01 Value the nurture of the students' scientific research capacity

I. Introduction

In the current trend of advocating quality education how to help our students to cultivate the consciousness and capacity of creativity is a new theme to be faced by every educator. Quality education is a main channel of classroom teaching. However, how to equip the students with various sorts of abilities in class? Through the nurture of scientific research capacity, the students are instigated to raise questions, analyse difficulties and solve problems. This is an important and effective method to meet the required end. The mentioned scientific research means the students may utilize the acquired knowledge to appreciate scientific speculation and to comprehend the method and the process of the activities that the scientists used to adopt to investigate Nature. By undertaking the procedure of scientific research activity, the students may learn and may combine what they have learned to observe, to reason and to speculate so as to take the active move to acquire the comprehension of the knowledge. During the process of learning, the situation of information grasping is extended to information searching. The latest << Curriculum standard of National Science of U.S.A>> published in the States clearly demonstrates that Scientific Research is the nucleus of Fundamental Education. This shows that the nourishment of the capability of Scientific Investigation takes a very important position in the Fundamental Education Stage. Therefore, in the process of teaching, teachers have to nurture the students' capacity of Scientific Investigation wherever the pedagogic material permits. Here are the few points which I have drawn from my Chemistry teaching to reflect on the cultivation of the students' ability of Scientific Research.

II. A Few points to ponder on the development of Scientific Research

There are various modes to conduct a scientific research. Basically it is actualized through the following elements.

1. Question Raising

Normally, the secondary students are curious about the phenomena of Nature, Life and Experiment. During their observation, investigation and reading, the teacher has to encourage and guide the learners to discover the problems therein in order to activate the process of acquiring a solution to the uncertainty through scientific researches. Michael Faraday, a British scientist of the nineteenth century, was greatly interested in the greasy liquid in the coal gas barrel and brought out the question of what that thick liquid was and what material structure it belonged to? Due to the series of questions of physical and chemical nature, he, therefore, succeeded to settle a succession of problems and gained a distinguished reputation in history. Inspired and stimulated by the examples of the scientists, the students are encouraged to be observant in their daily life and be conscious persons who will never let go any problem on their way. Only in this way that discoveries will be manifested. Students are usually limited by the knowledge imparted by the teacher in the classrooms and dare not to surpass even a little of the direction. In this way, what the learners will ask are only some main points or some obvious difficulties perceived in knowledge absorption. For the topic of <<Electrolysis and Electroplate>>, most students would understand that a coat of a thin layer of metal could be electrometalized onto the surface of another metallic article after the impartation of such a lesson. Nevertheless, is there any chance of speculating, in the sense of daily life and productivity, that even a plastic surface can also be electroplated? We often say that it is more important and more meaningful to raise a good question than to solve a problem. How to arouse the students to be more active in thinking and to bring out questions from the process of learning, living and social practice is a theme that a secondary school teacher has to value when he/she is in class.

2. Courageously conjecturing and assuming

Collect all the relevant information and associate them with the acquired chemical knowledge and questions to try to conjecture and assume theoretically. This is a speculative procedure which must be logically done while at the same time being creative and achieving a breakthrough. Furthermore, it is important to see if it is ready for tentative examination which can be tested by experimenting, information checking or other statistics or data verifying. In the primary stage, the teacher has to encourage students to speculate widely and be courageous enough to overcome the bondage of "the teacher didn't say so". During lesson time, the teacher has to set some time for the students to delve into digestive thinking. Should the learners find no way to start, the teacher may hint at a point and guide them along. Never consider such a practice to be time-wasting or hindering the syllabus flow and throw the answers out without waiting for the students' response. It is absolutely not proper for the current quality education operation. In the world of today, the growth of knowledge is in geometric progression and there is really much to be acquired. We cannot stress how much they can master in school but help them to nurture the capacity of learning, question raising, problem analysing and solving. It is in this way that we are able to cultivate the men of talent required by the world.

