CHINESE SCEINCE TEACHERS' BELIEFS ABOUT AND PRACTICES OF ASSESSMENT

by

PING WANG

(Under the Direction of Lynn A. Bryan)

ABSTRACT

The purpose of this study is to examine Chinese science teachers' beliefs and practice about assessment as well as the factors that affect their assessment beliefs and practice. I employed a qualitative research approach with three Chinese science teachers who taught chemistry, physics and biology, respectively. The data gathering procedures included classroom observations, interviews and document collection. The findings indicate that the teachers use assessment mainly for evaluating student performance, guiding instruction, and giving grade/score; teacher beliefs and practice about assessment are shaped by the goals for school science; the National College Entrance Examination greatly affects teacher beliefs and practice about assessment; school culture, such as administration involvement, colleagues' attitudes, class size, and the length of class period affect teacher beliefs and practice. The significance, implications and limitations of the study are discussed.

INDEX WORDS: Chinese science teachers, Beliefs, Practice, Assessment

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CHAPTER 1

INTRODUCTION

The 1990s have been characterized by the widespread concern about the need for reform in science education in many parts of the world. Organizations in some nations such as the American Association for the Advancement of Science (AAAS) and the National Research Council (NRC) have been strong advocates and supporters of reform. Numerous reform documents have been developed. Two of the most prominent ones in the USA are the National Science Education Standards (NRC, 1996) and the Benchmarks for Science Literacy (AAAS, 1993). On the basis of a constructivist paradigm, these two documents view science as a process in which students learn skills, such as observation, inference, and experimentation. Through inquiry-based learning, students are expected to develop an understanding of scientific concepts and the nature of science, skills necessary to become independent inquirers about the natural world, and the dispositions to use the skills, abilities, and attitudes associated with science.

As the world is increasingly becoming a “global village” in which actions in one part of the world exert powerful influences on other parts of the world, science education in China is facing unprecedented challenges and opportunities. Science education in the People’s Republic of China (PRC) has a long history. Because of the country’s size, traditional culture and unique political system, science education has its own characteristics and differs in many ways from that found in the United States and other Western countries. For example, it is typically characterized by large class size, expository approach of science instruction, teacher-centered, subject/knowledge focused, national examination oriented, and a highly centralized system of control over curriculum (Wang et al., 1996; Zhu, 2000). Such a traditional model of science education has been under going heavy criticism. People both from education circles and public society have realized the necessity for reform in science education.

The reform document, *National Science Education Standards* published by Chinese Ministry of Education (CME) in 2001, takes the position that inquiry-oriented instruction is the best way to promote student understanding of the nature of science. Students should be allowed to pose scientific questions for themselves, develop procedures for answering these questions, collect and interpret data, and come to conclusions regarding their original questions. Such an approach will help students develop problem solving and critical thinking skills within an environment that carefully considers students' interests. The solutions to real world problems involve the application and interaction of many academic disciplines; therefore, students should develop interdisciplinary knowledge rather than the various disciplines that people have arbitrarily separated. In aligning science assessment with the change in the nature of science educational changes, the CME issued another reform document (2003), which, together with others, calls for a need to change the traditional strategies or supplement them with a broad range of assessment tools to measure higher-level cognitive skills, such as problem solving, inquiry, communication, and interpersonal skills.

Teachers are the central determining factor in successful implementation of reform in science education (Bybee, 1993). The success of current programs of science education reform depends on teachers' ability to integrate the philosophy and practices of current programs of science education reform with their existing philosophy, extant practices, and established district models (Bybee, 1993). Researchers (Bybee, 1993; Haney, Czerniak, & Lumpe, 1996; Tobin, Tippin, & Gallard, 1994) stated that teacher beliefs are precursors to change and called for close examination and direct study of the relationship between teachers' beliefs and educational practices. These statements imply that teachers' beliefs and practice are vital factors that result in a successful transfer in science assessment from traditional approaches to alternative strategies.

The focus of this study will be the beliefs and practices of Chinese science teachers about assessing students' understanding of science. The specific questions that guide this study are

1. What are Chinese science teachers' beliefs in assessment?
2. How do they assess their students' understanding of science?
3. What are the relations between these teachers' beliefs and practices?
4. What influences their assessment strategies and beliefs?

Significance of the Study

Some studies in the international science education community have been conducted on teachers' assessment in science; however, those studies have investigated teacher practice; that is, the approach science teachers take to assess student performance (Bednarski, 2003; Brookhart, 2001; Green, 1992; Gullickson, 1983; Harmon & Mungal, 1992; Herman & Golan, 1993; Impara, Plake & Fager, 1993; Osborne & Ratcliffe, 2002; Shepardson & Adam, 1996; Stiggins & Conklin, 1986, 1992; Treagust, Jacobowitz & Parker, 2001; Winter, 2002). These studies have investigated the formats teachers use to assess students (e.g., paper-pencil, performance based), the student abilities assessed by teachers and their assessment practice (e.g., factual understandings, process skills), and the cognitive level of assessment questions (e.g., recall questions, analysis questions). Little research, however, has addressed the knowledge and beliefs that undergirds science teachers' assessment practices. Furthermore, there has been no such study both on teacher beliefs about and practices of assessment conducted with Chinese science teachers as well.

