A CONTRIBUTION FROM MACAO, CHINA, ON TEACHING MATHEMATICS

Maria de Fátima Oliveira
Math Department
Portuguese School of Macao
Macao, China
moli.maria.oliveira@gmail.com

João Garrott Negreiros
Faculty of Creative Industries
University of Saint Joseph
Macao, China
joao.garrot@usj.edu.mo
(corresponding author)

Ana Cristina Neves
Faculty of Humanities
University of Saint Joseph
Macao, China
ana.neves@usj.edu.mo

Abstract: This present research is directly related to an international comparative analysis about success in Mathematics as a teaching subject. The main research questions are as follows: What type of network of interactions is established during the teaching-learning process of this matter? How much of what has been said and written about such process is nothing else but some form of myth? The main goals of this writing are (1) to analyze and compare the teaching-learning process at three of Macao's schools different traits (Hou Kong School, International School and Portuguese School of Macau) and (2) to explore hypothetical connections between the school's inherent traits and the academic achievement in math. A mixed methodology took place during the academic year 2012/2013 to reach the global conclusion that the teaching-learning process of Mathematics does not exhibit a unique successful model; on the contrary, it is singular according to the different subject values and cultural contexts, for example. It is also possible to understand, by means of this study, that the cultural perspective lacking of such different practicum may be responsible for the establishment of myths. For instance, the PISA 2009 Shanghai results have demystified what once was the Chinese student stereotype while, simultaneous, the Macao's results have proved that it is necessary to find the singularity of each surrounding environment to allow a greater success in learning Math.
Keywords: Teaching-learning; Mathematics; Socio-cultural; School success; International studies.

1. The problematic of teaching mathematics

Numbers rule the Universe
Plato

Much has been written on teaching-learning mathematics and studied on the causes for the academic success/failure in this area of studies. Is it a prejudice or a myth? According to Popper (2003), it is erroneous to conclude that uncertainty theory, given its conjectural and hypothetical character, minimizes its pretension of describing the reality. The Popperian conception of science relies precisely on the possibility that this can be contested. After all, what makes science move forward are not as much the experiments that confirm the theories but hypotheses as those that put them in question.

Mathematics has always been, and still is, a major area of studies in all educational systems. It is a very ancient science that has been making part of the set of school subjects for centuries, has a compulsory character for many school years and has been chosen as a criterion for education selection. It is claimed to be an absolute language, an infallible standard, the key to progress.

Besides language, among other abilities that human beings were born with, the sense of number is also innate to mankind. We are capable of determining the number of objects that make part of a collection, counting and processing simple additions and subtractions without the need for direct instruction. At age of 10, a child understands about 10000 words and speaks his/her mother tongue with 95% of accuracy. However, some 11-year old children already claim not being able to understand mathematics. How can one explain this difference? One of the reasons is that spoken language and the sense of number are survival skills, which is not the case of abstract mathematics. Thus, some people say that learning mathematics is difficult, as it is abstract and it requires a more logic and orderly reasoning. Some others allege that the various symbols used in mathematics turn it into a challenge similar to the one of learning a foreign language (Sousa, 2008).

The fact is mathematics is considered by a high number of students to be a difficult subject that deals with extremely abstract, more or less unintelligible objects and theories. However, how much of the students' opinions are intrinsic to their real experience and not only a result of reduplicated utterances heard from other voices, as echoes from their parents, friends, social media and teachers? The critics consider that solely a

reduced number of students are really incapable, in terms of cognitive development, of dealing with mathematics and that the poor performance in this subject is due to an inadequate teaching. One thing seems to be certain: students that are weak in mathematics in the early years of their studies remain weak throughout the more advanced years (Sousa 2008).

Students' performance in this area has been object of various studies, such as the International Assessment of Educational Progress (IAEP), the Third International Mathematics and Science Study (TIMSS) and the Program for International Student Assessment (PISA). Created in 1997, PISA, an OECD (Organization for Economic Cooperation and Development) program on international assessment of students, represents a commitment among the governments to monitor the results of the educational systems in terms of students' performance, within a common framework and agreed on an international level. Experts from the participating countries make part of working groups and are in charge of bringing together the goals of PISA with the best technical and scientific knowledge available in the field for international comparative assessment. Through the involvement in these groups of experts, the member countries make sure that PISA assessment tools are internationally valid and take into account the cultural and curricular context of each OECD member state.

Despite the American schools and their students have been considered for a long time as being the best, along with much of the produced theory on how to teach mathematics, these international studies reveal that American students' performance in mathematics (487 points) has relatively stagnated and lies below the 497 point average of the countries involved in the study. On the other hand, those studies have documented better outcomes in Math from Asian students, when compared to students from other countries. Fifteen year old students from secondary schools in Shanghai reached by far the best results of PISA tests carried out in 2009, with a score of 600 in mathematics. Comparatively, the best performance from OECD members, namely, South Korea, attained 546 and Finland, the best performance among Western countries, reached 541. Hong Kong and Macau, two special administrative regions of China, show a performance gap. Whilst the former reached the third place with 555 points, the latter was placed in 12th place with 525 points (see Table 1).

MATH	Points	Science	Points	Reading	Points
Xangai, China	600	**Xangai, China**	**575**	**Xangai, China**	**556**
Singapore	562	**Finland**	554	**Korea**	539
Hong Kong, China	555	**Hong Kong, China**	549	**Finland**	536
Korea	546	**Singapore**	542	**Hong Kong, China**	533
Taiwan	543	**Japan**	539	**Singapore**	526
Finland	541	**Korea**	538	**Canada**	524
Liechtenstein	536	**New Zealand**	532	**New Zealand**	521
Switzerland	534	**Canada**	529	**Japan**	520
Japan	529	**Estonia**	528	**Australia**	515
Canada	527	**Australia**	527	**Holland**	508
Holland	526	**Holland**	522	**Belgium**	506
Macau, China	525	**Taiwan**	520	**Norway**	503
New Zealand	519	**Germany**	520	**Estonia**	501
Belgium	515	**Liechtenstein**	520	**Switzerland**	501
Australia	514	**Switzerland**	517	**Poland**	500
Germany	513	**England**	514	**Island**	500
Estonia	512	**Slovenia**	512	**USA**	500
Island	507	**Macau, China**	511	**Liechtenstein**	499
Denmark	503	**Poland**	508	**Sweden**	497
Slovenia	501	**Ireland**	508	**Germany**	497
Norway	498	**Belgium**	507	**Ireland**	496
France	497	**Hungary**	503	**France**	496
Slovakia	497	**USA**	502	**Taiwan**	495
Average	497	**Average**	501	**Denmark**	495
Austria	496	**Czech**	500	**England**	494
Poland	495	**Norway**	500	**Hungary**	494
Sweden	494	**Denmark**	499	**Average**	494
Czech	493	**France**	498	**Portugal**	489

England	492	**Island**	496	**Macau, China**	487
Hungary	490	**Sweden**	495	**Italy**	486
Luxembourg	489	**Austria**	494	**Latvia**	484
USA	487	**Latvia**	494	**Slovenia**	483
Ireland	487	**Portugal**	493	**Greece**	483

Table 1: PISA 2009 results (Source: www.oecd.org/edu/pisa/2009).

