, and the distinct pathways in later grades, that – understandably – not all students are comfortable with that pace. There are alternatives that have been designed for further reinforcement of basic content and matching students' interests.

Assessment:
Zhongkao mathematics is the state-set Grade 9 examination that assesses performance and serves as entry selection for further study. Shanghai exams last 100 minutes, allowing about three minutes per question, and there are multiple choice, blank-filling and short-answer questions. The content is predominantly related to algebra and geometry, often connecting both, and is drawn from the Basic content.

Gaokao is the examination set by the state for university entrance. There are around 20 questions, some short answer but most needing extended responses. The level of algebraic manipulation is extremely demanding. The questions predominantly involve algebraic reasoning about functions or curves and geometric proofs requiring algebra.

There are no context questions set in the papers. Questions increasingly involve symbols rather than words in later grades.

Key competencies:
Key competencies are not enumerated but given in descriptive paragraphs. They are given in two categories that correspond roughly to mathematical processes and mathematical reasoning/methods. They progress between grade bands.

1. Mathematical processes

For Grades 6-9, mathematical processes involve modeling practical situations with concepts and symbolic mathematics; using calculator and graphical methods to solve equations; moving from hands-on experiences of geometric objects to abstract geometric reasoning; collecting and processing data, analyzing and explaining.

For Grades 10-12 mathematical processes involve expanding concept of number from the real to complex numbers, exploring variables and functional relationships in real-life situations, solving problems choosing appropriate mathematical models and tools; exploring problems and objects in space and the plane and the relationship between them; connecting geometry and algebra; awareness of probability and statistics in real world situations involving uncertainty, using data- analytic research methods. Using digital technologies to observe phenomena, explore mathematics problems, compare the use of modern technology to solve mathematics problems with traditional methods.

These processes are strongly related to the mathematics content strands. In other curricula they could be integrated with them as overall objectives. There is more emphasis on making connections between strands here.

Mathematical reasoning/methods
This concerns students' abilities and aptitudes for learning methods of working mathematically.

For Grade 6-9, it includes logical reasoning ability, calculating ability, spatial ability, exploring ability, creative ability, application ability. Students should be able to use mathematics language precisely to explain and communicate, to conduct research independently and collaboratively, show critical thinking and self-management. They should master the methods of abstract mathematics such as exploring, applying, categorizing, analyzing, and reasoning.

At Grade 10-12, almost all the same abilities are listed but with more demanding examples. The exceptions are that spatial ability becomes spatial *imagining* ability to suit the more abstract approach to geometry. Language, explaining and communicating are not listed (although formal reasoning is expected in examinations and in class).

Secondary: Biology

Orientation:
The Ministry of Education (MOE) develops national curriculum standards including all core curricular areas. In the curriculum reform of 2001, the first National Curriculum Standard of Science Education for Grades 7-9 was issued by the MOE.

In 1988, Shanghai established a three-block curriculum that enabled students to participate in required and elective courses as well as extracurricular activities as part of their schooling. This was a major change from the previous curriculum focused solely on core subjects.

Schools were encouraged to create their own curriculum and outside groups such as museums became partners in education. Part of the new curriculum includes an emphasis on inquiry-based education, which is a critical component of science. Students independently explore research topics of interest to themselves in order to promote social wellbeing, creative and critical thinking, and again, learning to learn.

The curriculum is organized around learning domains, which include language and literature, mathematics, natural science, social sciences, technology, arts, and physical education.
It is also organized into three separate components: the basic curriculum (core subjects); the enriched curriculum (elective courses); and the inquiry-based curriculum (extra-curricular activities). Schools are encouraged to adapt the government's curriculum frameworks to meet their students' needs.

The place of biology in the curriculum Grade 1 – Grade 12 is:

- Grade 1 – Grade 5 primary natural science
- Grade 6 – Grade 7 integrated science
- Grade 8 – Grade 11 life science
- Grade 12 – integrated science.

The overall aims for science are:

1. to obtain basic scientific knowledge and skills, and explain simple phenomena in life
2. develop the basic ability to solve the scientific method – the process of scientific enquiry
3. to develop a positive attitude and interest in science, and to know the relationship between science and society.

The integrated science curriculum, compared with separate science subjects, is stated to go beyond the boundaries of disciplines, has integrative design of the whole system, and pays attention to the relation and penetration among separate science subjects. Integrated science is helpful to students to learn science and the nature, to study scientific method, to develop their inquiry ability, to understand science, technology and society.

The objectives for Grade 6 –7 science are:

- Knowledge and skills
  Know some basic concepts; be able to carry out experiments, and to be able to explain them
- Scientific enquiry
  Through the enquiry method be able to present a question, form a hypothesis, make a plan, and collect the evidence, process it, express and communicate ideas.
- Attitudes and values
  Have a desire to explore, learn independently, think independently but be able work with others and share; love nature and life; understand the relationship between science and society, and have an awareness of the responsibility to save the country by using scientific knowledge and skills.

