An American in China: Science Education in a Macao Elementary School

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Matthew Garcia is a proud recent graduate of Central Washington University (Des Moines Campus), with a BAEd in K-8 Education and a minor in K-8 Science Education. In his senior year, Matt was offered an opportunity to participate in a 10-week teaching practicum at Hou Kong Premier School in Macao, China. Matt had never travelled outside of the United States, and this experience was "the greatest adventure of his life" thus far; in addition to its being a great opportunity to broaden his cultural horizons and to observe learning and teaching in another culture. Matt was fortunate to be matched with a Chinese teacher of 5th and 6th grade science, "Mr. Roy", who also masterminded and organized afterschool STEM clubs and competitions at the school. On his return to Central Washington University, Matt shared his experiences, photos, and new knowledge with CWU science education professor, Vanessa Hunt.

About Macao:

Macao (also called Macau) is one of two special administrative regions of The Peoples Republic of China, the other being Hong Kong. Macao is an hour's ferry ride across the Pearl River from Hong Kong and is positioned on a peninsula of the Pearl River Delta, incorporating two former islands, Taipa and Coloane, now joined together by a strip of reclaimed land named Cotai.[1] The country was once a Portuguese colony, leased from China in 1557 and returned to Chinese sovereignty in 1999. Macao retains much Portuguese cultural influence, with Portuguese still one of the official languages of the region .

Macao is a small region, comprising less than 12 square miles and the permanent home of only 600,000 citizens. However, it has become known as the 'gambling center of Asia', important in this context as the resulting economic growth in Macao has provided both incentive and means to improve the educational opportunities offered to Macao citizens (below) .[2] The economy of the region currently depends upon tourism, with visitors attracted by the casinos and shopping opportunities in addition to the hybrid Chinese and European architecture, food, and culture

Education in Macao and the Hou Kong Premier School

Macao has a unique education system. In the past, under Portuguese control, education was viewed as a private good and the government did not provide public education.[3] Most schools were privately run and operated by religious organizations, businesses, non-governmental organizations, and individuals, with freedom to provide curriculum and educational experiences as they saw fit. The language of instruction was (and remains) English, Portuguese, or Chinese, depending on the operators of the school. Schooling standards were variable, and the education provided was not necessarily of high quality, especially for students of less affluent backgrounds and this decentralized laissez-faire approach was ultimately deemed detrimental to the long-term economic competitiveness of the region. In 1991, the Macao government issued the *Macao Education System Bill*, outlining long-term objectives of education in the region. To support these goals, a 15-year free education scheme was established in Macao by 1998, with the government offering subsidies to private institutions willing to provide free education to students in addition to the provision of a limited number of public schools (currently numbering 10 institutions throughout Macao).

At present, Macao provides three options for the now-compulsory schooling. There are 10 free public schools open only to legal citizens of Macao, and a few (expensive) private schools, but the dominant provision of education is through government subsidized tuition at former private schools. These last retain significant autonomy in operation and administration but are required to adhere to the government standards and objectives in their curriculum. And although these subsidized private schools provide free tuition, most require that parents pay for school uniforms and many extra-curricular activities. Thus, parental income is an important factor in the selection of a school by Macao citizens, followed by academic considerations, and the particular emphasis of individual schools, such as a focus on technology, or teaching English.

The Hou Kong Premier School

Hou Kong Premier School in Macao is an elementary (primary or' premier' school that serves grades 1 to 6) and that is affiliated to Hou Kong Middle School, serving grades 7 to 9. This school is a subsidized private school, and although technically open admission, is generally at enrollment capacity, so admission is in reality competitive. There are more applicants than available places, thus families make appointments with the principal and petition for admission for their children.

Figure 1: *Entrance to Hou Kong Premier School*

Hou Kong is a relatively new and physically impressive school. The primary school consists of seven stories, and is adjacent to a five-story kindergarten, which is a separate entity. The kindergarten building also contained dorms for visiting pre-service teachers from the United States. Between the two is an open area a little larger than a basketball court, where students gather for physical exercise once or twice daily.

Figure 2. Twice Daily Exercise!

Science Education Standards in Macao: The Basic Academic Attainments (BAA's)

Coming from Washington State classrooms, Matt was a little surprised at the apparent lack of rigorous state standards and a specific curriculum to guide teaching as he began teaching in Macao. He discovered during his internship (2016) that Hou Kong Premier School was still in the early stages of aligning its curriculum with some very new reform efforts by the Macao government.