Following the work of Eli and Edythe Broad Foundation (www.broadfoundation.org), American schools outcomes are the result of a failing educational system, namely in public schools. What about East Asian countries? Do they provide a better quality in math education? What are the factors that contribute to such an outstanding result among Shanghai students? Li and Nuttall (2001) lead to several explanatory factors: more mathematics courses in China's higher schools (Xu & Farrel, 1992); teaching quality in classroom (Stigler & Stevenson, 1991); parents' engagement in their children's academic results (Steinberg, Dormbush & Brown, 1992); parents' ease in dealing with mathematics (Huntsinger & Jose, 1997); the belief that hard work is essential (Skinner, Wellborn & Connell, 1990); ability (Steinberg, Dormbush & Brown, 1992) and the written language (Li, Nuttall & Zhao, 1999).

Are these results due only to the fact that China's educational system is excellent in preparing students' for exams within this Confucian cultural sphere (Singapore, Korea, Japan and Hong Kong)? Which role should be assigned to the cultural perspective and dimension? We cannot ignore the impact that Confucionism had in the teaching and learning conception and practices among the Chinese. Confucius' cultural heritage allows us to understand and explain better how Chinese students learn (Ngai-Ying, 2004). Commonly associated to this heritage are the teacher-centered practices, deeply linked to memorization, involvement of large classes and passive students coping with an authoritarian teacher that makes use almost exclusively of the expository lecture and focused on the preparation for exams. Is this not a too much of a reductive and simplistic way of putting things, if compared to the cultural heritage of Confucius?

The PISA program released a video set reporting on educational practices and policies of the countries that showed the best 2009 PISA results. Curiously, the video on Shanghai (www.pearsonfoundation.org/oecd/china.html) does not stand out for drill tests but rather a coherent and efficient support of all teachers and schools that need it. When a school faces difficulties (which would be a school with only 89% of successful exams), a school of high performance is immediately brought together and teachers and school managers of the high performance school help the school in need till its students show better results.

2. Research Questions and Limitations

In today's multicultural schools, analyzing students' cognitive types through a socio-cultural approach by highlighting potential similarities and differences of thinking, attitudes, beliefs and conception patterns of different ethnical groups is certainly a complex and didactic research task. Yet, a detailed microanalysis might allow us hypothetical inferences at a macro-level (DiPaola & Spagnolo, 2010).

Macau is a multicultural society, where different educational systems co-exist and students' school outcomes mirror necessarily the context in which they are live in. On the other hand, each school has also its own cultural identity and, thus, a research focused on the school itself might show aspects that contribute to the generic comparative international educational studies. How does the teaching-learning process operate particularly in the Portuguese School of Macau, Hou Kong School and International School of Macao? What are their specific characteristics? What do they have in common? What are their main differences? What impact do such differences have on students' academic success/failure? The general goals of the present study focus on the following sub-items: (1) Identify, describe, analyze and compare the general/specific features of Math teaching-learning process in the above mentioned schools; (2) Explore possible relations between those features and students' academic outcomes in Math.

Specifically, we seek to: (1) Gain understanding on students' opinion in three institutions with respect to Math importance, to the relation that they establish with it and to classes type that they consider more favorable to their learning; (2) Shed light on Mathematics teachers opinion with regards to their students' academic success/failure, the factors of that success/failure and the way how their work runs outside/inside

the classroom; (3) Show parents' opinion with respect on how they envision Mathematics, especially when they were themselves students, on the importance weight they give now to this subject and on the way how they monitor their children's school work.

In this sense, this research consists of four other sections, namely (III) partially review of the literature on social-cultural issues, (IV) adopted research approach that served as framework to the research design, (V) detailed and concise presentation of the data collected in the three schools including statistical analysis and respective interpretation and (VI) general conclusions. As expected, bibliography and appendices with the questionnaires carried out to teachers, students and parents wrap up this writing.

It is also worthy highlighting some of this study's limitations. These researchers do not master the Cantonese language, which made the desirable interactions to students, teachers and parents of the Chinese Hou Kong School quite difficult, and hampered class observations. Consequently and faced with the absence of a comparison item, it was decided not to request the class observations at Hou Kong School, thus missing an important source of information and reality immersion we intended to describe. Due to the need of translation, all contacts at Hou Kong School were mediated through third parties.

3. The Social-Cultural Constraint: Review of the Literature

Confucius' doctrine left a great mark in China, recognized as one of the greatest historical personalities of the Chinese culture. His teachings had a significant influence not only in the educational domain, but also in the political, economic and cultural fields, along with the ethical and moral domain. From the pedagogical perspective, this is probably the oldest philosophy that is still in place, with over 2500 years of accumulated experience and in a full swing process of application, development and adaptation to present times. Many of Confucius' sayings are still pertinent and of great relevance today.

Associating Confucius to education is, therefore, inevitable and those links are not limited to the traditional Chinese education. His large contribution to teaching ensured Confucius a very special place in history. Sometimes idolized, sometimes despised, his legacy influences one fifth of the world population. His pedagogy is currently still remarkable while experts wonder how his ideas resist to time. Certainly, Chinese are familiar with the universal validity answers of his thoughts.

Many Westerns point out incongruence regarding the positive outcomes that students of Asian countries achieve in math, since they consider their teaching is obsolete and favorable to a mechanized and routine learning, not leading to a higher skills development. A teaching system with an authoritarian, teacher-centered pedagogy and a centralized curriculum does not fit the differentiated educational needs and does not promote creativity. With obedient and non-critical students, they learn by means of drills and having exams as their final goal (Gardner, 1989; Ginsberg, 1992; Ouyang, 2000). For centuries, the Chinese believed in the value of education either for collective benefit or individual development. Positively, this education significance has both a historical and a current meaning.

Leung (2001) systematized six dichotomies when comparing the teaching of mathematics in Asia when facing Western cultures:

- Outcome VS Process - Is math essentially a product (a body of knowledge) or a process (a single way of dealing with particular aspects of reality)? Although Western and Asian scholars assert that both aspects are math components, it is their position between both extremes of this continuum scale that differentiates them. Western scholars consider their Asian homologues are outdated because they stick too much to the content, without following last decades' trend of focusing teaching-learning on the process rather than on the outcome, namely through research activities and problem solving tasks. Asian scholars believe that their Western homologues go too far in the valorization they assign to the process itself and underline the content importance in the learning process of mathematics.
- Memorization VS Significant learning: While Western memorization is linked to a mechanized and meaningless learning, Asians face it as a legitimate, perceived and interactive process of repeated practice.
- Hard study VS Recreational pedagogy: Western educators are of the opinion that it is crucial for students to enjoy themselves and have fun while they learn, whereas, from the Asian point of view, learning and study necessarily imply hard work (the pleasure of learning comes essentially from the outcomes

achieved). Huang (1969) refers, in this sense, the sentence pinned on a school wall in Beijing: "the roots of knowledge are bitter, but its fruits are sweet".