The orientation for Grade 8 –11 life science is to:

- provide a diverse learning experience

- focus on living organisms, biological structure and function, the living environment, medical, agricultural, population issues and environment.

This is a very fundamental course to develop the students' scientific attitudes and values.

The aims for Grade 8 –11 life science are:

- to obtain basic scientific knowledge
- to understand the relationship between life science development and population development.

The objectives for Grade 8 –11 life science are the same as Grade 6 –7 science.

Grade 12 appears to be focused on the *gaokao*, and the sciences are once again combined, but focusing on scientific enquiry, and adapting and using knowledge from the three sciences to solve problems.

Coherence and Clarity:
The curriculum documents from Grade 1 to Grade 12 provide clear and specific goals for each grade that are traceable throughout the different grades, and the documents often contain common statements for each set of grades. There are goals for both content and scientific enquiry skills.

Grade 6 –7 science, Grade 8 –11 life science and Grade 12 science each contain clear themes. Each theme is broken down into topics. Each topic is provided with teaching content descriptions, suggested activities, further explanation and attitudes.

For Grade 6 –7 science, there are fifteen themes to be taught across the two years. Teachers can rearrange the order, and no time is prescribed.

1. Scientific enquiry
2. Biological world
3. Cells and respiration
4. Particle models
5. Energy
6. Water and humans
7. Life and air
8. Electricity
9. Human body
10. Chemical reactions
11. Perception of the environment
12. Universe and space
13. Earth science
14. Marine development

15. Development of humans and nature

Theme 9 Human body contains many biological topics, for example:

- Nutrition and health
    - Nutritional components of food
    - Digestion
    - Transfer of digestion products around the body, the circulation
    - Balanced diet.

- Extension material is provided to extend more able students:
    - Healthy vitamins and the influence of vitamins.

- Suggestions for activities are provided:
    - Get a package of food and analyze the nutritional information
    - Observe the structure of the intestine of a pig
    - Observe the structure of the heart of a pig.

- Suggestions are provided for further study:
    - Evaluate whether the student has a healthy diet
    - Introduce knowledge for giving blood for transfusions.

Theme 1 Scientific enquiry includes experiment, investigation, designing and making things to be able to learn scientific enquiry. Example lesson plans are provided.

A similar degree of detail and clarity is provided for Grades 8-11 and Grade 12.

Scope:
The biological aspects of integrated science at Grade 6 –7 are integrated within the fifteen themes. For example, theme 11, Perception of the environment, has content about light, the physics of light, sight, sound and hearing. Each theme contains topics which are clearly described and supported by extension material and activities. The depth and breadth of the content appear to be appropriate to the grades, and the content is designed to be engaging and to interest students.

There are four themes for Life Science Grade 8 –9: human biology, health, classification of living things, and ecosystems. Each has a set of sub themes, for example:

1. Human biology
    - Structure of the human body
    - Internal environment
    - Life activity and its adjustment
    - Genetics and heredity

Each sub-theme is provided detailed teaching content with supporting activities.
A grading system describes each teaching and learning objective.

The grading system uses letters A – D, where

A knowing
B understanding, can do basic calculations, analyze
C apply understanding to practical problems
D apply understanding to solve more complex problems

which allows for more closely targeted lesson planning for the particular class of students.

For example, teaching content for sub-theme:

- structure of the human body
    - characteristics and structure of some basic tissues A
    - the human body's main organs and systems A
    - the holistic character of the human body B.

- Suggested activity:
    - use the microscope to observe human tissues, for example section of stomach.

There are seven themes for Life Science Grade 10–11:

- Introduction to life science
- Foundations of life
- Energy conversion and transfer – photosynthesis and respiration
- Formation of life – genetics
- Continuity of life
- Biodiversity and sustainable development
- Modern biotechnology and its application

As in the previous grades, detailed teaching content is provided with supporting activities, for example:

- Modern biotechnology and its application
    - DNA technology and applications
    - Outcomes of DNA technology
    - Cloning – technology and process
    - Influences of modern biotechnology
    - Security and ethics of modern biotechnology.

Extension material is provided for more able students and at Grade 8 – Grade 9 follows the same four themes: human biology, health, classification of living things, and ecosystems. In human biology, for example, extension material includes:

- Bone marrow transplants A
- ABO blood groups and transfusions B
- Sport science and forbidden drugs B

The biological content in science for Grade 12 has four themes:

- Microbiology
- Internal environment and homeostasis
- Genetics
- Bio-engineering

There is research and enquiry content:

- Experimental research
- Information collection
- Designing a case for the protection of environment or resources
- Social investigation – a personal report.

