Aust. J. Phys., 1995, **48**, 259–65

Cultural Influences on Physics Education*

Gao Lingbiao

Center of Curriculum Study and Teaching Material Development,
South China Normal University, Guangzhou 510631, P. R. China.

Abstract

This paper gives a brief description of the cultural influences in China today on education in general, and on the teaching and learning of physics in particular. The discussion focuses on (a) the emphasis on moral and intellectual development as the aims of physics education, (b) the content of the school physics course, teaching strategies and the reform of physics teaching, and (c) students' approaches and conceptions of learning, their ways of thinking and their understanding of concepts in physics.

1. Introduction

About fifteen years ago, China started its open policy and accepted new teaching–learning strategies from the outside world. The one that received the most attention was the 'discovery learning strategy' promoted by J. S. Bruner. Many Chinese educators and teachers claimed that they were practising this strategy in their classroom. I, as a researcher, attended and observed many of these so-called experimental classes. I was surprised to see that the classroom situations were very different from what I expected. Students' activities were highly restricted and directed by the teacher. Teachers suggested questions for students to study, gave students instruction on how to perform or observe the experiment, and showed them the way towards the conclusion. After showing some of the video tapes from the U.S. to those teachers, I asked them: 'Why is your classroom situation so different from that in the video? What do you mean by "discovery learning" and what can students discover in your class?' The answer was that they did not appreciate the classroom atmosphere shown by the video from the U.S. and did not really think that students could discover anything in the classroom setting. What they tried to do was to let the students get a feel of the process of discovering (Gao 1986).

This experience told me that teachers with different cultural backgrounds understand things and perform and behave in very different ways. As an important connection in the chain of human culture, teaching behaviours and, in

* Refereed paper based on a plenary lecture given to the joint Sixth Asia Pacific Physics Conference and Eleventh Australian Institute of Physics Congress held at Griffith University, Brisbane, July 1994.

0004-9506/95/020259$05.00

a larger sense, education in a certain society are greatly influenced by its cultural background. In the field of physics education in China, a variety of things, including the aims of physics education, the design of the curriculum, modes of teaching and testing etc., are greatly influenced by the Eastern/Chinese culture.

2. Emphasis on Moral and Intellectual Development in Physics Education

The Chinese tradition in education emphasises students' moral development. Educators and physics teachers in China follow the Chinese tradition and try to cultivate students both intellectually and morally through the physics course (State Commission of Education of P.R. China 1983, 1987). In a recent study, my research group interviewed more than fifty physics teachers, all of whom contended that students' intellectual development should not be separated from their moral development, and that the aim of physics education should focus on the development of students' quality and potential in science (Gao 1994). Fig. 1 illustrates the factors that influence student quality and potential in science in this view.

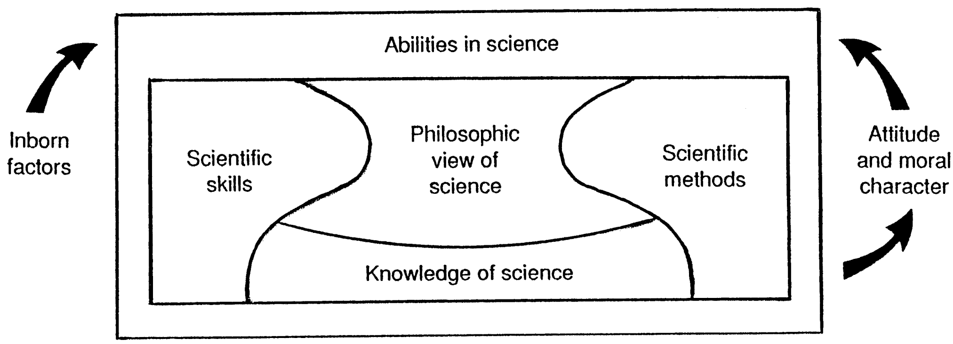

Fig. 1. Factors influencing student quality and potential in science.

Students' character and attitude are regarded as very important indicators of their quality and potential in science. We asked the teachers to rank students according to their view of student quality and potential development in science; the results are shown in Table 1.