Moreover, although there may be a common core of contemporary standards that has influenced the development of the current educational reform documents, documents that were developed within the Western culture are quite different from the educational settings in many countries. Research has shown that school teaching and learning are context dependent; teachers and students in different cultural contexts have different values and beliefs regarding education, teaching and learning (Gao, 2002; Morton, 1981; Salili, 1994, 1995; Su, 1994; Wang, 1998). Marton (1981) stated that conceptions of teaching are assumed to be context dependent and culture, as a contextual lens through which people view and understand the world, has direct influences on students' cognitive processes and understanding of science. Volet (1999) pointed out that in any society, the context of learning is shaped by the cultural values that are shared by the participants of that culture. These shared values are critical in determining what is perceived as appropriate to learn and how to go about learning it. For instance, under the influence of Confucian philosophy, the Chinese place great importance on filial piety, hard work, and education (Salili, 1994, 1995). Filial piety means loyalty and obedience toward one's parents and by extension, authority figures such as teachers. One way for children to fulfill their filial duties is to work hard and excel in academic work so as to make their parents and families' proud. In ancient China, only the most knowledgeable scholars were assigned government and administrative positions. This was achieved through competitive civil examinations—a tradition which is believed to influence educational systems in Chinese societies even today (Chen et al., 1995). The Chinese believe that the best way to learn a subject is through repeated practice and memorization (Liu, 1986). A typical classroom in a Chinese school is highly structured and teacher-centered. Teachers provide instructions, often in the form of lectures, while students take notes or listen quietly. This is often followed by assignments and exercises, as well as memorization of factual material. Students are given enormous amounts of homework and frequent tests and examinations (Salili, 1995). In addition, Gao (2002) pointed out that since Chinese schools have put the heavy emphasis on examinations, changing the Chinese teachers' conceptions of teaching, specifically of examinations, is extremely important to improve the quality of Chinese education. While some aspects of teaching conceptions may be consistent across cultures, others will vary with differences in contexts, such as differences in the stage of schooling, major subject area, curriculum, evaluation system, social and cultural background, etc. This study was designed to explore teacher beliefs and practice in assessment of three Chinese science teachers—physics, biology and chemistry teachers. Since there is no in-depth account of Chinese science teacher beliefs and practice about assessment in the current research literature, this study, probably the first both in China and Western context, represents an effort to address such a gap and could generate fruitful discussion among science educators around the world. In addition, Richardson (1996) stated reflecting on beliefs and practice is important if instructional change is to take place. This study offered participants an opportunity to explore their beliefs and practices as teacher Wang Ying said "I never though and talked about what my beliefs and practice about assessment are like today" (Interview, 6/29).

CHAPTER 2

THEORETICAL FRAMEWORK AND LITERATURE REVIEW

In this chapter, I review the relevant theories and literature that has informed my understanding of Chinese science teachers' beliefs and practices about assessment, how they develop their beliefs, and how beliefs and practices interact with each other. I first describe the Chinese cultural and historical context in which science education occurs. Then, I delineate my understanding of assessment/examination, which most Chinese educators think has driven the Chinese educational system. Further, I review research on teacher beliefs about teaching and assessment both in US and China.

Education and Science Education in China

Historical and Cultural Context of Chinese Education

Ancient selection examination system. China has a long history of education and selection examinations that can be traced back to 2000 years ago. Through open testing, not through official recommendations or kinship relations, the emperor of the Sui dynasty (581-618) attempted to find loyal and capable officials from the public in the hope that such a mechanics would strengthen his authority and reduce the threat from the old noble families. The examination system was succeeded by the emperors of all dynasties as the major approach to select civil service personnel. During the long dynastic period, changes of this system were very few and minor. It reached its climax of complexity and stiffness in the Qing dynasty (1644-1911), and was abolished in 1905.

The structure of this system was like a pyramid. Applicants took a series of tests from the bottom to the top—the county test, prefecture test, provincial test, capital test, and up to the palace test. Most of the applicants would be screened out level by level before they could take the final test, the palace test, which was often given by the emperor himself. At each of these levels, civil servants were selected for the highest prestige jobs in the country based on their performance on the examinations. The examination required extremely rigid styles and forms. For instance, the test may require the candidates to compose a poem, using five words to a line, on a set theme, and to a set rhyme, or to reproduce an article by an emperor without a single mistake. Its testing contents were always Confucians classics. An examinee would be looked down upon if he liked math, science, or technology, or if he wanted to be creative in composing (Miyazaki, 1976).

Due to the rigidity in form and content, the process of learning was almost entirely a matter of sheer memorization. In order to memorize a passage of contents of Classics, the students would parrot the teacher, word by word, as he read out the text. A student may have to recite it a hundred times. Inattentive students would be scolded by the teacher or hit on the palms and thigh. The teachers believed an old saying “if education is not strict, it shows that the teacher is lazy.”

The ancient selection examination had a dominant influence over the development of education in ancient China. It oriented people’s educational goals toward a single end of becoming government officials because it carried more prestige, power, and reward than any other position. The desire for wealth and power motivated people to pursue success in the examination.

Confucianism and its influences on education. For centuries Confucianism provided an ideological framework that told people how to organize society, and how to live a good and moral life. A central tenet of Confucianism was respect for authority and tradition. A second tenet was an emphasis on conformity. Individuality was a threat to the established order of society. Political centralism was the core of Confucianism (Elman, 1991) and loyalty was the most important virtue. It required unconditional sacrifice of oneself to an authority. A son should obey his father. A younger brother should obey his older brother. Wives should obey their husbands. Subjects should obey their rulers. Such a value system nurtured the Chinese characteristics of absolute obedience to, and dependence upon, authority. Academic inquires, such as scientific exploration and critical thinking, were discouraged by the Confucianism.