Example investigations are provided, for example:

- design a case to classify rubbish for recycling
- Investigate the history of Chinese medicine, for example acupuncture.

So, there is a broad and deep curriculum that builds on each preceding grade, and pays particular attention to scientific enquiry and the social impact of science.

Levels of demand:
The level of demand is appropriate for biology. This is illustrated by the way many content standards build from previous grades, and within the sub-topics. The curriculum provides basic content for all students and extended content for more able students. The provision of both core and extension content allows teachers to best judge what is appropriate for each group of students, and to build a teaching program that builds sequentially on prior knowledge.

For example, in Life Science Grade 8 – 9: human biology, there are four sub-themes

- Structure of the human body
- Internal environment
- Life activity and its adjustment
- Genetics and heredity

that build on content from Grade 1 – 7. Extension content is provided for more able students that builds on the basic content, and allows students to apply knowledge and understanding to more complex ideas and situations.

Progression:
The curriculum documents explain that the content and skills at each grade build on those from previous grades, so there is a clear progression, even though the biological content is embedded in different ways at different grades: Grade 1- 5 natural science, Grade 6 - 7 integrated science, Grade 8 – 11 life science and Grade 12 integrated science. Although teachers are allowed to change the sequence of themes in the different grade bands, there is still an expectation that the content will be covered, with reference to preceding and following grades.

Assessment:
Chinese students receive assessments throughout their education. These typically take the form of year-end or term-end tests as well as casual assessment from teachers. Guidance is given on the method of internal assessment. Assessment for an individual student may be by teachers, peers, head teacher, parents or external examination organization. The assessment is made on three key areas:

- Scientific attitudes and values
- Knowledge and skills
- Scientific enquiry

Written examinations are set by the school, and additional ways must be used to assess the level of the student. Guidance is provided on the method of assessment. This guidance includes:

- Daily assessment
  - Homework
  - Questioning
  - Experiment
- End of term assessment
  - Written examinations set by each school
- Improving examination assessment, which may include model-making
- Assessing attitudes and values.

Teachers are expected to provide feedback based on collected comments. There should also be the use of IT and portfolio assessment.

For *gaokao*, three subjects are mandatory everywhere: Chinese, mathematics, and a foreign language – usually English, but this may also be substituted by Japanese, Russian or French. The other six standard subjects are three sciences: Physics, Chemistry, Biology, and three humanities: History, Geography, and Political Education.

Many of the biology questions are quite demanding and would certainly provide considerable discrimination amongst the candidates.

Key competencies:
The new curriculum has three components: the basic curriculum, to be experienced by all students, mainly implemented through compulsory courses; the enriched curriculum, which aims to develop students' potential and is realized mainly through elective courses, and inquiry-based curriculum, which is mainly implemented through extra-curricular activities.

The inquiry-based curriculum asks students to identify research topics based on their experiences, backed up by support and guidance from teachers. It is hoped that through independent learning and exploration, students can learn to learn, to think creatively and critically, to participate in social life and to promote social welfare.

Secondary: Chemistry

Orientation:
There is a curriculum document for science in Grade 6-7 (junior high school) and a curriculum document for chemistry in Grades 8-12 (senior high school). Grade 9 is the end of compulsory education, when students may progress into vocational education or remain in academic education. Grade 12 is essentially a revision year when chemistry is integrated with the other sciences before being assessed as a separate science in the final examination.

Both of the curriculum documents are organized so that there is an introduction, aims and objectives, content requirements, and guidance on implementation; this supports the transition from junior high to senior high. Furthermore, the introductions to both documents stress the importance of scientific literacy, and introduce their key concepts and course designs. High-level aims emphasis: knowledge and skills; scientific inquiry and problem-solving; and, attitudes and values. More specific objectives for Grade 6-7, 8-9 and 10-12 are consistent with these aims and become focused on individual disciplines, including chemistry, in Grade 8-12.

Coherence and Clarity:
In Grades 6-7, the first section of the required curriculum content is divided into themes with content, suggested activities and explanatory notes. In each section, the content comprises a few items of basic content and one item of extended content. The second section of the required content provides guidance on inquiry activities involving investigations, experiments and/or design with detailed plans for teachers that provide examples. Two or three of these activities are expected per term.

At Grades 8-12, there are three degrees of extended content.