- Intrinsic VS Extrinsic motivation: For Westerns, intrinsic stimulus is overvalued and considered to be the best way of keeping students interested in studying math, whereas the extrinsic incentives, such as exams preparation is solely a cause for anxiety. Although Asia educators do not disagree on the relevance of intrinsic motivation, exams have been traditionally considered to be an acceptable motivation source for students' learning. They also consider that both can be complementary to each other, although the distinction between both types is not clear.
- Class VS Individualized teaching: From the Western perspective, individualized teaching-learning is considered to be the ideal model whilst the existence of students' classes is essentially justified for economic reasons or other resources limitations. Under the Eastern culture, education is understood mainly as a socialization process. Therefore, collective classes or group learning is highly valued. This abrupt difference leads to different understandings on the teacher's role. Western teachers have the main role to meet individual needs of students and on the basis of individualized syllabi where classes should be as small as possible. Under Eastern cultures, the professor's role as a model is essential, so teaching and learning in a group makes all the sense, whereas the group size does not represent a limitative factor. From this perspective, it is not the class size that makes the difference in the teaching-learning quality, but rather the teacher's qualifications and the manner how he leads that process.
- Teachers' scientific competence VS Pedagogy: The knowledge boom and the easy access to the Internet contributed to the belief that the teacher will not be able to compete with that potential knowledge, reducing his/her importance under the teaching-learning process. The teacher is less and less the knowledge source, merely leading students to the knowledge itself. He/she is a facilitator of learning, helping them to learn how to learn, even when him/herself does not master the content. As a result, this leads to a pedagogical competence question. According to Leung (2001), this issue happens in Western countries with mathematics teachers at the primary level. On the contrary, the image of the math educators in Asian countries is still the expert. Unsurprisingly, this math scholar image holds deep roots in the Confucian culture ("a teacher needs to have a bucket of water before he is able to give students a bowl of water").

At last, Queirós (1945), in his corrosive meditations prominent recipes on teaching, stated that in order to teach there is a tiny little formality to be observed: to know.

4. Study Description

The target population consists of Macau students who are about to finish the so-called basic education, which corresponds to 9 school years, being equivalent to 15-year old youngsters. Analogous to other countries, the present school system of Macau consists of public and private schools. According to the Education and Youth Affairs Bureau on the non-tertiary levels, under the academic year of 2011/2012, there were 78 schools of which eleven were public and sixty-seven private ones. Among the latter, sixty-six are of regular teaching, three of adult education or back-to-school education and nine are mixed.

Macau population holds a total of 557400 inhabitants (December 2011), of which 11,8% under 15 years old, 80,8% between 15 and 64 and 7,3% with 65 or more years old, being the population density of 18400 habitants/Km^2. The majority of the population's nationalities are made up of Chinese (92,3%), Filipino (2,7%) and Portuguese (0,9%).

The total number of students attending the non-tertiary level was of 73425. 70719 of those attended the regular education and were distributed as follows: 11787 (16%) - preschool; 22646 (30%) – primary education; 35726 (48%) – secondary school, of which 1601 (2%) were enrolled in the technical and vocational education and 560 (1%) under the special education program. 2706 students attended, in turn, the adult education. Finally, the total number of on-the-job teachers in the non-tertiary education reached 5284, representing an increase of about 0,3%, when compared to 2010/2011.

4.1. Portuguese School of Macau

The Portuguese School of Macau, hereafter PSM (www.epmacau.edu.mo), stands out from all the other public and private schools in the Special Administrative Region of Macau. The public schools are either Chinese or Luso-Chinese, whilst the private schools differ in the language used as means of communication which can be Chinese, English and Portuguese, as it is the single case of PSM. The particularity also stems from the fact that it is the only school where students attending basic and secondary education have to undertake external evaluation exams, namely intermediate, final and national examinations, following what was laid down in Portugal (IGEC, 2013).

PISA (Program for International Student Assessment) results of 2009 place this school above the OECD average level under the three different types of literacy: reading, mathematical and scientific. These results are higher than the average of Portugal and Macau results, as well. The stable teaching staff and the pedagogical continuity, the early prognosis of learning difficulties, the pedagogical relationship associated to a strong connection to parents and educational tutors has been identified as decisive factors for this school's success (IGEC, 2013).

4.2. International School of Macau

The International School of Macau, hereafter ISM (www.tis.edu.mo), located in the campus of the University of Science and Technology of Macau (MUST), was created in 2002. It started with 58 students and has reached over 500 pupils in 2006, attaining 950 in 2012, of which 44% stem from the region and surroundings (Macau, Hong Kong and China). Nowadays, it counts on 76 teaching staff members working full time with 3 administrative staff members.

It provides a curricular program based on the Canadian province, Alberta, and has English as the main means of instruction. This school intends to accredit local and expatriated students with the diploma of the Higher School of Alberta, which took place for the first time in June 2009, with 27 pupils that continued their tertiary studies in Australia, Hong Kong, Canada, USA and Europe.

Homework is considered a building block of this school curriculum, aiming at highlighting the contents covered in class and providing students with the opportunity to practice them. Every student has his own agenda, a notebook used as a means of communication between school and home, where a record of daily homework is kept. Although it can vary according to the subject and time of the year, the school suggests a daily time average of 75-90 minutes. Besides homework, ISM students are encouraged to practice physical exercise, read and study additional languages.

With regard to its performance in PISA, according to information gathered during the interview to the school director, Howard Stribbell, ISM has enhanced significantly its results. Whilst in 2006 it attained averages lower than the other schools of Macau, in 2009, it increased its performance by 18% in Reading (544 points), Sciences (538) and 15% in Mathematics (567), exceeding the average of Macau and reaching the best results in comparison to other similar countries.

4.3. Hou Kong Secondary School

Hou Kong Secondary School (www.houkong.edu.mo), founded in 1932, is an educational institution that declares to abide the principles "Love for the Motherland and Macau" and "Educating talents for the local society", providing equal educational opportunities to all youngsters in Macau, without class discrimination and following a policy of support to students' personal development, in terms of moral, knowledge, physical health and love for art. It has been a school of reference under the Chinese education in Macau, having received several awards in various competitions from dance contests and sport events to Mandarin, Chemistry, Mathematics and Computer Olympics.

It holds a great dimension, integrating teaching levels from pre-school to upper-secondary level and even the Academy of Talents. It counts on 196 teaching staff members and 4100 pupils of Chinese nationality, of which 2200 attend the Middle School (grades 7, 8 and 9) whilst 312 are enrolled in grade 9. It was not possible to gather information on its pupils' performance in PISA tests of 2009. The data collection regarding this school was mainly retrieved through its school principal interview, as the information available on the school's website.

4.4. Data Collection Tools

In the initial phase, the first moments were dedicated to motivate the interviewees, requesting their cooperation and assuring ethnical questions, such as confidentiality and permission to carry out interview recordings. The interviews took about thirty minutes. The questionnaires to students, teachers and parents were previously translated and ministered directly into the language used as the means of communication of each school (Portuguese, English and Chinese, namely Cantonese). They included both open/closed-ended questions based on multiple-choice and multiple response items, checklist items and rating scales. Additionally, questionnaires were ministered to all Mathematics teachers and parents (see appendices). The statistics analysis software SPSS was partially used for data treatment.

5. Results Analysis and Interpretation

5.1. Pupils

The analysis of the questionnaires ministered to students allows us to describe the population sample, regarding gender (see Table 2). Only at Hou Kong school, there was a significantly lower percentage of male students (29%) when compared to female participants (71%), unlike the records of ISM (male - 57%; female - 43%) and PSM (male - 53%; female - 47%), where the percentage of male and female participants is almost equitable.