With the Confucian society then, Chinese education exhibited a number of features, which continued to characterize the current Chinese educational system (Bartels & Eppley, 1995; Fouts & Chan, 1995; Lunetta & Lederman, 1998):

- A highly elitist system. The selectivity of the examination system ensured that only a few advanced past each level and were needed for the ruling class.
- A high respect for learning and the learned. Learning was seen as the sole means for advancement within society. Those who had been successful (the learned) became the ruling class and were to be respected.
- Teacher-centered pedagogy. The above respect also extended to teachers who were given great authority over their students. Teachers have long been regarded as authority figures second only to parents. Students obey teachers' demands unconditionally. They do not dare or seldom discuss with, argue with, doubt, and challenge their teachers.

- Acceptance of authoritative answers. The teachers were considered to be the holders of the knowledge. Since what was important to learn had already been decided by authorities (teachers, books, administrators), questioning or independent thinking was not encouraged and could be seen as disrespectful.
- A separation of education from the world of work. Physical labor was considered to be beneath the dignity of the educated, and education was seen as the method of escape from physical work and to a life of prestige.

Education/Science Education during the 20th Century

Pre-1949. When western-style schools emerged in the 19th century, China was in a state of turmoil (Bartels & Eppley, 1995). Separatist warlord regimens, the successful aggression of the European powers and the subsequent exploitation of China, and the defeat of China by Japan in 1895 weakened the central imperial power, and eventually resulted in the decay of the last feudal imperial dynasty in 1911. As the Republic of China proclaimed, Western ideas had spread. The government adopted a new educational system of a combination of Chinese thought and some western knowledge, attempting to make schooling available to wider sections of the population and to modernize the educational system. But further disorder occurred due to the long period of war waged by the National Party against the Communist Party. The following eight years after the Japanese invasion beginning in 1937 and four years of civil war between National Party and Communist Party (from 1945 through 1949) made the Chinese educational system almost collapse (Lewin, 1994; Wang, 1997; Wang, 2002).

Post-1949 to 1978. After the foundation of People's Republic of China (PRC) in 1949, the Communist government began to reorient Chinese education, separating from the Western Capitalism and adopting the educational system of Soviet model. Most textbooks and curricula were translated from the former Soviet Union (Wang, 2002). However, severe tensions in Sino-Soviet relations grew around the late 1950s. That left China no choice but to develop her own educational system concerning basic educational objective, curricula, teaching methods, scientific research, new textbooks, etc. Soviet-oriented subjects and teaching materials were either reduced or eliminated. A series of educational reforms were implemented, but these efforts were engulfed in the Cultural Revolution (1966-1976) (Fu, 2003).

In the middle of the 1960's, Mao Zedong, the leader of the PRC, stated that education must serve proletarian politics and be combined with productive labor. He criticized Confucian education for its elitist nature and separation from the world of work which he saw as counter-revolutionary and bourgeois. He continually reiterated the need for reduced curricula, shortened schooling period, and examination removal (Wang, 1997). Under his powerful influence, school science was reduced to cover only applicable aspects of knowledge base, such as knowledge about rice and wheat, pigs and cattle, tractors and pumps, and such. Cultural Revolution (1966-1976) was one of the considerable turmoil in China. School rules and regulations were abolished or suspended. Many schools and universities were closed for years at a time. The tracking system, elite schools and university entrance examination practices were cancelled. Lewin (1994) stated that the Cultural Revolution was a period when much of China's cultural and educational traditions were discarded. By the mid-1970's, it was evident that this anti-intellectual revolution was having devastating effects on China's society and economy.

Since 1978. In 1978, China has adopted the education policy of "nine-year compulsory schooling system," which means all children are required to attend school for at least nine years. During the period, students will finish both the primary school program and the junior high school program. With the largest population in the world China always confronts the scarcity of educational resources, thus, selection of students for further education becomes necessary. On average, 50% of the junior high students across the nation were accepted by various types of high schools (CEM, 2002). For higher education, students must pass the national examination. In 2002, about 30% of high school students passed the examination and were admitted to universities or colleges.

The National College Entrance Examination: the Wind Vane for Science Education

Shortly after the death of Mao in 1976, Deng Xiaoping came into power and lost no time in reinstalling the education system that was severely damaged during the Cultural Revolution. The major changes he made were the reintroduction of national college entrance examination (NCEE) and school tracking system. Soon children had to take tests in order to decide whether they would go to a "key" or an ordinary school at both elementary and secondary levels.

Key schools are elite institutions at all levels from elementary up to higher education, which enjoy a number of privileges in regard to recruitment of students and teachers and financial support. Key schools were reintroduced in 1977 after the Culture Revolution with a conviction that they should cultivate future scientists, engineers, and government officials. This goal has been achieved to a large degree (Thogersen, 1989). For example, in 1984, more than 80% of high school graduates recruited by colleges in Shanghai came from the city's sixteen key middle/high schools, compared to less than 20% from the more than 270 non-key schools. The top key schools often have college admission rates close to 100 percent.