In Grades 8-12, the first of the required content is organized as sections (Grade 12 only), themes with topics and then sub-topics. There are explanations of the content and suggested activities for each theme as a whole. In addition, there are study levels for each sub-topic, which refer to: a. knowing, b. understanding and/or c. applying. Lastly, there is basic content in each sub-topic for all students and extended content in each sub-topic. The extended content is required for progression into Grade 12 and university entry. There are time allocation requirements for the basic content as follows:

- Grade 6-7 – 170 hours for science
- Grade 8-9 – 68 hours for chemistry (136 physics and 102 biology)
- Grade 10-11 – 136 hours for chemistry (136 physics and 102 biology)
- Grade 12 – 60 hours for advanced science.

Physics is therefore prioritized above and beyond biology and chemistry. Furthermore, although biology and chemistry are treated equally over the course of junior and senior high, students who progress into vocational education or leave formal education at the end of Grade 9 will also spend more time on biology than on chemistry. No explanation for this was evident in the aims or objectives of the curriculum documents.

Scope:
In the required content for Grades 6-7, four of a total of 15 themes are particularly relevant to chemistry: water and humankind; the particle model of substances; air and life; and chemical solutions in everyday life. The themes have between three and five sections divided into three columns relating to content, suggested activities and explanatory notes. As noted above, there is guidance on inquiry activities, which may relate to these themes. The *particle model of substances* theme has five sections. The content in these five sections relates to: physical states (liquid, solid and gas); the particle model (solutions, molecules, particles and atoms); air pressure and the atmosphere; volume, density and buoyancy of materials; and, thermal expansion and contraction. There are three or four suggested activities for each theme. The suggested activities for the particle model content call for the observation of an experiment relating to: the volume of a mixture of alcohol and water; the diffusion of perfume or vinegar in the air; and, the solution of potassium permanganate crystals in waters. The explanatory note for these suggested activities states that the intention is to look for proof or evidence to support the particle model.

In Grade 8-9, there are six themes: chemical substances; the wonder of substances; the classification of substances and diversity of change; chemical solutions; life and chemistry; experimental activities. The life and chemistry theme comprises three topics: domestic fuel; fertilizer; and, fireworks. Only two of the themes involve level c. application and then only calculations or balancing equations. In Grade 10-11, there are five themes: Microworld of substances; Substances and changes; Elements and compounds; Common organic compounds; and, Experimental activities. Only one theme involves level c. application. Indeed, the experimental activities for Grade 8-9 and 10-11 are limited to level a. knowledge or b. understanding.

Grade 12 comprises extended content only, divided into four sections. Students choose two of these sections and each section incorporates two or three themes each with two or three sub-topics. The four sections are: structure and properties of substances (for example, comprising three themes: character of atoms, structure of substances, organic matter); law of chemical reactions; chemistry and industry; and experimental activities.

Demand and progression:
The statements of learning objectives and accompanying suggested activities make the demand of the programs clear. The progression in the statements through from 6-7 to 9-10 and 11-12 appears appropriate, and each at stage there is a reminder that the learning proposed builds on prior achievement. Each part of the programs include two sections of basic and extension materials, with the provision that the extension is for higher-attaining students, but will not be examined in the end of course tests. The provision of extension material is a further aid to differentiating the demand according to ability, although it is not clear how this works in practice. Many of the suggested activities, especially those concerned with research projects, can be set at a suitable range of demand.

Assessment:
The final section of the Grade 6-7 curriculum document relates to implementation and one section sets out the suggested assessment. All themes should be assessed and evidence can be pooled from teachers, parents, external assessors and students themselves. The mode of assessment should be appropriate for the content and not only knowledge and skills, scientific inquiry and problem-solving but also attitudes and values should be assessed. A suggested plan for assessment including using formative assessment and conducting summative assessment with detailed instructions (for example classroom observation of student engagement) is provided.

In the implementation section of the Grade 8-12 curriculum, the suggested assessment sub-section calls for a variety of modes, including practical activities. It also calls for both formative and summative assessment but there is little detail (the sub-section is 1.5 pages in length). The document states that basic content and the most challenging extended content (which is clearly identified in the document) should be assessed with written and practical examinations. Less demanding extended content and experimental activities should be assessed using non-written assessment, types of which are listed and include peer and self-assessment.

In the *zhongkao* examinations across China in Grade 9 at the end compulsory education, Chinese, Mathematics, and English are the three core subjects. In Shanghai, a science examination is administered with separate parts, including for chemistry. The item formats are multiple-choice and blank-completion. At the end of Grade 11, students graduate from high school by taking *huikao* examinations, which include chemistry. There is a high pass rate for these examinations.

Chemistry is one of the subjects generally assessed in the *gaokao* examination at the end of upper secondary education. The *gaokao* chemistry examination (2013) for university entrance was two hours in duration and involved a written paper with a range of question types: multiple-choice with one correct answer; multiple-choice with more than one correct answer; blank-completion, experimental-interpretation; and complex calculations (involving the development of an equation and its solution). The demand of the questions is generally very high, though some differentiation is evident.