Until the last two years, Macao schools have not been required to deliver a standards-driven academic curriculum and even now do not employ standardized testing. Schools planned their own curriculum, syllabus, assessment methods, and examinations. However, a recent and ongoing curriculum reform effort by the Bureau of Education and Youth Affairs (known colloquially in Macao as DESJ) is the codification of the BAA's: the Basic Academic Attainments.[4, 5] These Basic Academic Attainments consist of a framework outlining guidelines for academic knowledge and skills, and personal characteristics ("character") that should be acquired after completion of a

particular grade level. These new region-wide standards were required to be implemented at the kindergarten level in academic year 2015- 16, for grades 1to 3 in 2017-18, and for grades 4 to6 in 2018 – 19.[6]

The Basic Academic Attainments in STEM Subjects for Grades 1 - 6[7]

For Grade Levels 1 through 6, the new Basic Academic Attainments divide 'Science and Technology' into two areas, 'General Knowledge', and 'Information Technology' Information Technology attainments have not yet been specified by the Bureau of Education, but **Table 1** lists the specific competences in science general knowledge for this grade range. Two areas or 'Learning Scopes' are specified: Learning Scope C – *Natural Environment and Life* and Learning Scope D: *Science and Life*.

The Academic Attainments specified within Learning Scope C: *Natural Environment and Life* address general aspects of the environment with a predominantly earth and space science focus (e.g., the solar system, freshwater distribution and issues, landforms and geography) as well as some more specific content such as the phase changes of water and the structures of animals and plants. Desirable personal characteristics of the student are included within Learning Scope C (e.g., 'loving animals and plants', and a commitment to the habits of recycling and reusing resources) in addition to dimensions known to science educators in the United States as Practices and Cross-Cutting Concepts: careful observation, being able to obtain information from charts and graphs, understanding cause and effect, and discussion and exchange of opinions about environmental issues such as global warming.

The BAA's specified within Learning Scope D: *Science and Life* address areas of physical science (e.g., gas laws, heat, light, sound, electricity, magnetism, forces and simple machines) in addition to some applications of physical science to modern technology. Social issues are intertwined with the science content (e.g., modern methods of producing power and energy-saving issues) and some history of science is also included. For example, two items within Learning Scope D specify that students "appreciate the spirit of scientific inquiry by reading short stories about historical discoveries and inventions," and that students should be able to "appreciate the contributions of former scientists to social development." A limited number of lab skills are also described, such as being able to distinguish between conductors and insulators by experimentation and the ability to construct a simple electrical circuit.

Figure 3. Matt Garcia teaching 4th Grade General Studies in Macao

These Basic Academic Attainments in science are not currently as extensive, ambitious, or rigorous as the NGSS employed in Washington State, but there are some recognizable correspondences, particularly in the obvious desire of the BAA authors to introduce science in a social and personally relevant context at the elementary level.

Table 1: Science General Knowledge Attainments in Grades 1 -6 in Macao

Learning Scope C: Natural Environment and Life	
C-1-1	Be able to distinguish living and non-living things;
C-1-2	Be able to identify the morphological characteristics and living habits of common animals;
C-1-3	Be able to tell the functions of roots, stems and leaves in plants;
C-1-4	Be able to know that plants need water, air, sunlight and nutrients to grow through planting;
C-1-5	Be able to know that animals need water, food and air to grow;
C-1-6	Be able to love animals and plants, and value life;
C-1-7	Be able to have appropriate reaction according to weather forecast;
C-1-8	Be able to tell that the length of daytime and nighttime varies with the seasons, and describe the climatic characteristics of the four seasons of Macao;
C-1-9	Be able to tell how to protect themselves from such common natural disasters as rainstorms and typhoons;
C-1-10	Be able to notice that the sun rises in the east and sets in the west, and be able to tell the relationship between the sun and life;
C-1-11	Be able to notice the waxing and waning of the moon, and appreciate the beauty of the starry sky;
C-1-12	Be able to take the initiative to carefully observe the natural phenomena in daily life;
C-1-13	Be able to name the common energy sources used in daily life, and have the habit of saving energy;
C-1-14	Be able to describe the distribution and application of freshwater resources;
C-1-15	Be able to tell the sources of the drinking water in Macao, and have the habit of saving water;
C-1-16	Be able to tell that the earth's resources are limited, and form the habit of recycling and reusing resources;
C-2-1	Be able to compare the similarities and differences between the structures of common animals, and distinguish different types of animals such as reptiles, birds, fish and mammals;
C-2-2	Be able to name the types and methods of plant reproduction, and describe the characteristics of wind-pollinated plants, water-pollinated plants and animal-pollinated plants;
C-2－-3	Be able to tell the reproduction methods and characteristics of viviparous