The NCEE and key schools have become the symbols of the post-1977 educational elitism. From the late 1970s through the mid-1990s, success in passing the national examination and graduating from college meant free higher education, a decent job with security and relatively high income, a free or low rent house, free health care, and many other important social and legal benefits. Most of these benefits have been gradually cancelled around the mid-1990s with the establishment of the so-called Socialist Market Oriented Economic System. Today, higher education is, however, still an important and effective way to raise one's social and economic status in China.

Characteristics of Science Teaching

The approach to science instruction in China appears largely to be expository. It is quite common that lecture-type instruction dominates the entire classroom activity from the beginning until the last minute of the class (Wang, 1996). I found in the classroom observations (2002, 2003) that I made in a college of education and two secondary schools in China found that the teacher delivered over 90% of the talking in most classrooms. Periodically, teachers asked some questions that often invoked rote responses. They normally did not probe deeper conceptual understanding of their students. Science classes are not characterized by frequent laboratory work, demonstrations, and "hands-on" investigations. Students are expected to learn the necessary subject matter through lecture and textbooks. Drills and practice-oriented worksheets are common as well.

Several reasons may contribute to this highly teacher-centered instruction (Su, 1994; Wang, 1997; Wang, 2002). First, since the national examination generally covers theoretical knowledge, not other skills, in a limited time, lecture can cover as much information as possible. Teachers are afraid of missing something that might appear on the test. Second, a typical class has 40-50 students; it is difficult to meet individual needs. Third, a teacher-centered approach fit well in the Chinese cultural setting which suggests that the teacher is the ultimate authority and holder of knowledge.

Science Education Reform in Recent Years

Under the influence of particular political system and traditional culture, science education in China has formed its own unique characteristics, which are teacher-centered, theory focused, and national examination orientation (Gao, 1998; Wang, 1997; Wang, 2002). Such a model is going under heavy criticism. People both from education circle and public society have realized the necessity for reform in science education.

In recent years China launched a campaign for the educational reform with a majority of efforts focusing on school curriculum. The major reform objectives and steps have been determined as follows (CME, 1999; CME, 2003; Zhu & Liu, 2000)

- Shift from an overemphasis on knowledge transmission/acquisition to a focus on students' all-round development. Correspondingly, call for changes in assessment from traditional paper-and-pencil test to alternative assessment, such as acquiring of information, lab work, essay writing, systematic observation of student performance, and student projects
- Change from an overemphasis on the independence of disciplines to a focus on the integration of various disciplines, such as an integration of biology, chemistry, physics and earth science into a single science subject at middle level
- Comprehensive activity course added in science education program in attempt to encourage students' active participation, hands-on and minds-on learning and cooperation, focusing on application of scientific knowledge, issues relevant to science, technology, and society
- Reform in the highly centralized educational system. For instance, the CME encourages individual provinces/municipal cities to publish and use their local

> textbooks according to national standards instead of nationally united textbooks. The CME has authorized about ten provinces/municipal cities to hold their own college entrance examinations instead of the NCEE. The country hopes that the decentralization of educational system will contribute more to local economic and societal development.

China has a long record of formal education that can be traced back to 2000 years ago. Over the long course of history, Chinese education has evolved into a highly elitist system where the most able intellectuals were selected through rigorous examinations to enter the ruling class, thus, to obtain wealth and power. Confucius and Confucianism were highly respected as authority and tradition. The development of modern Chinese educational system has not been smooth and consistent, which had experienced decades of wars, radical changes in regime (from feudalism through half-feudalism and half-capitalism to socialism), the introductions of Western-style schools and former Soviet model of education, and political anarchy. Till the mid-1970s, the Chinese educational system nearly collapsed.

In 1977, China resumed the National College Entrance Examination (NCEE) which was called off during the Cultural Revolution (1966-1976). Both the government and the public have considered the NCEE system critical for China's political, economic and educational development. The NCEE has soon become a powerful tool and driven the Chinese educational system for more than two decades (Feng, 1994). Science education in China has formed its own unique characteristics (Wang, 1996): teacher-centered, theory focused, and national examination-oriented.

Since the late 1990s, China has been attempting to re-structure its educational system; however, a majority of reform efforts are focusing on curriculum area with little concerns about assessment. Assessment has become increasingly important during the past decade and is now at center stage (Doran, Chan & Tamir, 1998). I believe that assessment should share the same weight as curriculum does in the efforts of China's ongoing educational reform.

Assessment

Definition

Assessment can be defined as the collection of information, both quantitative and qualitative, obtained through various tests, observations, and many other techniques (e.g., checklists, inventories), that is used to determine individual or group performance (Doran, Lawrenz and Helgeson, 1994). The terms *assessment, test, measurement* and *evaluation* are easily confused because all may be involved in a single process (Linn and Gronlund, 2000). Assessment is a general term that includes the full range of procedures used to gain information about student learning (observations, ratings of performances or projects, paper-and pencil tests) and the formation of value judgments concerning learning progress. A test is a particular type of assessment that typically consists of a set of questions administered during a fixed period of time under reasonably comparable conditions for all students. Measurement is the process of obtaining a numerical description of the degree to which an individual possesses a particular characteristic. Evaluation is the process of making carefully determined value judgments and decisions related to the issues and concerns (Doran, Laurenz & Helgeson, 1994).