Table 1. Student quality and potential development in science

Student attributes	Ranking (%)
Good moral character and excellent intelligence	100
Good moral character and medium intelligence	82
Medium moral character and excellent intelligence	75
Medium moral character and medium intelligence	73
Good moral character and low intelligence	65

All teachers hold the view that they do not only teach physics in the classroom, but also set up some sort of role model for students. They try to perform their best both morally and intellectually in teaching physics.

Parents hold similar points of view. In answering the questionnaire, 92% and 86% of the parents agreed that teachers should tell more historical stories and stories about scientists in class, 91% of them thought that the teacher's exemplary role is important, and 80% of them hoped that the course will give their children a proper philosophic view of the material world (SPAQIS Reports 1994).

The fostering of students' characters and attitudes is always one of the common goals of the school physics course in the national syllabus published by the Chinese government (State Commission of Education of P.R. China 1983, 1987, 1990). Historical stories of science and stories of the outstanding scientists have been included in the school physics textbooks to promote the philosophic view of science and aid in setting up role models for the students.

3. Influences on the Content of Physics Courses

There is an old Chinese saying: 'In books there are golden houses and beautiful girls'. It means that if you study hard, you will eventually own everything you want. From this old saying we can see that the Chinese culture emphasises the value of knowledge, especially book knowledge. Knowledge is important not only in fostering students' ability, but also in developing their moral character and behaviour. On the other hand, the Chinese culture disparages technical skills as trifling skills. This is extremely harmful to education in physics, and to science in general. In the national school physics syllabus, the fostering of experimental skill is one of the major aims but is not actually practised. The total number of teaching hours of senior middle school physics is about 340, but there are only 27 hours for student experiments (State Commission of Education of P.R. China 1990). There are no feasible objectives and evaluation of practical skills. The national university entrance examination syllabus lists 116 knowledge units but only 17 student experiments (State Commission of Education of P.R. China 1994), and the exam is a paper-and-pencil test. There is no way to test the students' experimental skills. The result is that many schools in rural areas do not cover the experiments. Physics learning has become solely book learning.

Chinese tradition attaches great importance to theoretical knowledge. In deciding on the content of the physics course, teachers pay much more attention to the essential physics concepts, principles and laws. They do not like the idea of using everyday problems or applications as a scheme or basis for the physics course. They contend that it would be impossible to give students an overall view of the subject or a firm starting point for further learning (Gao 1988). Subsequent to Mao Tse Dong's criticism of this theoretical tradition, all schools in China cancelled physics courses during the Cultural Revolution. In its place, a course based on the principles, structure and operation of 'engines, electric generator, electric motor and water pump' was implemented in all schools. This proved to be a total disaster to physics education and the whole education system. It is therefore very difficult today for anyone to suggest basing school physics on daily life or applied topics.

Chinese culture emphasises the unity of things and the interrelationship between things. Physics teachers would hardly agree to any change which may break down the knowledge structure, worrying that it is impossible to give students a clear understanding of the interrelationship between different parts of physics knowledge. Many physics teachers in China are opposed to the Integrated Science course, arguing that the different parts of the course do not seem to harmonise with each other. They consider that with the integrated course, students can only pick up the physics knowledge here and there. It is difficult to show students the interrelationships between different part of physics knowledge. This will be a bad influence on the development of student ability.

China has the longest history of central control in the world. All the major decisions on education come from the central government. More than that, most of the teaching materials, such as textbooks and teachers' guides, have been designed and published by the People's Educational Press directly under the leadership of the central government since the 1950s. There is only one set of school physics textbooks for about 150 million students. In order to change this unreasonable situation, the State Commission of Education set about making some changes. In 1983, they published a B level school physics syllabus and began work on the development of a set of textbooks. Compared with the original A level syllabus and textbooks, some topics have been deleted to make the course easer and not too lengthy. In 1993, several sets of alternative textbooks were published. Some of these textbooks are up to date and close to the students' lives. However, the Chinese culture and tradition became a powerful resistance to these reforms, and made diversity of school syllabus and textbooks very difficult to establish. One obstacle came from the tradition of 'saving face'. For Chinese people, getting a high social status and winning the respect of other people is very important. Parents and teachers cannot accept the fact that their children or students study a lower-level course, even though it might be more suitable to them. They regard this as 'losing face'. Most of the schools chose the A level syllabus and textbooks, although 80 per cent of their students found it hard to follow this A level course (PEP Report 1987). The government finally had to suspend the A level syllabus and textbook compulsorily in 1988. Another factor was the tradition to 'follow the crowd'. People compare with each other and wish not to be dropped out of the crowd. Hence in Guangdong (the special experimental area for the diversity of textbooks), most of the schools decided to keep on using the original textbooks which were edited and published by the People's Education Press. School principals gave several reasons for their decision, but the most common was simply that they considered it to be better to follow the central government and adopt the textbooks that are used by most other schools in China.