	animals and oviparous animals;
C-2-4	Be able to illustrate with examples the structural features of plants that enable them to adapt to the natural environment;
C-2-5	Be able to illustrate with examples the morphological features and life styles of animals that enable them to adapt to the natural environment;
C-2-6	Be able to explain the relationship between photosynthesis and the growth of plants;
C-2-7	Be able to explore the influence of environmental changes on living things;
C-2-8	Be able to tell the three states of water and that the state of water varies with temperature;
C-2-9	Be able to explain the causes of natural phenomena such as rain, snow, cloud and fog;
C-2-10	Be able to describe the weather by using such meteorological elements as temperature, wind direction, precipitation and humidity;
C-2-11	Be able to compare the difference of climatic characteristics between Macao and other places by reading meteorological charts and data;
C-2-12	Be able to tell the composition of the solar system and the characteristics of its major members;
C-2-13	Be able to tell that natural phenomena such as the phases of the moon, solar eclipse and lunar eclipse are caused by the relative positions of the sun, the moon and the earth;
C-2-14	Be able to tell the geographical location, composition and the basic characteristics of the terrain of Macao;
C-2-15	Be able to name different landforms of the earth;
C-2-16	Be able to illustrate with examples the harm brought by extreme natural disasters such as volcanic eruptions, earthquakes, tornados and tsunamis;
C-2-17	Be able to discuss the non-renewable feature of fossil fuels and the harm brought to the environment by using fossil fuels;
C-2-18	Be able to name the major new energy sources, and explain how the development and application of these new energy sources can promote sustainable development;
C-2-19	Be able to explore the causes of global warming and its effects on life;
C-2-20	Be able to explore the causes and effects of such environmental pollutions as the pollution of air, water, noise and solid waste;
C-2-21	Be able to collect and organize information about natural phenomena and environment issues and discuss and exchange opinions with classmates.

Learning Scope D: Science and Life	
D-1-1	Be aware of the existence of air and be able to tell the properties of air
D-1-2	Be able to name the common light sources in daily life;
D-1-3	Be able to know the law of rectilinear propagation of light, and investigate the formation of shadow through experiments;
D-1-4	Be able to know that mirror images are formed by the reflection of light, and enumerate the application of mirror in life;
D-1-5	Be able to know that a rainbow is formed by the refraction of light, and appreciate the beauty of rainbows;
D-1-6	Be able to notice that objects vibrate when they make sounds, and investigate sound propagation through experiments;
D-1-7	Be able to tell the ways of producing heat and describe the influence of heat on life;
D-1-8	Be able to know that objects will expand when heated and contract when cooled through observation;
D-1-9	Be able to know the temperature measurement unit, and know how to use a thermometer;
D-1-10	Be able to tell that thermal conductivity varies with materials through life experience;
D-1-11	Be able to tell that a magnet has a north pole and a south pole, and discover, through experiments, the law of magnetic attraction and repulsion;
D-1-12	Be able to tell the applications of magnets in life
D-1-13	Be able to tell the safety precautions in use of electricity
D-1-14	Be able to illustrate with examples the application of science and technology in life;
D-1-15	Be able to stimulate the spirit of scientific inquiry through reading short stories about scientific inventions;
D-2-1	Be able to make a simple electric circuit with basic components;
D-2-2	Be able to distinguish electrical conductors and insulators through experiments;
D-2-3	Be able to tell that energy such as electricity, light and heat can be converted to each other, and give common examples;
D-2-4	Be able to tell the power generation methods in Macao, and develop the habit of saving power;
D-2-5	Be able to notice that forces are ubiquitous, and give common examples;

D-2-6	Be able to tell that forces can change the motion or shape of an object through experiments;
D-2-7	Be able to explain simple mechanical principles, and tell their applications in life;
D-2-8	Be able to design or make simple mechanical models;
D-2-9	Be able to enumerate the achievements of famous scientists, tell and appreciate their contribution to social development;
D-2-10	Be able to tell the course of human exploration of the universe, and show concern for the development of aerospace science and technology of China;
D-2-11	Be able to show care for the development and application of new science and technology and tell the influence of science and technology development on life.

Primary School General Knowledge: Requirements of the Basic Academic Attainments 2015. Education and Youth Affairs Bureau, 2018. Government of the Macao Special Administrative Region.