Three kinds of assessment can be carried out at the different points of a learning/teaching phase: (a) Diagnostic or pre-assessment usually occurs at the beginning of the school year or before a unit of instruction. It can be used for identifying whether students have the prerequisite knowledge, understanding, or skills; providing information to assist in planning appropriate learning opportunities; identifying student interests and misconceptions, (b) Formative assessment is ongoing assessment during instruction that keeps students, parents, and educators informed of students' progress. It provides direction to students in how to improve their learning; encourages students to take responsibility for their own progress; provides teachers with information upon which instructional modifications can be made; helps teachers understand the degree to which students are achieving the learning expectations, (C) Summative assessment occurs at the end of a cluster of expectations, at the end of a unit and at the end of the course. The purposes are to evaluate what has been learned; to summarize student progress; to report on progress to students and parents.

Why Assessment Is Important

Assessment in science is the collection and interpretation of information about students' knowledge, understandings, skills and attitudes relating to the science outcomes. Assessment results have important implications for science education and all concerned with science education.

Assessment data provide students, parents, and teachers with feedback on how well the students are learning with regard to goals, objective, cognition, and affective. These data can assist teachers in identifying students' academic progress and/or learning difficulties, and thereby guiding, modifying and improving instruction. Assessment results provide districts with feedback on the effectiveness of their teachers and program or curriculum, and policy makers with feedback on how well policies are working. Assessment data can provide data that assist in decision making about a student's future, such as access to higher education, entry into employment and admission to the professional. Feedback can leads to changes in the science education system by stimulating changes in policy, guiding teacher professional development, and encouraging students to improve their understanding of science.

Assessment has become increasingly important during the past decade, as educators and policy makers seek reforms to our educational system in response to national and international priorities and challenges. Assessment is now at "center stage" (Doran, Chan & Tamir, 1998). Educators concerned with weak science achievement, low levels of science literacy, and poor international test scores have undertaken major reforms in science instruction. Increased international economic competition has reinforced the importance of excellence in science education as a fundamental priority for every nation to maintain its competitiveness. New insights into how children learn and advance in learning theory, such as constructivism, have added impetus to assessment reform.

Assessment for Selection and Certification

Assessment has a long history, and its role is a function of society's needs at the time. Examinations first developed in China can be traced back to 2000 years ago. The purpose was to select loyal and capable candidates for government service. The Jesuits influenced by China's experience introduced the examination into their schools in the 17th century. It was not until the late 18th century and the early 19th century that examinations developed first in Europe, then in America, in order to curb political patronage and select candidates for government. Selection has probably been the most pervasive role of assessment over the years (Glaser & Silver, 1994).

In the Western world, family history and patronage instead of academic achievement or ability determined a person's access to the profession and university before the 19th century. Soon after the turn of the century, this picture began to change. As the industrial capitalist economy flourished, there was an increasing need for more trained middle-class workers to take on the role in the professions and in managerial positions. The economy and society needed ways to select those suitable for such an education and certifying those to be competent. As Eckstein and Noah (1993) stated " As modern states industrialized, improved communications, and evolved their large bureaucracies, the practice of selection by written, public examinations previously confined to China, became increasingly common" (p. 3).

The increased demand for entry to university resulted in the university entrance examination. These exams were designed to determine competence and, therefore, limited access to membership of the profession and university (Broadfoot, 1979). These exams were associated with high-status professions; hence, the exam itself became invested with high status. In addition, assessment for selection has also been a key theme within the school system. Selection tests within the school system were used to identify students as "bright, less bright, or dull" and group students of similar ability for instructional purposes (Glaser & Silver, 1994; Wood, 1986).

Historical Perspectives of Learning and Assessment

The roots of our current education system lie in the mass public school programs of the Industrial Revolution. The mechanized assembly lines and standardized processes that dominated that era found their way into education, where they remain deeply embedded today. As Rubba, et al. (1991) pointed out:

> School has been conceived as a manufacturing process in which raw materials (youngsters) are operated upon by the educational process (machinery), and turned into finished products. Youngsters learn in lockstep or not at all (frequently not at all) in an assembly line of workers (teachers) who run the instructional machinery. A curriculum of mostly factual knowledge is poured into the products to the degree they can absorb it, using mostly expository teaching methods. The bosses (school administrators) tell the workers how to

> make the products under rigid work rules that give them little or no stake in the process. (p. 6)

> This assembly-line approach relies heavily upon behaviorist learning theory (Doran, Chan & Tamir, 1998). Under behaviorist learning theory, knowledge is "decomposable" and can be broken into its component parts without jeopardizing understanding or applicability. Learning is tightly sequenced and hierarchical and can occur by accumulating decomposable bits of knowledge and skills using stimulus-response associations. Tests are equal to learning and should be used frequently to ensure mastery before proceeding to the next objective (Shepard, 2000).

The behaviorist approach still plays a dominant role in schools. Teaching and learning that relies heavily on textbook and the memorization of factual information reflects the behaviorist legacy in science education. Assessment aligned with these approaches use formats made up primarily of multiple-choice, true-false, and short-answer questions. Students focus on identifying the "right" answer, as opposed to developing inquiry skills and conceptual understanding (Doran, Chan & Tamir, 1998).

Recent Trends

In contrast to past behaviorism, constructivism suggests that learning is an active process in which learners construct new ideas or concepts or understanding of our world by reflecting on their current/past knowledge and experiences. Knowledge can not be passively received from the environment. Coming to know is a process of dynamic adaptation towards viable interpretation of experience. Each of us generates our own "rules" and "mental models", which we use to make sense of our experiences. The learner selects and transforms information, constructs hypotheses, and makes decisions. Learning, therefore, is simply the process of adjusting and revising our mental models to accommodate and assimilate new experiences (Bruner, 1966; von Glasersfeld, 1990).