Key competencies:
Key competencies are clearly stated as aims and objectives in the curriculum documents, ranging across application of knowledge, skills, values and attitudes. They are also cross-referenced and to some extent illustrated in the suggested activities. The examination pressure on students and teachers is likely to mean that the curriculum aims are not fully addressed.

Secondary: Physics

Orientation:
In the first two years of secondary level Grades 6-7, science is compulsory, in Grades 8-11, physics is an option and in Grade 12 science is offered. Some junior secondary schools also offer vocational subjects. Over a third of the curriculum in a junior secondary school is devoted to Chinese and mathematics whilst at senior secondary level over half of the teaching is concerned with science and mathematics. This review covers the physics in science and as a separate subject from Grades 6-12.

The content of the curriculum relates to daily experience, social development and technological innovation. It is based on the four pillars of learning: learning to know, learning to do, learning to live together and learning to be.

The curriculum has been under considerable development over the past decade; in 2008, to encourage student learning rather than accumulation of knowledge, the curriculum was set out as eight curricular learning domains, one of which is natural science. Schools were then encouraged to create their own curriculum with outside groups such as museums as partners in education. This curriculum includes an emphasis on inquiry-based education, in which students independently explore research topics of interest to themselves in order to promote social wellbeing, creative and critical thinking, and learning to learn.

The overall aims reflect the curriculum rationale and philosophy with a strong emphasis on promoting positive *attitudes* (for example curiosity, respect for evidence, respect for the living environment) and developing *skills of inquiry* (for example experiencing and learning about methods of inquiry) and on the *application of knowledge and methods* to everyday life.

Objectives are set out in broad terms in relation to the three dimensions of:

- *Attitudes* including: attitudes to science, scientific attitudes and awareness of the nature of science.

- *Knowledge* related to*:* Living things, the Physical World, Earth and Space incorporating Health and Hygiene, the application of science to solve problems in society and the work of scientists and their impact on human activity.
- *Scientific inquiry* including a range of skills and processes associated with planning, carrying out and reporting inquiry.

As science is replaced by physics in later years, the overall aims remain the same with somewhat more focused objectives relevant to physics, for example a greater emphasis on problem solving.

Coherence and Clarity:
Although the curriculum programs are presented for Grades 6-7, 8-9, 10-11 and 12, each is written in a similar format. This includes three sections of successively more detailed description from overall aims, to specific objectives. The programs for 8-9, 10-11 and 12, are in the same document, so are identical in presentation. The content of each program is divided into themes as a further aid to coherence. The specific statements of content are usually accompanied by suggested activities, which aid clarity of the specification. Each part of the program also includes two sections of basic and extension materials, with the provision that the extension is for more able students, but will not be examined in the end of course tests.

Scope:
6-7 Science has 15 themes of which the first is scientific enquiry, with objectives which specify scientific processes. Physics is present in approximately one third of the themes, although they are not exclusively divided into the three major sciences. Physics is the major part of *Particle theory of substance, Energy, Electricity and telecommunications,* and *the Universe and space exploration.*

Electricity and telecommunications includes the usual circuit concepts and elementary electromagnetism, but has a more unusual section on telecommunications, which includes modern equipment, future developments and, as an extension, the semiconductor chip. The *Energy* theme has sections on *Forms of Energy, Energy Transfers, including heat, Energy sources.* In *Energy Transfers, including heat* specific objectives include providing examples of these from everyday life. Suggested activities include the investigating the thermal insulation of clothing and exploring the use of batteries and electric motors. An extension in this section is a study of burning.

8-9 and 10-11 Physics each have the same four themes: *Substance, Mechanics*, *Electromagnetism, Energy*. At 8-9 *Substance* includes density, atoms, the Universe*, Mechanics* covers force, pressure, sound, motion*, Electromagnetism* includes circuits, magnetism, light, and *Energy* includes *work, internal energy, conversion and conservation, kinetic and potential energy.* Suggested activities in energy include designing arrangements to observe these energy conversions and their applications to real life. Calculations of kinetic and potential energy are not expected.

In the extension material, galaxies and constellations are included under *Substance*, and refraction under electromagnetism. At 10-11 there is a clear development of content for example in energy conservation there is a quantitative treatment of mechanical power, K.E. gravitational P.E. and internal energy. An additional area of study in this theme is atomic energy with specific objectives to learn about nuclear fission, its application in power generation and the implications for Chinese industry. There are cross references to the overall trio of aims, for example in *scientific enquiry*: the use of IT in experimentation, including measurement, and in *attitudes*: the impact of the atomic industry in China and the contributions of Chinese scientists.