Matt's Classroom Experiences

Elementary students remain in one classroom for the duration of the school day as they do in the U.S. and there are eight one-hour class periods. The academic year in Macao spans September to June, and contains 27-35 weeks, which varies with the grade level, and does not include final exam periods.

Students in each grade level are divided into three classes, A, B, and C. All classes within a grade are at the same academic level, but the students within each class appear to be matched to the language capability of the homeroom teacher. For example, students who speak only Cantonese are placed in a class with a homeroom teacher whose primary language is Cantonese, whereas those who have some skill in English are placed in a class where the homeroom teacher speaks English. Student proficiency in English is a core objective of Hou Kong Premier School.

Even at the primary level, the teachers are not generalists but travel from class to class to teach their specialty subject: English, Cantonese, Mathematics, General Science etc. Although each class has a homeroom teacher, that teacher does not have a particular classroom which they can organize and decorate around class needs, but instead has a desk in a common area.

Figure 4 *Lab Exercise in Electricity*

Matt's position at the school involved teaching English in addition to science, and he was matched with a homeroom teacher who taught English across the primary grades. In addition, twice daily he was assigned to teach science with Mr. Roy (Roy Leung) to the upper grades (5th and 6th). Matt says: "I was amazed at the formality and discipline in the homeroom class. The teacher would always enter at the front of the room, upon which the students would simultaneously stand until the teacher said, 'Good Morning'. The students would respond with "Good morning, teachers' and a bow. They would not take their seats again until invited to do so. This was followed by 15 minutes of announcements in Chinese, after which teachers would move to their first class to teach their subject. This ritual was repeated throughout the day." Matt commented that discipline problems and classroom behavior issues were essentially non-existent in this structured environment. However, he noted that when he provided

more open-ended lessons and/or allowed students to do inquiry group work, vivacity and high spirits emerged as they engaged with the activities.

As Hou Kong Premier is a subsidized school and not fully funded by the government, the teachers are given more leeway in teaching to the standards (BAA's) than the public schools. However, the Hou Kong Premier School administration has embraced the new curriculum reform, and the teachers aim to fully incorporate the BAA's, while also endeavoring to go beyond them as time permits. Typically, teachers of each grade level team up and evaluate the textbook for coverage of topics listed in the BAA's (they use science texts published by Longman Hong Kong Education[8]) then employ other resources or design other lessons to cover topics not contained within the text. Topics from the BAA are given priority, and other material is introduced as time allowed. Science in 1st through 4th grade is subsumed under General Studies, which is an integrated blend of social studies, scientific, and technological topics. The Bureau of Education specifies that a minimum of four one-hour periods per week be devoted to general science topics, and one to information technology in the primary grades.[5] Science as a separate disciplinary subject is only offered in 5th and 6th grades at Hou Kong and is offered twice weekly for a double period.

Figure 5. Sixth Grade Chemistry

Matt found that the teaching methods in Macao tend to be traditional and structured: based primarily upon lecture and involving a great deal of memorization. The textbooks were written in English; thus, language competency of the students was a prerequisite for understanding.

However, Hou Kong Premier School is transitioning to a more active model of teaching and learning, and Matt was permitted to offer lab activities when he taught science.

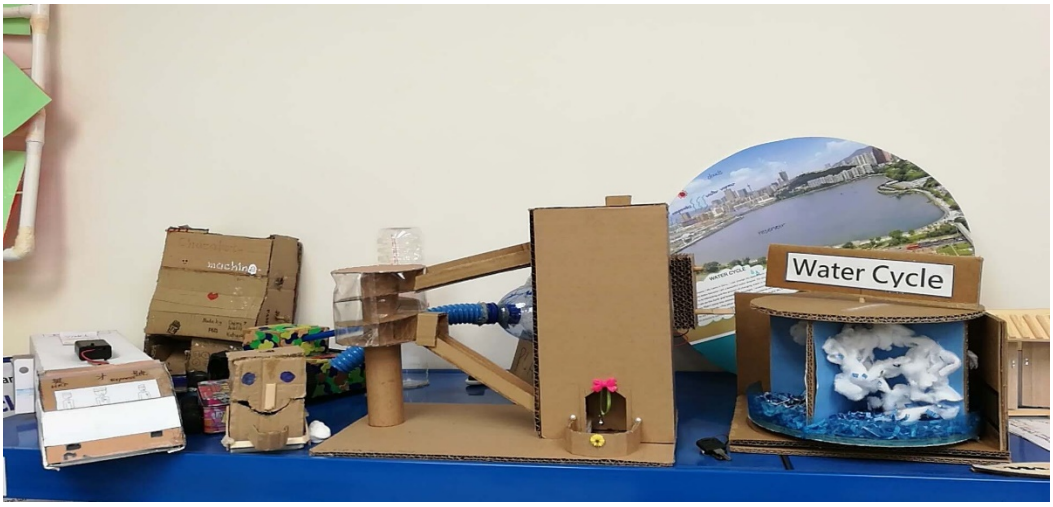
For daily formative assessment in science, students are given quizzes and homework. Summative assessment takes the form of two written tests plus a final every term, and also complete two projects per term to reflect their understanding of an assigned topic. An evaluation of the student - inclusive of exam results and the daily formative assessments - is reported to parents after each exam.