4. Influences on Student Learning

A recent survey of students' approaches to learning science in Guangdong showed that most chinese students (SPAQIS Reports 1994):

(1) are conscious of learning science from a social or extrinsic point of view. They think that social and family requirements are more important than personal development. They also regard internal motivation as important.

(2) devote much attention to their academic ranking in school. They attach importance to competition in learning.

(3) emphasise the understanding of the basic concepts, principles and laws and pay attention to the interrelationships between different parts of the knowledge.

(4) have a positive attitude to their learning task and put a lot of effort into their study. They think highly of learning on their own.

This research finding agrees with the research carried out in Hong Kong and other Asian areas in recent years. Biggs (1991) compared Western students with Asian (mainly Hong Kong) students and concluded that Hong Kong students:

(1) put more effort into learning. Parents and the students themselves are keen on their academic success.
(2) emphasise the need to seek meaning and understanding in learning, but do memorise key points for tests. Students tend to be watchful in seeking cues for assessment or other purposes.
(3) collaborate with each other in learning outside the classroom.
(4) are more reliant on their teachers.

Students' conceptions of learning and their learning behaviours are context-dependent (Samuelowicz and Bain 1992). The characteristics of Chinese students in learning can be explained in terms of the Chinese culture. The Chinese society values personal subordination to family, society and the elders. It values successfulness and devalues failure. Family honour and social status, and social rank within the school (the academic rank) are very important. The Chinese tradition in education emphasises both understanding and memory. 'Understanding derives from memory, understanding reinforces memory' is one of the significant beliefs in learning and teaching. The Chinese treat learning as a hard task. Students are influenced by role models of hard learners in Chinese history from an early age. These stories do not advocate the talent of those great scholars but their diligence, which implies that everyone may succeed if they use every ounce of their energy.

Cultural influence affects not only students' attitudes and modes of learning, but also their understanding and cognisance. Li (1988) points out that there are differences in ways of thinking between Chinese and Westerners; in particular:

(1) the Chinese prefer to view things as a whole while thinking, whereas Westerners prefer to think in an analytical way.
(2) the Chinese prefer to think in a dialectical way, emphasising the relativity, obscurity and transforming between the opposite sides, whereas Westerners emphasise logical thinking, the distinction between things, the solidity and accuracy in reasoning.
(3) the Chinese prefer to think in an ideological and philosophical way, whereas Westerners are positivistic.

We can see such influences on student learning in physics. For example, Chinese students prefer carrying out theoretical analysis rather than putting effort into practical planning, accurate measurement, data collection and analysis. This makes Chinese students not only poor in experimental skills, but also weak in mastering the methods of designing and drawing conclusions from physics experiments. In a recent survey on students' experimental ability, my research group asked a group of junior secondary students to measure the thickness of a single sheet of paper in their textbook by using a student ruler. Most of them knew the method from their textbooks but no one could get an accurate result.

They failed at the specific details of measuring skills. For example, the ruler was not placed perfectly vertical to the book, the book was not compacted enough, so there were gaps between pages, etc. To another group of senior students, we gave an ammeter and a galvanometer, the inner circuit of which was broken. We asked them to identify what was wrong with the galvanometer by using these two meters and several wires. Everyone knew how to use the ammeter and galvanometer. Many of them realised that the solution should be related to electric induction. However, no one could find the right method to make the identification. Although the sample in this test was not big enough (16 students in each group), we still regarded this as evidence of the poor experimental ability of students. We are planning to do the test with larger samples and, if it is possible, we wish to do a cross-cultural comparison to see the differences between students in different cultural backgrounds.