Each theme is set out with basic and extension aspects, with Grade 12 consisting of further extension material. Each year's program should include a research project that will gain end of course credits.

Grade 12 Science introduces no new topics but provides an opportunity to review all the material studied previously, as the emphasis in this year is to prepare for the university entrance examinations. Projects suggested include the analysis of projectile motion, applications of kinetic theory and exploration of electric fields.

Demand and Progression:
The statements of learning objectives and accompanying suggested activities make the demand of the programs clear. The progression in the statements through from 6-7 to 9-10 appears appropriate, and each at stage there is a reminder that the learning proposed, builds on prior achievement. The provision of extension material is a further aid to differentiating the demand according to ability, although it is not clear how this works in practice. Many of the suggested activities, especially those concerned with research projects, can be set at a suitable range of demand. Examples of this progression of demand and extension of demand are quoted in the previous section.

Assessment:
The assessment system is a combination of course graduation certification and entrance examination. The latter is the more important as it is selective, for both senior high and tertiary education. Throughout compulsory education, students are required to take end-of-term exams and tests at the end of each semester or school year, and these form the basis of the credits which a student needs to graduate.

There are two significant entrance examinations for students in school education, *zhongkao* at the end of Grade Nine and *gaokao* at the end of three-year senior high school study. *Zhongkao* is summative assessment of the nine-year compulsory education, so includes science. More importantly, it is the entrance examination to senior high school. The results of *zhongkao* decide whether students go to key senior high school, ordinary senior high school or vocational school. *Gaokao* is the entrance examination to universities and includes the elective subjects, one of which is physics. The results of *gaokao* decide whether senior high school graduates go to key university, ordinary university, college, or other high education institutes.

The changes in the past decade have seen a reduction in learning by rote and assessment of factual recall and an increase in the assessment of higher order thinking, contextual application and experimentation. This is reflected in the entrance examinations, through the skillful design of what are mainly objective questions.

Examples in Junior Secondary Physics include:

- sporting contexts for the application force and speed concepts
- everyday life contexts of rail travel and sailing for velocity and buoyancy
- experimental reporting on exploring images in a plane mirror.

The *gaokao* in physics is a two hour paper with a range of question types: multiple choice, blank completion, experimental interpretation and calculation (for 1/3 of the total marks). The demand of the questions is generally very high, though some differentiation was noted. Examples include:

- multiple choice: nuclear fission, forces on a swing
- blank completion: circuit data, mechanics
- experimental interpretation: use of electrical measuring instruments, magnetic field measurement
- calculation: pressure, friction, electromagnetic field.

Key Competencies:
These are clearly stated as aims in the curriculum documents, ranging across application of knowledge and understanding, skills of scientific enquiry and attitudes. They are also cross-referenced and to some extent illustrated in the suggested activities. The achievement of the credits for graduation from junior and senior high no doubt reflect something of each of these competencies. However the importance of the competitive entrance exams *zhongkao* and *gaokao*, for both students and their teachers, means that the latter part of each stage is dominated by exam preparation and this is unlikely to reflect the full range of the stated aims.

Secondary: History

This report is based on verbal translations of untranslated texts provided by a native speaker. It has not been possible to look at documents in detail.

Orientation:
The following overall aims are identified for both Junior and Senior High School History:

- Understanding of history as a discipline and of human society
- Understanding of historical materialism and human civilization
- The cultivation of humanism and values.

The following specific aims are identified in addition:

- Nationalism and modern awareness – respect for the past, broadening of horizons, patriotism and internationalism and respect for diversity
- Understanding development (change in/over time) is the key focus
- Students should develop a multi-dimensional framework for the understanding of the past – dimensions include chronology and topics
- Study should combine both active and independent learning with receptive and passive learning.

Although it is difficult to say very much with any degree of certainty on the basis of the above, it would appear that universalism (humanity) has greater salience than particularism (China) in the framing of the subject.

Coherence and Clarity:
The tables that follow explain the structure of the subject at different phases of secondary education (Junior – ages 12-15 years and Senior – ages 16-18 - High School).

The subject is divided into three levels (Basic, Expansion, Research) at both phases. The content for each of the above is as follows:

Levels	Junior High School	Senior High School
Basic	Chinese and Western History and Shanghai's local history. Students should ***understand*** history.	Topic-based history In addition to understanding history students should also ***evaluate*** and ***interpret*** history and have the option to select topics for study.
Expansion	In addition students should ***explore*** the above (rather than simply comprehend or know it).	
Research	Students should acquire hands on experience of history	Students should explore multi-dimensional issues and multiple perspectives and ***evaluate*** history.

The overall goals for both junior high school and senior high school are:

- Understanding the development of civilizations in a number of aspects (spiritual, material, and so on)
- The development of research and independent and cooperative learning skills
- Understanding of historical materialism – the relationships between nature and society
- The development of patriotism, nationalism and social responsibility.