After School Science Clubs and Science Competitions

The provision of ambitious and intense after-school clubs at Hou Kong Premier School is one facet of elementary education Matt found very different from United States elementary education. The after-school science club was where Matt observed most of the challenging and stimulating activities in science at Hou Kong Premier School.

The extra-curricular clubs are conceptually a little different from their counterparts in US schools. A number of these were held on Fridays and were in reality extra classes that were compulsory for every student. On Monday through Thursday, attendance at the clubs was voluntary, although Matt observed that almost all students attend these extracurricular offerings.

Figure 6. Various student science projects



The Monday through Thursday clubs are offered during lunch in addition to after school, and parents enroll their students in these activities. Enrollment is limited, and the more engaging offerings such as science and technology themed clubs or sports activities - exclusively aimed at entering competitions - fill quickly. Teachers will recruit talented students to certain clubs, and then talk to parents if a given student is reluctant to participate.

Figure 7. A High School Entry at the Macao Exposition.

The Science Investigative Club is led by Mr. Roy Leung, the upper elementary General Studies/Science teacher at Hou Kong. This club works on science investigations, robotics, and eco-friendly activities. School competitions are a part of the school culture in Macao and Hong Kong and are instituted at four different levels: local, Macao level, national and international.

Whatever the level of competition, the students are typically required to present a problem in applied science or technology along with a tested model for its solution.

Hou Kong Premier School students have enthusiastically participated in part of an annual series of international competitions named 'International Invention and Design Expositions.' These events are sponsored by the World Invention Intellectual Property Association[9] in conjunction with local businesses that promote invention, and with city governments. The host city changes every year and the competitions typically attract about 500 entries from schools in 60 countries, with participation from students from all levels, from upper elementary grades through technical colleges. Hou Kong Premier School Science Investigative Club earned gold medals in both the Macao International Innovation and Invention Exposition 2015[10] and in the 2017 Kaohsiung International Invention and Design Exposition in Taiwan. [11]

Figure 8: *Judges Confer at the Macao 2015 Exposition*

Summary: Elementary Science Education Practices in Macao from a U.S. Perspective

Matt found the science teaching in Hou Kong Premier School to be very competent, if sometimes lacking in open-ended inquiry. However, the new Basic Academic Attainments incorporate a number of 'big ideas' and socio-scientific issues into the curriculum and as teachers find way to implement these BAA's, it is likely that more discussion and hands-on activity will **Figure 9:** *Proud Gold Medal Winners at the Macao International Invention Exposition 2015*

permeate science education in Macao schools. Another potential advantage of the system is the utilization of subject matter teachers rather than generalists at the elementary level, although Matt commented that the majority of focused disciplinary science teaching was delivered to the, 5th and 6th grades. Up to and including 4th grade, science is subsumed within General Studies classes. The advantage of this is that history of science and social aspects of science tend to be better integrated into and included within the curriculum.

Figure 9. Proud Gold Medal Winners

A disadvantage is that the hard science presented to 4th grade and below is primarily book driven and somewhat limited in its pedagogical presentation. Objectively, this is not necessarily problematic, as student test results and projects did indicate mastery of science concepts, such as simple machines and electricity. Subjectively, a young teacher (Matt) trained in the U.S. in teaching with active inquiry methods, found the approach limiting, particularly as the texts he encountered were written in English.

The opportunity to pursue hands-on science at a more advanced level at the after-school science clubs, and exposure of upper elementary students to 'professional' venues via the competitions and expositions is the pinnacle of science education achievement at Hou Kong Premier and similar government subsidized schools in Macao, and an option that is less available to public school elementary science students in the United States. These expositions and other competitions give purpose and focus to the science club activities and provide a relevant context in which to use and develop the science ideas and concepts from the regular school curriculum.