The understanding of science terminology is also culturally dependent. The concept of energy causes much misunderstanding to Western students. However, Chinese students have similar misunderstandings of the concept of 'forces'. The meaning of the Chinese term 'force' in daily life is close to the English term 'energy' to some extent. Another example is the term 'weight', which could be explained as 'the amount of weight' and imply the meaning 'the amount of substance' in daily life Chinese language. The latter property would be better coded as 'mass', although there is an argument on the exact connotation of the term. Driver *et al.* (1985) pointed out that students in different cultures and regions share some common patterns of alternative frameworks. However, students with different cultural backgrounds do have some different patterns of alternative frameworks in physics. A study comparing the alternative frameworks in particular concepts of students in Guangzhou and Hong Kong (Tao *et al.* 1988) showed that there are more than ten different patterns of alternative frameworks. Most of these could be attributed to the difference in curriculum and teaching strategy. However, some may be due to the language context. For example, Hong Kong students regarded a tiny grain of solid as a particle when answering the test questions. This might be because the term 'particle' in daily Chinese language means 'tiny grain', but in physics terminology it is a generic term covering 'molecule', 'atom', 'ion', etc. In schools in Mainland China, the terms 'molecule' and 'atom' are used as standard textbook terms, and if teachers want a generic word for all of these, the term 'micro-particle' is used to avoid misunderstanding.

5. Conclusion

Cultural influences on physics education can be seen in many ways. One cannot simply value those influences from a specific culture as 'good' or 'bad', because they possess both advantages and disadvantages for students living in a particular culture. As a teacher or physics educator, both our views of physics teaching and learning and our performance in teaching are culturally dependent. It would be better if we could have the chance to see and compare what happens in other cultures. In this sense, a cross-cultural comparative study would be very constructive to physics education around the whole world.

Acknowledgments

My thanks go to Mr P. K. Tao and Mr Shen Jin for polishing my preliminary manuscript. I am also grateful to Professors J. Biggs and J. Butler for their valuable advice.

References

Biggs, J. B. (1991). *Education Res. J.* **6**, 27.

Driver, R., Guesne, E., and Tiberghien, A. (1985). 'Children's Ideas in Science' (Open University Press: Milton Keynes, U.K.).

Gao, L. (1986). *Education J. Chinese Univ. Hong Kong* **14–2**, 101.

Gao, L. (1988). Proc. Conf. on Science Education (SCIECON 88), New Zealand.

Gao, L. (1991). Proc. Conf. of Hong Kong Educational Research Association (HKERA 91), Hong Kong.

Gao, L. (1994). *J. South China Normal Univ.* (Guangzhou) **4**, 1.

Li, Y. X. (1988). 'Principles of Modern Education', pp. 131–7 (Beijing Normal Univ. Press).

People's Education Press (PEP) (1987). Report to the State Commission of Education of P. R. China (People's Education Press: Beijing).

Samuelowicz, K., and Bain, J. D. (1992). 'Higher Education' **24**, 93–111.

SPAQIS (Students' Potential and Quality in Science) Reports (1994). *J. South China Normal Univ.* (Guangzhou) **4**, 10.

State Commission of Education of P. R. China (1983). 'Basic Contents of Secondary School Mathematics, Physics and Chemistry' (People's Education Press: Beijing).

State Commission of Education of P. R. China (1987). 'Syllabus of General Secondary School Physics, Chemistry and Biology' (People's Education Press: Beijing).

State Commission of Education of P. R. China (1990). 'Revisions of School Syllabus for Physics, Chemistry and Biology' (People's Education Press: Beijing).

State Commission of Education of P. R. China (1994). 'Syllabus for the National University Entrance Examination (Physics)' (Higher Education Press: Beijing).

Tao, P. K., Mak, S. Y., Gao, L., and Chen, J. (1988). *Education J. Chinese Univ. Hong Kong* **2/15**, 1.

Manuscript received 5 July, accepted 17 October 1994