Goals are further differentiated by stage as follows:

Phase	Factual Knowledge	Beyond factual knowledge
Junior High School	The development of factual knowledge and overviews	Understandings of the motives behind events, the use of ICT and understanding of vivid examples. At this level students are expected to *understand*.
Senior High School	As above	As above and in addition, understandings of: • how past developments have been evaluated • the contributions of past events to development • understandings of the relationships between the history of China and the history of world civilization • the development of the understandings and dispositions that will enable students to understand and contribute to the modern world. At this level students are expected to *interpret and evaluate.*

Junior high school and senior high school are further differentiated as follows:

Phase	Historical understanding	Operations	Materials / representations
Junior High School	Chronological / narrative understanding	Comprehension and evaluation of knowledge Understand evaluations made by people in the past /about the past	Use diagrams and outlines
Senior High School	Topical and critical understanding	Interpretation, selection and explanation of knowledge Make evaluations of their own	Analyze and compare multiple materials and comprehend / make summaries

The differentiation of objectives by phase above is progressive in Bloomian terms. A possible drawback to framing progression in understanding in these terms is that such framing is:

- generic
- predicated on adult perceptions of the logical structure of the content to be covered rather than on an empirically grounded understanding of how children learn history or on an empirically grounded understanding of the challenges that learning to understand history actually presents children in a developmental sense

- operational (conceived in terms of what children will do) rather than conceptual (related to domain specific aspects of the understandings at issue).

Progression modeled in such terms can be schematic.

Curriculum arrangements are differentiated by phase and level as follows:

Levels	Junior High School	Senior High School
Basic	China and the world [136 x 45 minute lessons]	Topics in history [102 x 45 minute lessons]
Expansion	Local history (Shanghai) [10 x 45 minute lessons]	Thematic approaches to world history [90 x 45 minute lessons]
Research		

Scope:
The content for each of the above is as follows:

Levels	Junior High School	Senior High School
Basic	**(a) Chinese History** • Prehistory / ancient history and cultural prosperity in China. • The Quin and Han dynasties – the invention of paper and technological developments • Daoism and Buddhism • Sui and Tang (period of prosperity), culture and communication with other cultures • Royal rights, Ming and Quin literature and technology Chinese and World History From the end of the 19th century the focus expands to include world history (in the sense of history that impinges on China): • Mao • The war against Japan; • The PRC and some foreign policy (for example Nixon, 1970s, etc) **(b) World History** • Prehistory and ancient civilizations around the world • Europe, Christianity, Russia	Prehistory, focused on topics related to different periods. Topics are explored in a number of contexts – Chinese, Western and World (for example, catering in general, catering in China and in the West; transport in general, in China and in the West). At senior high school topics are treated globally (not simply in a Chinese context). At senior high school content is dealt with in chronological order but organized thematically across contexts.

	• East and South Asia, Arab and Mongol invasions • Renaissance / international expansion • The Enlightenment • The Industrial Revolution • Asia, America and Africa: reactions to bourgeois expansionism • The nineteenth century, WWI, the October Revolution, WWII • 20th century science and technology • The Cold War	
Expansion	Local history – Shanghai and its infrastructure	Themes in world history in general. Themes of different types – for example Wars in human development; modernization processes in developed countries. Key focus: China and the World since the 18th century.

The junior high school curriculum in very broad in temporal terms and broad in geographical terms. The senior high school curriculum appears to be explicitly comparatively (themes across regions).

Levels of Demand:
It is difficult to say much on the basis of the information provided. The levels offered at each stage (for example, Basic and Expansion) cater for a range of entry points / levels of demand. Recommended teaching approaches appear to be differentiated at each stage – at expansion phases, for example, it is expected that students will study by themselves and raise questions (rather than simply answer them) and that expansion students will analyze, select and present.

Progression:
In content terms it would appear that there is a clear progression between a China-centric approach at junior high school to a comparative and thematic approach to Chinese and world history at senior high school.

Assessment:
Assessment appears to be equally focused on multiple choice factual assessments that prioritize recall and deployment of information and on more open questions with narrative answers. One assessment was examined which consisted of 35 multiple choice questions (for example "Which was the cause of the French revolution?" from a provided list). Half of the available marks (75 marks) were allocated to multiple choice recall questions and half (75

marks) were allocated to narrative answers. The narrative answers consisted of stimulus material and comprehension questions on this material but also of questions that required more creative thinking (for example "What would you say if taking part in debates on schooling (and related issues) in the nineteenth century?").

Assessment enables the assessment of the more creative and student centered forms of thinking that the curriculum identifies: factual knowledge is only half the story.