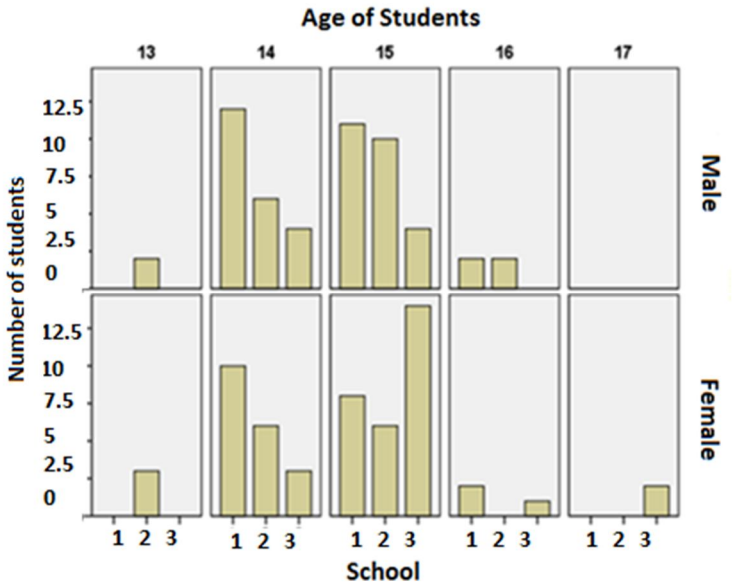


Table 2: Summary data concerning question 1 (gender) and question 2 (age) for each school (PSM=1, ISM=2, Hou Kong=3).

With regards to mother/father's studies level, the tertiary education is mostly frequently at ISM/PSM whilst in Hou Kong, secondary education dominates. In order to analyze a possible relation between father (question 5) and mother's (question 6) studies level, the coefficient χ^2 (chi-square) hypothesis was made of use under the next null hypothesis (H0): is the father's level of studies significantly different from the mother's in all three schools? Actually, there is a difference in the expected proportion of the three studies levels between mothers and fathers (the p-value of Pearson's Chi-square become lower than 0.05, which implies the rejection of H0). As well, under these three schools, pupils' majority does not refer Mathematics as a school subject they enjoy (question 7), although PSM claims for the highest percentage of students that Math is its favorite subject (Hou Kong-18%; ISM-17%; PSM-27%). From Figure 1, a summary graph is shown regarding student's outlook against several math statements.

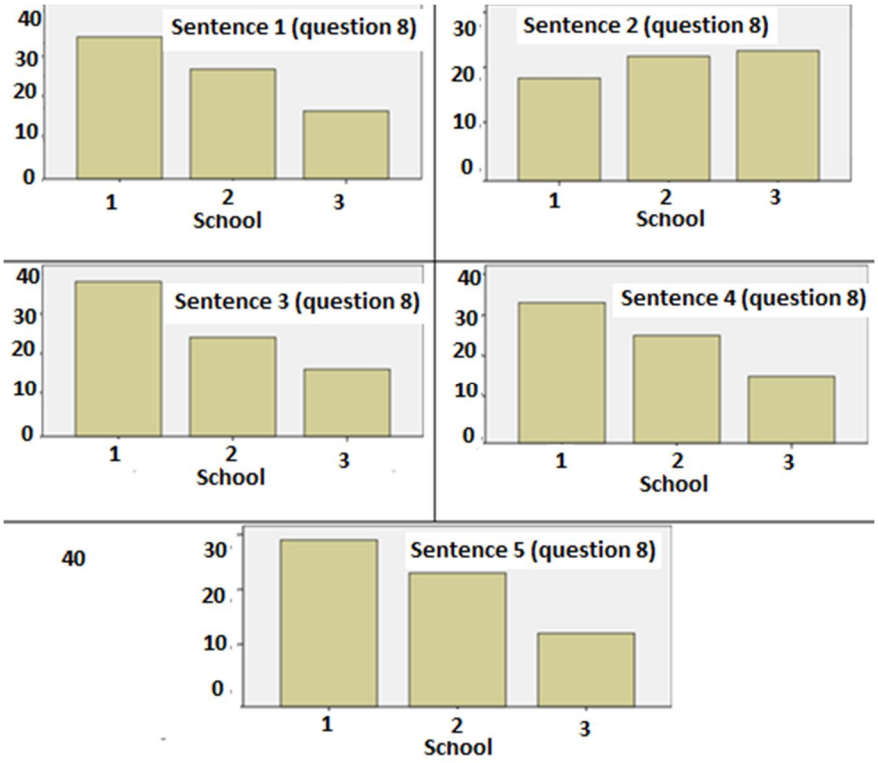


Figure 1: Results regarding Math opinion under the perspective of students (PSM=1, ISM=2, Hou Kong=3) where Sentence 1 – math help us on a daily basis; Sentence 2 – Math is a hard subject; Sentence 3- Math help us on other learning subjects; Sentence 4 – Math must be a requirement in all schools; Sentence 5 – Math is the language of science.

PSM stands out for being the school where more than one half of the students admitted to enjoy Math (question 9) but in Hou Kong, half of them claim to be indifferent. With regards to question 10 (what they most like in Mathematics), Hou Kong ranked first. Under this data set, several contents of Math were referred to as the favorite ones, with no predominance of a single one.

At Hou Kong's school, interestingly, only one student replied "Mathematics is fun, exciting and quite difficult". Unlikely, a high number of answers of this nature could be found at ISM, namely emphasizing the gratifying side of achieving a result or the fun side of learning: "To answer correctly to a difficult equation"; "The pleasure of solving difficult problems"; "I like it when there are several possible answers"; "If you know a couple of tricks, everything becomes easier"; "I like it when I can do it". Some of their answers took on a poetic touch: "The magic moment when you can do it".

For the inquire "What do you consider to be more difficult in Mathematics?", algebra stood out just as there were another broader answers such as "Interlinking of reasoning and contents" (Hou Kong); "Steps and procedures to answer specific questions" (ISM) and "Basic skills lacking that prevent one's understanding of advanced topics" (PSM). Regarding the type of class and to promote a better understanding, more than one answer was allowed:

- Lectures - Hou Kong- 29%; ISM-17%; PSM- 42%;
- Class using ICT - Hou Kong- 25%; ISM-26%; PSM-16%;
- Collaborative work - Hou Kong- 46%; ISM-57%; PSM-56%;
- Other - Hou Kong- 11%; ISM-3%; PSM-31%.

It is noteworthy the comparative highly number of PSM students for the traditional lecture class type. It should be noted, however, that the PSM sum of the different options surpassed significantly the 100% mark (Hou Kong- 111%; ISM-103%; PSM-145%) which denotes a larger multiplicity of responses selected simultaneously.

Math grade * Mother language Cross-Tabulation

		Math language				
		Mandarin	Portuguese	English	Other	Total
Math grade	Above	25	12	7	0	44
	Average	11	19	2	1	33
	Below	12	12	6	1	31
Total		48	43	15	2	108

Chi-Square Test

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	10.655[a]	6	.100
Likelihood Ratio	11.558	6	.073
Linear-by-Linear Association	2.546	1	.111
N of Valid Cases	108		

a. 5 cells (41.7%) have expected count less than 5. The minimum expected count is .57.