3. Experiment setting and Assumption testing

Set the project of experiment in accordance with the aim of the research and the actual situation available. Select a suitable scheme of experiment to carry out and design its logic procedures. Try to utilize the obtainable apparatus, equipment and technique to actualize the objective. Before the experiment, plan the details of the steps carefully considering also the factors affecting the result

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of the experiment. Of course, such an elaborate preparation is quite difficult for the secondary students and so it needs the guidance of and assistance from the teacher during a certain stage. It is wise to start first with a simple project. When the technique is well drilled with a solid foundation, try to take up a more complicated practice. However, please bear in mind to let the students understand that no matter how logical the motion seems to be, it has to undergo experimental proofs before the suggested subject can be acknowledged as the truth, otherwise, it is only a conjecture. What Robert Boyle said is very true: Without the actual experience, we can never acquire a thorough understanding of the new proposition.

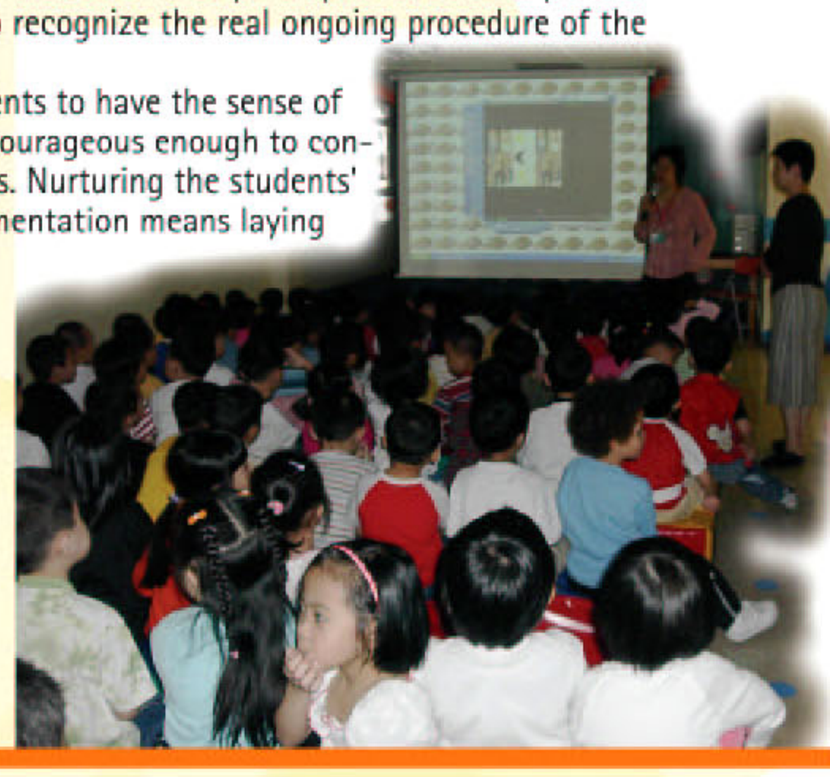
4. Should the assumption fail to stand, try another motion until it is confirmed to be a theory

For any event, we usually start from being ignorant of it to being quite acquainted with the affair and then finally arrive at full cognition of the whole matter, the process of which comprises a gradual progress. Therefore, it is normal that an assumption may fail to stand in the beginning. Then, after a few unsuccessful motions, we come to understand the problem from different situations which is very proper for the rule of recognizing things or affairs from objective views. When Friedrich August Kekul, a German Chemist, who before discovering the structure of the molecule of benzene, had undergone many assumptions and many times of adjustments so as to come to know about the structure of benzene, leading us to understand the true situation by and by. Therefore, during scientific researches, all teachers should stress the requisition for being bold to be creative. One has to be persistent and resolute until the matter is clearly understood.

III. Conclusion

Scientific research includes mainly the four elements of question raising, courageously conjecturing and assuming, experiment setting and assumption testing, and theory confirming. Through a properly selected topic for classroom impartation allow the students to participate the actual process of the scientific research to recognize the real ongoing procedure of the scientific investigation.

This may instigate the students to have the sense of question raising and to be courageous enough to conjecture creative assumptions. Nurturing the students' persistent morale of experimentation means laying a solid foundation of the operation of scientific research of the future.