Key competencies:
Competency relevant observations are apparent throughout the curriculum. Students are expected to develop the ability to:

- Collect and select information
- Use libraries and the internet
- To design questionnaires
- To use multimedia resources
- To problem solve, explain and critique
- To communicate, explain, analyze, argue and exchange ideas.

Comments on teaching approaches foreground cooperative learning and learning exercises that encourage situational learning and that encourage students to generate questions. Interdisciplinary links are encouraged.

Vocational education

Orientation and Scope
In order to maintain a thriving economy Shanghai has put in place an accelerated program of adapting its vocational provision to the service industry, the advanced manufacturing industry and emerging strategic industries.

At age 15 students can leave, or opt for a vocational or academic upper school, entrance being through an examination. In Shanghai more that 90% of resident students opt to remain in upper secondary education. Vocational schools offer coursework for two to four years in a range of occupational areas, including managerial skills, technical skills and traditional occupations such as agriculture.

In 2011 there were 81 vocational schools, which included technical secondary schools, vocational schools and technical schools with an enrollment of 51,600 students. The impetus for high quality vocational education took off in 2000 with the advent of 10 modern landmark secondary vocational schools, as part of the *Program for Key Construction of Hundreds of Schools*.

Shanghai subsidizes the vocational education of students from poorer families through free education, national grants, professional awards and Shanghai Municipal Scholarships. These grants are given to over 50% of the secondary vocational students in Shanghai. Shanghai has also worked with local industries and enterprises to develop courses that suit employers' needs. In addition it has promulgated a system of "double qualified" – in industry and education – teachers to improve the quality of the teaching force.

There are arrangements in place for employers to work directly with vocational schools and regional vocational education groups have been established. At the end of 2011, eight industrial vocational education groups that specialized in modern clinical nursing, transportation and logistics, electronic information, commerce and trade, tourism, construction, chemical industry and modern agriculture had been set up (Shanghai Municipal Education Committee 2008).

Coherence and clarity

The overall aim of vocational education in Shanghai is to train a high-quality, skilled workforce. Vocational education is skills-based and task-oriented. Curriculum is organized to reflect actual work tasks, processes and settings with direct links between the professional curriculum and jobs. At first 16 pilot schools were identified to trial researched based vocational curricula after which, in 2009, the Municipal Education Commission issued an action plan (2009-2013) the working goal of which was that "the structure and layout of majors should further adapt to needs of regional economic and social development, and a comparatively complete working mechanism of constructing majors should be basically established" (Shanghai Education Commission 2014, unpaginated) The number of courses was reduced from 717 to 621, covering 17 categories (majors).

Shanghai has put a great deal of effort into strengthening the quality and technical skills of secondary vocational students. One example of this is the biennial "Starlight" competition in which students take part. In 2011 the competition covered such areas as machining operation, vehicle maintenance and repair, IT, travel and tourism. Shanghai students also excelled in national competitions.

More than half of the secondary vocational schools in Shanghai have adopted a credit or semi-credit systems, allowing students to earn both academic and vocational course credits. Schools are overseen by steering committees that include both educators and representatives from industries and enterprises. Secondary vocational schools have set up more than 2000 off-campus practice bases in industries, with students benefitting from a combination of classroom learning and operational training. Teachers can also gain placements at local industries. Shanghai has also instituted "open practice centers" that serve adults as well as students. The centers feature simulation companies, banks, hotels and numerical control workshops. By 2010 almost 100,000 students had been trained in one of these centers, which the Committee on Education claims have "greatly improved the conditions for the secondary vocational education and ensured the realization of the 'employment-oriented' training targets.

Progression

The Shanghai Municipal Education Commission works with the Ministry of Education to oversee vocational education. The relative success of students from vocational schools in entering the job market has led the Education Commission to increase its support for vocational schools, aligning them with emerging industries: a petro-chemical academy, advanced manufacturing, information technology, Volkswagen Industry School, health, science and technology were awarded national model school designations by the Ministry of Education in 2009.

Students who go on to upper secondary vocational and technical schools can progress to regional polytechnic colleges, which provide both on-the-job training and classroom-based learning (NCEE 2013).

Shanghai's vocational high schools are not without their critics. Although Shanghai has put in a lot of effort in the first decade of the 21st century to improve its vocational offering, parents who can send their children to academic high schools – and from there onto universities – still prefer to do so. An article in the *Wall Street Journal* in December 2013 explained why:

> That's because under China's household permit system, known as *hukou*, Shanghai and other cities bar children whose parents moved from the countryside from attending academic high schools. For education past the age of 13, they can only attend vocational high schools that train them for blue-collar jobs (December 5, 2013).

This indicates that the lower status accorded to vocational education has social as well as ability aspects.

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