Figure 2: Based on the results of these three schools of Macau, what is the relationship between student's mother tongue and the success (or not) towards the knowledge level of mathematics? For a 95% level of confidence, the chi-square test indicated no significant association between these factors (acceptance of H0). In other words, this data set does not show significant differences in the proportion of mathematics final grades depending on the mother tongue usage of the students. However, to a level of 90% degree of confidence, this last assertion is no longer true (rejection of H0). Certainly, new studies should confirm this math VS mother tongue correlation.

The two major reasons pointed out for the academic failure of Math were "It was highly difficult to understand the topics addressed" and "Lack of study". For the statement "Methodology and resources used by the teacher were not the most convenient ones", Hou Kong (the rate of failure in Math is over 50%) perceived as a dominant answer (Hou Kong- 12%; ISM- 0%; PSM- 9%). For enhancement suggestions, students replied with (A) The teacher should explain the contents more slowly and as many times as needed till all students have understood them, (B) Students should study more, (C) A closer linkage to the real world matters, (D) The need for more practical and collaborative work, (E) Classes with more fun and lively activities including interaction, (F) Make use of schemata, images and drawings. It was also suggested that classes should have less pupils and those should be grouped according to their knowledge levels (ISM and PSM).

Under this global perspective, a first profile of each school's student was outlined. As expected, there are similarities between ISM and PSM students, but divergent traits can also be highlighted. The ISM student does not include Math among the school subjects preference, unlike PSM. Other trait stands out for ISM: the high appreciation for collaborative work in disadvantage of the lectures or expository lessons. The PSM student, on the other hand, s/he prefers the mixed class type but emphasizing the expository class. The Hou Kong student considers Math to be a difficult matter as it was proven with both questions 9 (What is your relationship with Math?) and 10 (What do you like most about Math?), where replies varies from "nothing" to "I don't know". This was also the case of question 16, an open-ended question, where students were asked for suggestions in order to improve the teaching-learning process of Math. No solutions were stressed.

5.2. Teaching Staff

Do PSM and Hou Kong's teachers consider their students to be successful in Mathematics? Is there any difference between PSM and Hou Kong's in how they perceive their students' results in Math? The teacher level of satisfaction is lower at Hou Kong, where only 30% falls at the top of the scale, whilst at PSM it amounted 50%.

T-Test

[DataSet2] D:\Papers\2013\Fatima\Inquéritos\Professores.sav

Group Statistics

	KongEPMProfessor	N	Mean	Std. Deviation	Std. Error Mean
Questao1	Kong	10	3.3000	.67495	.21344
	EPM	4	3.5000	.57735	.28868

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Questao1	Equal variances assumed	.128	.727	-.519	12	.613	-.20000	.38568	-1.04033	.64033
	Equal variances not assumed			-.557	6.526	.596	-.20000	.35901	-1.06158	.66158

Figure 3: Since the F-Levene's test (0128) hold a p-value of 0727, this might indicate that the variance of the samples from the teacher's questionnaires is different for both populations (non-homogeneity). The t-test cutoff value became -0.0557 (df = 6,526, p-value = 0.596), leading to the conclusion that H0 should not be rejected, that is, students of EPM and Hou Kong are considered successful students in Math, from the teachers point of view, and no significant differences on the results can be highlighted (ISM was not considered here because there was only one single teacher answer).

Taking into account the students who are not successful in Math, the lack of students' motivation accounts for this situation by all Hou Kong School's teachers. This is also the reason pointed out by the only ISM teacher that participated in this study and by 3 out of a total of 4 PSM teachers. It should be noted that both Hou Kong and PSM selected all the other possible multiple responses, namely the teaching methodologies while curriculum might not be the most adequate to their type of student, whereas in ISM the response was reduced to the lack of students' motivation and the lack of support from students' parents. Hou Kong teachers added the lack of pre-requisites, lack of self-study and social factors as possible causes.

Sharing lesson plans and materials (collaborative work among teachers) is a common practice at Hou Kong while ISM presents a 100% of positive responses, against 50% at PSM. Perrenoud (2002) approaches this individualism culture and the subsequent resistance to collaborative work, stating that "one can teach twenty years next to a colleague without having ever spoken of pedagogy and without knowing more about his practices than sheer rumors. The majority of teachers resist so much to objectivities of their professional deeds through research in what concerns the cooperative analysis of their practices among colleagues […]" (own translation, p. 96). Formosinho and Machado (2009) consider that from the individual teaching practice stands out for the "difficulty of a single teacher to individually change work situations and contexts and to build new professional skills from the work experience" (own translation, p.105).

Model Summary[b]: Question1 = Function Of (Question5)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics			Durbin-Watson		
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.247[a]	.061	-.017	.639	.061	.782	1	12	.394	2.386

a. Predictors: (Constant), Kong Question 5; b. Dependent Variable: Kong Question 1

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.319	1	.319	.782	.394[a]
	Residual	4.895	12	.408		
	Total	5.214	13			

a.Predictors: (Constant), Kong Question 5; b. Dependent Variable: Kong Question 1

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		
		B	Std. Error	Beta			Zero-order	Partial	Part
1	(Constant)	4.128	.888		4.647	.001			
	Question5	-.093	.105	-.247	-.884	.394	-.247	-.247	-.247

Figure 4: The regression model for mathematics success (question 1) = 4.128 to 0.093 × homework (question 5) is not statistically significant (H0), that is, the homework itself does not explain the success in mathematics. Note that the adjusted R2 (-0.017) is almost nil, confirmed by the ANOVA F-test (df = 1.12) for a confidence level of 95% (F (1,12) = 9.33> 0.782) . It is crucial to stress that the homework issue and its valid contribution weight to student learning cannot be viewed in a linear way, much less, measured in terms of quantity and/or duration. Undoubtedly, new studies should confirm this math VS homework correlation.

Regarding the methodology applied in every classroom (question 6), "presentation of the theoretical content/completion of various practice exercises/evaluation after a specified time" response was selected by 60% of Hou Kong teachers, whereas the ones of ISM and PSM did not select this option at all. At ISM, teachers prefer the "presentation of a real problem/association to the theoretical content using a variety of resources/final solution provided by students/evaluation and assessment by teacher" approach.

The expository class is a teacher-centered framework and considered to be a traditional practice. In the pedagogy of the so-called “new school”, the adopted methodology highlights “learning by doing” and the teacher starts from activities such as experiments, research and problem solving activities, while students work individually or in group, making use of the available information that enables them to solve the proposed problem by discussing and testing various hypotheses. This latter methodology can take on two variants depending on whether the initial task is based on a real problem (closely related to students’ daily life) or on problems whose modeling was previously undertaken by others and serve as examples on how to apply math content. Hou Kong teachers seem to identify themselves rather with the former outlined methodology whilst both ISM and PSM teachers favor the latter with its both variants.