Learning is also a social activity founded on collaboration and mutual respect of different viewpoints. Vygotsky (1978) pointed out that what is taken into the mind is socially and culturally determined. The work of others (Driver et al., 1994; Pollard, 1990; Cobb, 1994; Savery and Duffy, 1995; Vleuten, 2002) suggest that learning is embedded in the building of artifacts that are shared and critiqued by one's peers. Learning is best achieved through activities embedded in authentic and meaningful contexts. These studies also indicate that students perform best when they can: (a) experience an active rather than a passive learning mode, (b) tie new learning to what they know and believe already, (c) tell a "whole story" with many interconnecting parts, (d) talk with others about their understandings, (e) monitor their own progress and manage their time and resources in order to achieve specific goals, (f) have a clear statement of expectations, and (g) realize that their knowledge can be transferred to new situations more easily if they have had experience in learning how and under what conditions it is appropriate to do so.

Constructivism underlies the *National Science Education Standards,* published by the National Research Council (United States) in 1996 and *National Science Education Standards* published by Chinese Ministry of Education in 2001. These two documents view science as a process in which students learn skills, such as observation, inference, and experimentation. Through inquiry-based learning, students develop understanding of scientific concepts and the nature of science, skills necessary to become independent inquirers about the natural world, and the dispositions to use the skills, abilities, and attitudes associated with science.

As the nature of science education changes, so must our assessments. That means that there is a need to change the traditional strategies or supplement them with a broad range of assessment tools to measure higher-level cognitive skills, such as problem solving, inquiry, communication, and interpersonal skills.

The main purpose of these assessments is not that of selection or certification, and this different purpose allows greater flexibility in style of assessment (Shepard, 2000). In general, assessment becomes a more integral part of the learning process, broader in the sense that it encompasses more varied formats of assessment. It is deeper in terms of measuring more complex skills. As students carry out laboratory investigations that challenge them to increase their conceptual understanding, the distinction between assessment and instruction blurs into a seamless whole, and there is near perfect alignment with standards (outcomes and expectations), programs (instruction), and assessments.

Assessment is a general term that includes a wide range of procedures used for the collection of quantitative and/or qualitative information. This term is easily confused with test, measurement, and evaluation. Assessment has long played an important role in education. Traditional approach to assessment, which relies heavily on behaviorist learning theory and uses forms primarily of multiple-choice, true-false, and short answer questions, has been under criticism. Reform documents published both in America (NRC, 1996) and in China (CME, 2001), on a basis of a constructivist paradigm, call for a broad range of assessment to measure higher-level cognitive skills. Teachers are the central determining factor in successful implementation of reform in science education (Bybee, 1993). This implies that teachers' thinking and actions could influence the successful shift in assessment from traditional approach to new one.

Beliefs

Definition of Teacher Beliefs Based on Literature

Beliefs are a subset of a group of constructs that name, define, and describe the structure and content of mental states that are though to drive a person's actions (Pajares, 1992). Richardson (1996) stated that beliefs are thought of as psychologically held understandings, premises, or propositions about the world that are felt to be true. Reviews and analyses of the literature (Bryan, 2003) contribute to a consensus that beliefs are psychological constructs that:

> (a) include understandings, assumptions, images, or propositions that are felt to be true; (b) drive person's actions and support decisions and judgments; (c) have highly variable and uncertain linkages to personal, episodic, and emotional experiences; and (d) although undeniably related to knowledge, differ from knowledge in that beliefs do not require a condition of truth.

Teacher belief is a particularly provocative form of personal knowledge that is generally defined as pre- or in-service teachers' implicit assumptions about students, learning, teaching, classroom, the subject matter to be taught, and such (Kagan, 1992). The term "teacher belief" is not used consistently, with some researchers referring instead to teachers' attitudes (Rokeach, 1968), conceptions (Clark, 1988), values (Rokeach, 1968), perspectives (Goodman, 1988; Tabachnick & Zeichner, 1984), orientations (Porter & Freeman, 1986), theories (Nisbett & Ross, 1980), personal knowledge (Ernest, 1989), and practical knowledge (Robson, 1991). In all cases, Pajares (1992) suggested that most of these terms were simply different words meaning the same thing. Beliefs have taken over as a major construct of interest in studying teachers' ways of thinking and classroom practices, though others are still examined from time to time.

Teacher Beliefs: The Most Valuable Psychological Construct to Teacher Education

Belief is an important concept in understanding teachers' thought processes, classroom practices, change, learning and teaching. Researchers (Fenstermacher, 1979; Pintrich, 1990) predicted that teachers' beliefs would become the focus for teacher effectiveness research and eventually prove to be the most valuable psychological construct to teacher education. Since then, studies have showed that teachers' beliefs play an essential role in how they interpret pedagogical knowledge, conceptualize teaching tasks, and subsequently enact their teaching decisions (Bryan, 2003).