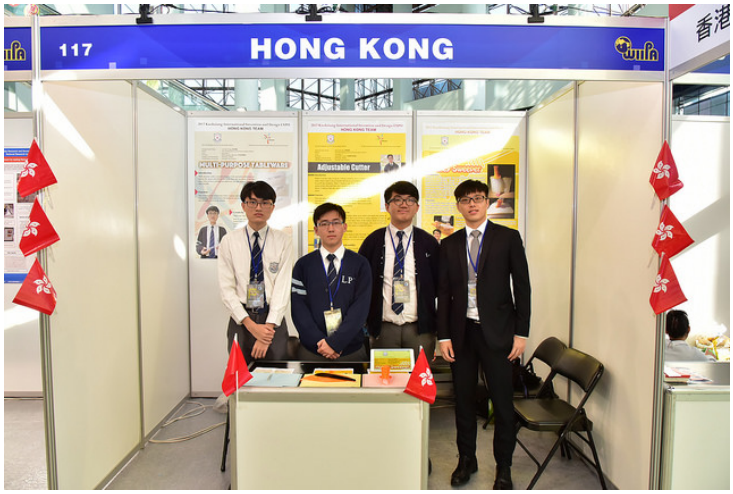


Figure 10: Young Inventors from Hong Kong at the Taiwan Exposition

Unfortunately, problems of inequity are manifested in Macao as in the United States. The texts Matt encountered at this school were written in English, presenting a problem of equity as not all students in science classes will be sufficiently fluent in English to utilize the texts. Second, opportunities to participate in extracurricular activities in science are not available to all students at a given school, as while some of the costs of competing may be covered by the Bureau of Education, much is dependent upon financial support from parents. Also, as discussed previously, not all students who wish to participate in the science clubs are able to attend, usually due to lack of capacity in the club.

However, there is hope for these areas of inequity to be addressed in upcoming years. As we stated previously, a vigorous governmental interest in education is still in its infancy in Macao but has

made considerable progress in the last two decades. As Macao's economy (ironically driven by gambling opportunities which in turn promote tourism) continues to develop, we might reasonably expect greater subsidy of education by the regional government, and less financial contribution required by parents. Market forces also drive publishing, and in the climate of economic growth, we might also expect that more provision of science and STEM texts in Chinese will become a reality in the near future.

References:

1. Yee, A. H. (1990) A Comparative Study of Macau's Education System: Changing Colonial Patronage and Native Self-Reliance. *Comparative Education* Vol 26(1). 61-71. https://www.jstor.org.stabe/3099395
2. Osnos, E. (2012, April). Letter from China. The God of Gambling:Why Las Vegas is Moving to Macau. *The New Yorker.* https://www.newyorker.com/magazine/2012/04/09/the-god-of-gamblers
3. Lua, M.Y.L and Li, H. (2014). A Multiple Case Study on the Perceived Impacts of the 15 –Year Free Education Policy in Macau. *International Journal of Chinese Education* 3(2014) 223-249
4. Education and Youth Affairs Bureau, 2018. Government of the Macao Special Administrative Region. http://portal.dsej.gov.mo/webdsejspace/internet/Inter_main_page.jsp#
5. Education and Youth Affairs Bureau, 2016. Government of the Macao Special Administrative Region. *Curriculum Reform and the Development of Primary Education.* http://www.dsej.gov.mo/crdc/edu/Pri_edu_CRD_intro_e.pdf
6. The Requirements of Basic Academic Attainments. 2018. Education and Youth Affairs Bureau, 2018. Government of the Macao Special Administrative Region. http://www.dsej.gov.mo/crdc/edu/requirements-e.html
7. Primary School General Knowledge: Requirements of the Basic Academic Attainments 2015. Education and Youth Affairs Bureau, 2018. Government of the Macao Special Administrative Region. http://www.dsej.gov.mo/crdc/edu/BAA_primary/despsasc-19-2016-anexo_ix_eng.pdf
8. Longman Hong Kong Education. https://www.pearson.com.hk/en_GB/learning-and-teaching-resources/stem.html
9. World Inventions Intellectual Property Association. http://www.wiipa.org.tw/en/about.asp
10. Macao International Innovation and Invention Exposition 2015 http://www.wiipa.org.tw/en/gallery_detail.asp?id=14
11. Kaohsiung International Invention & Design Exposition 2017 http://www.wiipa.org.tw/en/gallery_detail.asp?id=5