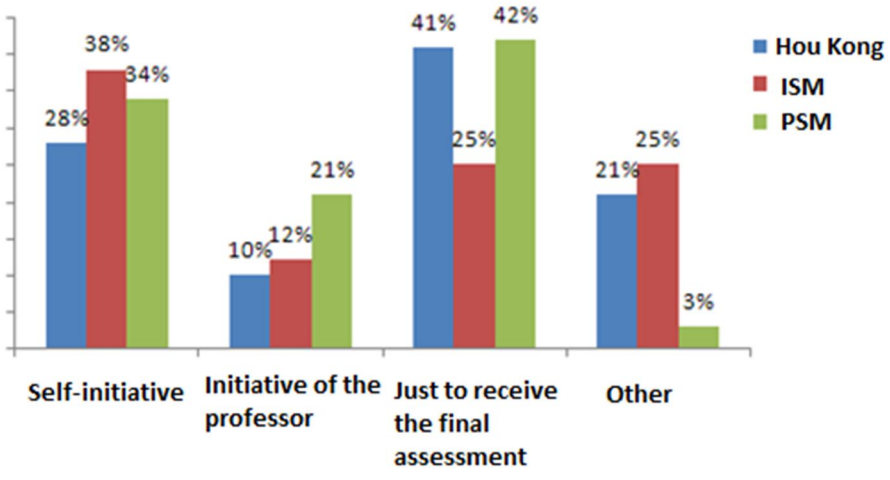
Concerning class organization and implementation, it reveals that only Hou Kong teachers selected "all activities are previously planned and executed in class according to that plan" with a total response of 60%. At this stage, it is crucial to comment about the complexity theory, advocated by authors as Edgar Morin, a French anthropologist, sociologist, philosopher and considered one of the renowned contemporaneous thinkers and major theorists of the complex thought. Morin (2008) sets the complex thought against the linear causality, claiming that the way of scientific method is misleading as by intending to fragment knowledge, it ends up undermining the sense of the whole. The complexity paradigm sets forward a mankind vision as being undivided, participative in the knowledge construction, not only by the use of reason but also the combination of emotions, feelings and intuition. This proposal requires that the teacher overcomes the fragmentation paradigm and acts according to a systemic and holistic vision when facing the teaching-learning process that involves complex and non-linear relations (Ngai-Ying, 2004). In doing so, it is not possible, nor desirable, to assure a linear sequence of students’ learning experience, nor to foresee interaction patterns to teacher, classmates and learning setting. To plan in advance all tasks and implement them in class implies an inflexibility towards educational action and prevent any desirable path change for students’ different needs and requests to be met.

5.3. Parents

The number of parents that claim to have enjoyed Mathematics as students was comparatively low at Hou Kong (55%). The percentage of PSM parents that rectified this indifference was comparatively inferior (9%). Considering a systemic vision, the following comments were gathered and organized as follows:

- "Mathematics helps us in our day-to-day life": It is a true statement for all ISM parents whereas PSM recorded 88% and Hou Kong 79%.
- "Mathematics is a hard subject": At ISM, there was a higher percentage of parents considering this statement true (75%), confirmed by the 100% support of "Mathematics help us in our daily life".
- "Math helps us on learning towards other subjects": Similar outcomes in both ISM and PSM can be uncovered, whereas in Hou Kong only 69% respondents corroborate with this statement.
- "Math should be compulsory in all levels of education": This statement caused a similar reaction as the first statement by having been selected by all ISM parents. PSM showed the lowest percentage of answers with only 55% of the parents consider that Math should be compulsory in all levels of education. Hou Kong reached 72%.
- "Math is the language of all sciences": ISM parents perceived this statement as not being completely true (38%), against the relatively high number at PSM.
- Figure 5 and 6 stresses PSM and ISM major close connection by parents when facing their children school life.

Figure 5: Distribution type of parent's contacts with teachers.



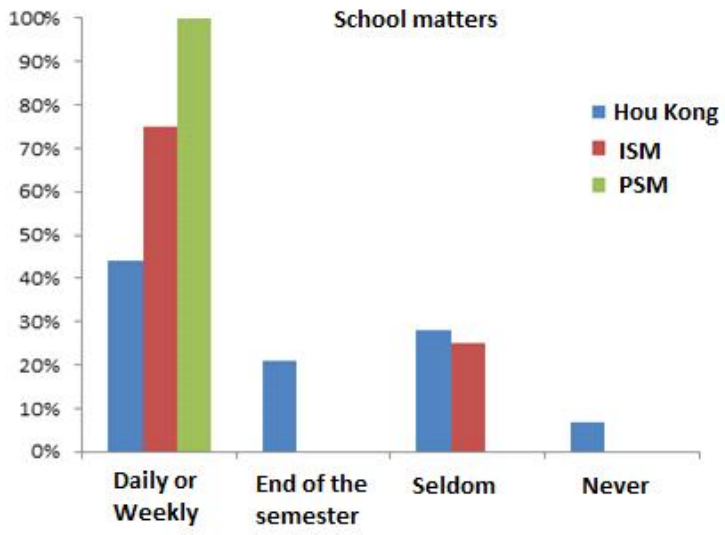


Figure 6: How often parents have a school conversation with their child?

5.4. Global Analysis of the Results

It is not easy to establish a boundary between analysis and interpretation since they are closely linked. “The analysis is meant to organize and summarize the data in such a way that it provides answers to the proposed research questions. Interpretation, in turn, aims at searching for the broadest meaning of the answers, which is achieved by linking them to previous acquired knowledge.” (Gil, 1999, p. 168).

The majority of Hou Kong pupils have Cantonese as their mother tongue, a language that is mentioned as a facilitator for learning Mathematics. Contradictorily, these students showed the highest percentage of academic failure in Math, as well as of answers indicating that this subject is particularly difficult. Considering teachers’ attitude, their level of satisfaction about students’ results is even lower, where all teachers pointed out students’ lack of motivation as the main cause for this academic failure.

What concerns the reasons for students to fail Math, Hou Kong was the only school where students pointed out the teaching methodology and the resources used by teachers as the main causes for this present status. This analysis might back up somehow the idea that Chinese teaching methods are too traditional in a teacher and content-centered framework, overlooking students’ specific needs, as supported by major relevant literature. Unlike PSM and ISM, 60% of Hou Kong’s teachers confirmed students’ answers by reckoning the follow structure: "(1) presentation of the theoretical content, (2) completion of various practice exercises and (3) evaluation after a specified time". This is considered to be the methodology that least involves students in their learning process by placing the teacher on the center of the stage (Ponte, 1992; Freire, 1975).

The considered “new school” pedagogy highlights intervention, interpretation and the process itself to the detriment of facts, curricula and contents. Dewey (1902), quoted by Crato (2006), recognized that “the danger of the new education is to consider children’s strengths and interests, things with a definitive significance". However, "dogmatic interpretations of his work linked him systematically to the ideas of the so-called modern school of romantic inspiration. Romantic not in the sense of being lunatic and foolish, but rather because it fits into an anti-rationalist philosophical and pedagogical movement, that has Jean Jacques Rousseau as precursor" (Crato, 2006).

The expository class, usually a feature of the Chinese teaching, students assumes a passive role as receivers of knowledge. Yet, it was not pointed out as a preference of Hou Kong School’s pupils. It is, however, PSM pupil’s best choice. “Collaborative learning” was the response with the highest answer rate among Hou Kong School’s students, which is in line with what can be read in the literature regarding the “Confucian cultural heritage” that values the team spirit. It is noteworthy that collaborative work among teachers, namely the sharing of class plans and materials is already a practice among all teachers at Hou Kong School and ISM, against the 50% of PSM teaching staff.