Richardson (1996) stated that beliefs are thought to have two functions in learning to teach. The first is related to constructivist theories of learning that suggest that learning is an active and constructive process that is strongly influenced by individual's existing understandings, beliefs, and preconceptions. Prospective teachers' beliefs about teaching play a strong role in shaping what they learn and how they learn it. Practicing teachers' beliefs about the academic material to be taught, classrooms, learning, and teaching influence the way they approach staff development. The second is that beliefs are also the focus for instruction. Fenstermacher (1994) argued that

> One goal of teacher education is to help teachers transform tacit or unexamined beliefs about teaching, learning, and the curriculum into objectively reasonable or evidentiary beliefs. The process by which this can happen is to help preservice and in-service students identify and assess their beliefs in relation to their classroom actions. (p. 38)

Results of a study by Munby (1984) implied that the way teachers adapt or adopt new practice in their classroom relates to whether their beliefs match the assumptions inherent in the new programs or methods. Summaries of the research suggest that beliefs drive classroom actions and influence the teacher change process (Nespor, 1987; Pajares, 1992).

Thus teachers' beliefs are important considerations in understanding classroom practices and conducting new programs and effective education designed to help prospective and in-service teachers develop their thinking and practices. Several science education researchers (Bryan, 2003; Haney, Czerniak, &Lumpe, 1996; Tobin, Tippin, & Gallard, 1994) support the notion that teacher beliefs are precursors to change and that the teacher is the crucial change agent in paving the way to reform.

Since teachers' beliefs lead to actions and these actions impact students, teachers and their beliefs may play a major role in science education reform. Central to the idea of effective educational changes is the premise that teachers and their teaching are the most essential components for educational progress (Bybee, 1993). In reflecting upon restructuring science education, he asserts:

> I remain convinced that the decisive component in reforming science education is the classroom teacher. We certainly need books, reports, and recommendations for new policies, and we need materials, projects, and programs. However, unless classroom teachers move beyond the status quo in science teaching, the reform will falter and eventually fail. (p.144)

Studies in US and China

A number of studies have examined the formation and change of teachers' beliefs. According to Richardson (1996), three categories of experiences influence the formation of teachers' beliefs that, in turn, affected learning to teach and teaching. They are personal experience, experience with schooling and instruction and experience with formal knowledge. These categories may not be mutually exclusive and, in fact, may be studied together.

Personal experience. Personal experience includes aspects of life that "go into the formation of world view; intellectual and virtuous dispositions; beliefs about self in relation to others; understandings of the relationship of schooling to society; and other forms of personal, familial, and cultural understandings… Ethnic and socioeconomic background, gender, geographic location, religious upbringing, and life decisions may all affect an individual's beliefs that, in turn, affect learning to teach and teaching" (Richardson, 1996). Nespor (1987) also pointed out that belief systems rely heavily on affective and evaluative components, which can influence how much effort and energy a teacher will expand as well as how s/he expand the effort and energy on activities. For example, Bryan (2003) reported that Barbara, a prospective elementary teacher, valued science and science learning, and hence was motivated to engage in time-consuming activities (e.g., interviews, journal writing, video analysis) to learn how to teach science.

Clandinin and Connelly (quoted in Richardson, 1996) conducted research on a theory of personal knowledge with a principal and found that an important image in his narrative to understand his personal knowledge and actions was a tightly knit community on Toronto Island in which he grew up. This image of community affected his approach to the involvement in his school. Holt-Reynolds (1992) found preservice teachers' personal prior knowledge about learning and teaching, which derived through life experiences, affected the development of constructivism belief. In their research about teachers' conception of teaching science and classroom practice with three prospective elementary teachers, Meyer et al (1998) reported that the progress all those teachers made was in rather different ways that were dependent on their own conceptions of knowledge, science and learning. One of the major challenges to their classroom practice was experiencing the range of their peers' views and dilemma between the diversity of views expressed around them in methods class. Trying to reconcile these views became a consuming task for them.

Shepardson and Adams (1996) indicated that teachers construct their beliefs and knowledge about assessment within the contexts of their school culture. Delandshere and Jones (1999) found that teachers' beliefs about assessment are shaped by its externally defined functions and purposes as well as what they perceives as the official curriculum within the school structure. Haney et al. (1996) concluded that external factors, such as time, resources, class size, teacher training, and equipment, significantly influenced inservice teachers' intentions to implement new teaching strategies. Gao (2002) stated that relating students' intellectual development to their moral and personal development, attending to the development of students' learning attitudes and personal conduct as an important aim of teaching, and expecting teachers to act as role models, all seemed to be aspects which made the teaching conceptions of Chinese teachers different from those within a Western cultural context. These studies imply that in researching teachers' beliefs and practices about teaching and learning, it is important to consider not only their personal cognitive understandings, but how these understandings have been developed socially and within the context of the culture of the classroom and school.

Experience with schooling and instruction. A number of studies have examined beliefs acquired from experiences such as being students and/or teachers and how these beliefs affect teachers' beliefs of their role as teacher. In a study of teachers' theories of children's learning, for example, Anning (quoted in Richardson, 1996) concluded that the teachers' beliefs about children's learning were determined "by their own particular previous experiences of teaching and learning in their classrooms." Britzman (quoted in Richardson, 1996) stated the conception of the role of teachers gained from observing teaching models heavily influenced their classroom actions. In her study with a preservice elementary teacher, Bryan (1999) found that both positive and negative experiences influenced the teacher's beliefs about how children learn science and how she wanted to teach science. As a science learner the preservice teacher had much hands-on in physical science class, in which she felt she learned science best while she described most of her experiences in learning science as didactic, textbook driven and seeking answers. These experiences contributed to her vision of using hands-on, activity-based instruction. Eick and Reed (2002) obtained a similar result that learning experiences influenced teachers' beliefs about teaching science. The student teacher under the study wanted to teach science like her high school biology teacher who used many hands-on activities and having a good rapport with students. Other researchers also conclude that previous schooling and student teaching are more powerful in building conceptions of teachers about teaching and the teacher role than the formal pedagogical education received in teacher education program (Brousseau, Book, &Byers, 1988; Feiman-Nemser, 1983; Knowles, 1992).