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02 澳门科普教育的机遇与挑战

—专访科技委员会委员唐志坚先生

第9/2000号法律《科学技术纲要法》中有明确条文鼓励科学技术知识的教育和推广。其具体内容包括鼓励学校和社会对教师提供科学技术知识的培训；支援学校在教育上运用先进的资讯科技；协助学校建立完善的资讯科技教育网络。与教育实体合作，采取必要的措施，将科学技术知识的教育融入课程体系，并定期进行检讨。推动社会对科学技术的关心和认识，提升市民尤其是青少年的科学技术素养。

《教师杂志》专访科技委员会委员、科普小组召集人唐志坚先生，目的是让广大教师进一步认识本澳科普教育的现况以及科技委员会的工作。

问：澳门特别行政区政府近年十分重视科学技术的发展，除了颁布了《科学技术纲要法》，也成立了科技委员会。作为委员之一，唐先生可否向《教师杂志》的读者介绍一下科技委员会目前的工作和将来的发展方向？

答：科技委员会的性质是一个谘询机构，主要是就科技政策向行政长官提出建议，并配合施政方针提出一些政策性的意见。

现时的工作大致分成三个部分。第一部分是科技发展基金方面，该基金主要支持一些从事科研、开发、创新以及把科研成果转化成产品等的单位机构，包括高等教育机构、研发机构和企业等；同时也会奖励在科技方面有成就的人士。基金的草案现已基本完成，目前正处于修改细节条文的阶段，预计今年将会正式成立。第二部分是如何推行科普工作和推广科普教育，科技委员会已经制作了一本计划书交给行政长官。第三部分是作为科技中介人的工作，推广科技产品，帮助企业引入和应用创新的概念、创新的产品等。科技委员会在这三部分的工作都已取得一定的进展。

教师比较关注的是科普工作及科普教育的推广。我们把科学技术的发展用两只翅膀来作比喻：第一只翅膀是科技创新，第二只翅膀是科学普及。要同时具备两只翅膀，科技才能得以发展。过往一些人只想到创新、创造发明或提升生产力，未能意识到科普的重要性。其实科技作为生产力只是科学发展的其中一只翅膀，要真正做到科学技术的发展，就需要另一只叫科普的翅膀。科普是指全民科学知识的普及，如果社会的科普工作做得不好，社会的发展就会遇到阻力，人会欠缺科学的思维方法，这是一个很重大的议题。科普推行得不好，社会上迷信的风气就会满天飞，只会用唯心的思维方法。社会上的科技产品日新月异地推出，但是人的思维跟不上，就会出现很多违反科学的迷信行为或现象。有了这两只翅膀，科学才能真正得到发展。

很多国家和地区，不论是先进国家还是发展中国家，都很重视教育学生的科普知识。欧美很多中型城市都投入很多资源建立科学博物馆、科技馆等作为科普教育的基地，也投入人力物力促进青少年接受科普教育。很多社会活动都围绕著这方面开展。教育界的责任很重，特别是如何向青少年进行科普教育，使青少年从小就养成“学科学、爱科学、用科学”的精神。近二三十年来对成年人开展科普活动和教育也越来越重视。

问：澳门的科普推广在目前已进行了哪些工作？以后有哪些长远的发展计划？

答：科普小组已经拟定了一份意见书，并已在科技委员会讨论过。意见书大致可分成短、中期和长期计划。

短中期计划是指在二至五年间开展的几项工作。第一项是配合科技馆的建成，如何充分发挥科技馆在科普方面的推广作用。第二是进行科普导师的人员调查，培训科普的导师队伍。导师均是科普领域的专家，以后会靠这批专家去推行一些计划，而且可以到学校进行推广，也可以在社会上组织一些活动。因此需要调查这方面的人力资源和培训工作。第三项工作是想建立一些科普教育基地，目前澳门尚未有科普基地。澳门只有一些科技含量较高的政府部门及公、私立机构，这些部门和机构本身的科技含量高但并不等于能成为科普基地，所以将来先要建立一些科普基地，把科技含量高的公共机构或私立部门提升变成科普教育基地。比如说天文台的知识含量很多，在天文和气象等方面有很多工程师和技术人员，本身有较高的专业职能和技术。但要提升成为科普的教育基地，就要有一些教育配套措施，例如向到来参观的学生和公众进行讲解，目的是要

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