From the teachers’ point of view, students’ lack of motivation is considered to be the main reason for the failing rate in Mathematics. Interestingly, Hou Kong teachers also pointed out lack of study habits and social factors as reasons for this academic failure. The former relies on pivotal point’s negation of Confucian cultural heritage; the latter could be considered a reference to the particular features of Macau, where gambling industry rules this particular society as source of the main economic activity and of professional opportunities. This is, in fact, one of the decisive factors that distinguish the way of being and living of Macau and Hong Kong youngsters and it might even explain the results of PISA 2009.

The answers given by the students for the enhancement of teaching Math clearly indicate factors and causes diversity for the academic success or failure, which implies that Math enhancements should not be subject to a single methodological line. Quite the reverse, it will have to involve a process of methodological diversification based on coherent psychosocial grounds. If there are differences between some of the findings of the present study and others, it shows the relevance of further research in different contexts and cultures as a contribution to the enhancement of the existing theoretical models.

6. Final Considerations

The teaching-learning process of Mathematics does not hold a single model that leads to success. It is a rather unique process to differentiate contexts and cultural values. Thus, the lack of a cultural perspective of its different practices may lead to myths creation: three educational institutions, three different realities, three

distinct work cultures, integrated in an even larger cultural diversity that is Macau, a multiplicity of interactions. How to texture this web?

Mathematics and its teaching-learning process dwell often in a limbo area, between myth and reality. Contrary to what was expected, Hou Kong school's students did not achieve the best results in Math and did not show a positive attitude towards Math itself (contrary to their Shanghai counter partners) by revealing the highest failing rate in this subject. Taking into account the national results of Portugal in PISA, one could have expected PSM to attain the worst results among the three studied schools but, once again, this was not the case. It was also expected that PSM students reject the expository class type; instead, they reckoned to learn well through that, though not only, method. These situations confirm that there are no absolute truths as there is no absolute education. One cannot speak about absolute good practices in the teaching-learning process context. There is a need to open horizons, keep in mind that the ultimate goal of education research is to contribute to the educational practice improvement. Caution is imperative in the evaluation of educational practices and to be open to surprises or to let oneself be surprised.

Eastern Asia countries have been surprising us for some time with the achieved results in international evaluations on Mathematics. Long and deeply-rooted myths of these teaching countries marked by the Confucian cultural heritage, it prevented us from realizing the shifts that were/are happening there. What some consider to be weaknesses are actually assets for others. Tradition and what works out in a culture might not be successful in another.

Macau is a window that allows us to look into a reality that is supposed to be similar but, for some reason, is not. Although its 12th position of PISA 2009 cannot be considered an unfavorable result, the low percentage of students that achieved the highest marks in mathematical literacy and the even higher rate of academic failure among the 65 countries force us to keep a detail-oriented and watchful eye. This allows us to see a multifaceted reality, of which Macau makes part of with over 90% of students attending private schools with their own particularities, teaching philosophy, curriculum identity and didactic model.

Does this mean that the gambling industry plays a positive role in the youth of Macau? The answer seems to be negative. How can one revert this situation? Adopting a full set of successful practices from a specific culture to another is not necessarily the answer. It is imperative to take into account cultural differences in order to understand what should be adopted, how it should be adapted and what needs to be modified. Each culture is unique. Shanghai results in PISA 2009 demystify the stereotype of the Chinese student in what theoretically would prevent him from gathering above-average results while Macau outcomes confirm the need to search for extra factors in a more successful learning of Math.

Bibliography

CRATO, N. (2006). Desastre no ensino da matemática: como recuperar o tempo perdido. Lisboa: Gradiva.

DIPAOLA, B., Spagnolo, F. (2010). European and Chinese cognitive styles and their impact on teaching/learning mathematics. Journal of Mathematics Education. 3, (2), 139-153. [online, educationforatoz.com/images/11.Benedetto_ Di_Paola_Filippo_Spagnolo.pdf].

FREIRE, P. (1975). Pedagogia do oprimido. 2a edição. Porto: Afrontamento.

GHIGLIONE, R., & Matalon, B. (2001). O inquérito (4ª ed.). Lisboa: Celta.

GARDNER, H. (1989). To open minds: Chinese clues to the dilemma of American education. New York: Basic Books.

GIL, A. C. (1999). Métodos e técnicas de pesquisa social. São Paulo: Atlas.

HUNTSINGER, C. S. & Jose, P. E. (1997). Cultural differences in parents' facilitation of mathematics learning: A comparison of Euro-American and Chinese-American families. Paper presented at the annual meeting of the American Education Research Association, Chicago, IL.

LEUNG, F.K.S. (2001). In search of an East Asian identity in mathematics education. Educational Studies in Mathematics, 47, 35-51.

LI, C. & Nuttall, R. (2001). Writing chinese and mathematics achievement: a study with chinese-american undergraduates. Mathematics Education Research Journal, 13 (1), 15-27.

LI, C., Nuttall, R, & Zhao, S. (1999). The effect of writing chinese characters on success on the water-level task. Journal of Cross-Cultural Psychology, 30, 91-105.

MA, L. (1999). Knowing and teaching elementary mathematics: teachers' understanding of fundamental mathematics in China and the United States. N.J.: Lawrence Erlbaum Associates.

MORIN, E. (1995). Introdução ao pensamento complexo. Lisboa: Instituto Piaget.

NGAI-YING, W. (2004). The CHC learner's phenomenon: its implications on mathematics education. In Lianghuo, F. et al. (Eds) How Chinese Learn Mathematics: Perspectives From Insiders. Singapura: World Scientific.

PONTE, J. P. (1994). O estudo de caso na investigação em Educação Matemática. Quadrante, 3 (1) 3-53.

POPPER, K. (1957). Philosophy of science: a personal report. In C. A. Mace (ed), British Philosophy in Mid-Century – A Cambridge Symposium. London: George Allen & Unwin.

POPPER, K. (2003). Conjecturas e refutações. Coimbra: Almedina.

QUEIROZ, E. (1945). Notas Contemporâneas. Lisboa: Lello.

SKINNER, E. A., Wellborn, J. G., & Connell, J. P. (1990). What it takes to do well in school, and whether I've got it: A process model of perceived control and children's engagement and achievement in school. Journal of Educational Psychology, 82, 22-32.

SOUSA, D. A. (2008). How the brain learns mathematics. Califórnia: Corwin Press.

SOUSA, I.C., (2010). Confucionismo. In U. Macau, Ditema: Dicionário Temático de Macau, Volume I. Educational Studies in Mathematics, 47, 35-51.

STEINBERG, L., Dormbusch, S. M., & Brown, B. B. (1992). Ethnic differences in adolescent achievement: An ecological perspective. American Psychologist, 47, 723-729.

STIGLER, J. W., & Stevenson, H. W. (1991). How Asian teachers polish each lesson to perfection. American Educator, 15, 12-20, 43-47.

XU, J., & Farrell, E. (1992). Mathematics performance of Shanghai high school students: A preliminary look at gender differences in another culture. School Science and Mathematics, 92, 442- 445.

Appendices

I – ENTREVISTA / INTERVIEW / 訪談

Questões a colocar à Direção da escola

Questions to address to the Principal of the school

給學校行政人員之訪談問題

1 - Quantos anos de experiência têm os professores de Matemática desta escola?
- In general, how many years' experience do Math teachers have at this school?
- 這間學校的數學老師有幾年教學經驗?

2 - Há rotatividade ou permanência dos professores na escola?
- Is there a turnover of teachers or do they stay in the school?
- 這間學校老師更換率或長期任職穩定度為何?

3 - Os professores são avaliados? Por quem?
- Are teachers assessed? By whom?
- 老師會被評核嗎? 由誰來評核?

4 - Há um programa de formação contínua de professores? Em que moldes?
- There is a training program for teachers? In what form?
- 是否不斷提供老師訓練課程? 這些課程以何種形式進行?

5 - Qual a percentagem das aulas de Matemática em relação ao total?
- What percentage are Maths lessons comparing to the total of classes per week?
- 數學課相對於學校所有課程之比例為?

6 - Qual a distribuição semanal (número de aulas por semana?
- What is the weekly distribution (number of classes per week)?
- 每星期有多少堂數學課?

7- Qual a duração de cada aula?
- How long is each lesson?
- 每一次課的時間為?

8 - Qual o número de alunos por turma?
- How many students are there per class?
- 每班有多少學生?

9 - Qual o critério para agrupar os alunos numa turma?
- What criteria is used for grouping students in a class?
- 將學生分至個別班級的標準為?

II – STUDENT'S QUESTIONNAIRE

1. Gender
( ) Female ( ) Male
2. How old are you? _____
3. What is your mother tongue?
( ) Chinese ( ) English ( ) Portuguese ( ) Other. Which?_____
4. What is the language in which you usually communicate?
- At home

( ) Chinese ( ) English ( ) Portuguese ( ) Other. Which?_____
- With your friends

( ) Chinese ( ) English ( ) Portuguese ( ) Other. Which?_____

5. What is the level of education of your father?
( ) Primary ( ) Secondary ( ) University
6. What is the level of education of you mother?
( ) Primary ( ) Secondary ( ) University
7. What is your favourite subject? _____
8. Regarding **your opinion about Math**, mark the following sentences with **T** (true) or **F** (false)?
( ) Math helps us in our day-to-day life.
( ) Math is a hard subject.
( ) Math helps us on learning towards other subjects.
( ) Math should be compulsory in all levels of education.
( ) Math is the *language* of all the sciences.
9. What is your relationship with Math?
( ) I like it ( ) I do not like it ( ) It is indifferent to me.
10. What do you like most about Math?
11. What do you think is the hardest topics in Math?
12. In which type of classes do you believe you learn best?
( ) Lectures
( ) Classes using Information and Communication Technologies (ICT)
( ) Collaborative work (groups/pairs)
( ) Other. Please specify_____
13. When compared to your class colleagues, your grade in Math is:
( ) Above average ( ) Average ( ) Below Average
14. During your school life, have you ever failed Math?
( ) Yes ( ) No
Have you ever failed any other subject?
( ) Yes ( ) No
If yes, what/which subject(s)? _____
15. In case you have failed Math, the mainly reason was:
( ) You simply don't like Math.
( ) It was very difficult for you to understand the topics addressed.
( ) Lack of study.
( ) Little interest from you.
( ) The methodology and resources used by the teacher were not the most convenient ones.
( ) Poor attendance in class.
( ) Other. Please specify._____
16. What do you suggest to improve the process of teaching-learning of Math?

III – PARENT'S QUESTIONNAIRE

1. As student, what was your relationship with Math?
( ) You liked it ( ) You did not like it ( ) It was indifferent to you.
2. As a student, your grade in Math when compared to your class colleagues was:
( ) Above average ( ) Average ( ) Below Average
3. Regarding your opinion about Math, mark the following sentences with T (true) or F (false):
( ) Math helps us in our day-to-day life.
( ) Math is a hard subject.
( ) Math helps us on learning towards other subjects.
( ) Math should be compulsory in all levels of education.
( ) Math is the language of all the sciences.

4. Do you usually discuss your child's behaviour and/or progress with his/her teacher(s):
( ) On your own initiative
( ) On the teacher's initiative
( ) Only when you collect the end of term assessment sheet
( ) Only when you collect the end of term assessment she
( ) ----------

5. Approximately, how often do you talk to your child about:

- School matters
  ( )daily or weekly ( ) at the end of the semester ( ) rarely ( ) never
- Socio-political and economic issues
  ( )daily or weekly ( ) rarely ( ) never

6. ----------

IV – PROFESSOR'S QUESTIONNAIRE

1. In general terms, do you consider that your current students are successful in Math?

(Place your opinion on the scale below)

I----------I----------I----------I----------I

0% 25% 50% 75% 100%

2. In the case of students who are not successful in Math, why do you think this happens?

(Select one or more options)

( ) The teaching methodology is not the most adequate one to the student.

( ) The curriculum content is not the most adequate one to the type of student

( ) The student lacks motivation to learn

( ) There is lack of support from the student's parents

( ) Other. Please specify._____

3. Regarding the teaching of Math, please rank the following aspects on a scale of 1 (minimum) to 10 (maximum).

( ) Scientific knowledge.

( ) Knowledge of the students by the teacher (for instance their different types of intelligence: linguistic, logical-mathematical, musical, spatial, bodily-kinaesthetic, pictorial, intra-personal, interpersonal).

( ) Use of Information and Communication Technologies (ICT).

( ) Use of group/pair work.

( ) Lectures.

4. Do you share the preparation of classes with other teachers (collaborative work)?

( ) Yes ( ) No

5. *Homework is essential to student learning.*

On a scale of 1 to 10, state your degree of agreement with the previous statement.

Not at all Completely agree

1 2 3 4 5 6 7 8 9 10

6. In general terms, what is the sequence of pedagogical work in the classroom that you most often use? (Please select one option)

( ) Presentation of the theoretical content / Completion of various practice exercises / Evaluation after a specified time.

( ) Presentation of exercises to be solved / Association to the theoretical content / Presentation of more exercises to be solved / Evaluation after a specified time.

( ) Presentation of a real problem / Association to the theoretical content using a variety of resources / Final solution provided by students / Evaluation and assessment by professor.

( ) Other. Please specify.

7. Which type of resources do you use in class?

(Select one or more options)

( ) Classic/interactive whiteboard

( ) Projector

( ) Textbook and activities

( ) Other support materials (for instance solids, ruler, set square/triangle, compass,...)

( ) Objects/materials from real life situations

( ) Calculator

( ) Computer

( ) Other. Please specify. _____

8. Regarding the organization and implementation of your class, please indicate in which situation you identify yourself the most. (Please select one option)

( ) All activities are previously planned and executed in class according to that plan.

( ) Only part of the activities are previously planned. The development of the remaining class is improvised.

( ) Hardly any part of the activities is previously planned. I plan only what content will work in the classroom and most of the activities are developed during class.

( ) I strictly follow the content sequence of the official book / programme and the activities proposed there.

( ) Other. Please specify.