Field experiences, for instance, teaching or/and observing in the classroom, also is thought to shape beliefs and practical knowledge; in fact, a teacher may only acquire practical knowledge through classroom experience (Carter, 1990; Fenstermacher, 1994). Black and Ammon (1992) suggested that teachers' conception of learning develops with classroom experience. Through experience, teachers move from behaviorist conceptions toward more constructivist conceptions. Bullough, Knowles, and Crow (1992) suggest that teachers' personal identities develop and change with teaching experience. Bullough and Baughman (1993) concluded that the beliefs of Kerrie—a teacher of their study— "grew out of her life experience generally and her teaching experience specifically." Skamp and Mueller (2001) pointed out that student teachers developed their conceptions about science teaching by doing it and consciously or unconsciously reflecting on it. They also found that practicum observation of mentoring teachers was an influential factor to student teachers' beliefs, especially one who completed a constructivist oriented science professional development course.

Experience with formal knowledge. Researchers (John, 1991; Leinhardt, 1988; Richardson, 1991) have examined how teachers' experiences with subject matter contributed to their beliefs and understanding of classroom instruction. For instance, John's study (1991) with five British student teachers found differences in their views of planning between the math and geography teachers. The math student teachers' views of their subject had a strong impact on their formation of perspectives about planning, whereas the geography student teachers' views of their subject had little effect on their planning. Wilson and Wineburg (quoted in Richardson, 1996) studied four history teachers and found that their subject-matter knowledge and beliefs about the nature of history strongly affected their teaching of the subject. Yerrick, Parke, and Nugent (1997) pointed out that viewing science as a list of facts may contribute to teachers' visions that their primarily responsibility was to audibly and/or visually present students with scientific concepts and that "telling resulted in the students' immediate and complete understanding of that scientific concept."

Pedagogical knowledge may affect the formation of teachers' beliefs. Knowledge of subject matter, in combination with understanding of how students learn the subject matter, combines to form what is called pedagogical content knowledge. Clift (1987) found the significant differences in the beliefs about teaching and learning between English majors not interested in teaching and English majors who had completed their student teaching in a certification program. The English major saw the teacher as the authority on the interpretation of literature, whereas the future teachers were much more constructivist. Peterson, Fennema, Carpenter, and Loef (1989) found that teachers with a more cognitive perspective taught mathematics differently than those with a less cognitive perspective. The former taught more word problems, and their students did better on achievement tests than the latter group of teachers. Shepardson and Adams (1996) suggest that a teacher's beliefs about assessment are developed based on his pedagogical knowledge, that is, the purposes of teaching are that students learn and solve problems. "He always considers any evaluation to be a learning experience." However, some research found that there seemed a delay effect of pedagogical knowledge on teaching practice (Crow, 1988; Featherstone, 1993). Richardson (1996) states that experiences with formal pedagogical knowledge are seen as the least powerful factor affecting beliefs and conceptions of teaching and the teacher role.

Beliefs and actions. Teachers give meaning to education beliefs primarily through their behavior in the classroom (Tobin, 1993) and the beliefs teachers hold about teaching and learning have a significant influence on the teacher's behavior (Bybee, 1995; Pajares, 1992). MacKinnon and Erickson (1992) stated that the student teacher in their study held the positive view of scientific knowledge which led to her strong verbal domination of the classroom. Moreover, she had "great difficulty understanding her constructivist-oriented cooperating teacher's critique of her teaching." The findings by Stipek et al. (2001) indicated that teachers had a fairly coherent set of beliefs which predicted their instructional practices. For instance, teachers with more traditional beliefs emphasized students' getting correct answers, getting good grades, instead of learning and understanding. They also gave students relatively less autonomy. Bryan found (2003) that a prospective elementary teacher's regular use of review sheets and question-answer sessions not only relayed her belief that science consisted of unambiguous truths, but also evidenced that the goal of her instruction was the acquisition of factual knowledge. Her "foundational beliefs" about control and goal of science instruction seems to support her teaching practice—a didactic, teacher-centered approach.

Teachers' behaviors influence, strengthen or modified the continual development of their beliefs and theories with more evidence gained by classroom practice. Events in the classroom, as well as in the school setting provide either constraints or opportunities for the development of beliefs and theories. Levitt (2001) found once teachers observed their students learning, the teachers' belief in the new approaches and commitment to them changed significantly. With changes in classroom practice, teachers' beliefs continually evolved.

Although the connection of beliefs to action may be described simply, the relationship between beliefs, which are mental, and teacher actions, which take place in the social arena, is highly complex; they actually often interact (Tobin, 1993; Keys, 2001). Evidence suggests that beliefs and behaviors interact in an ongoing way, and changes in one can bring about changes in the other (Guskey, 1986). Some research showed the inconsistency of beliefs and practice (Haney & McArthur, 2001; Levitt, 2001; Simmons, 1999), however. In some cases, there were changes in thoughts that were not reflected in changes in actions. In others, new actions did not appear to be supported by their current thinking (Czerniak, 1999; Meyer, et al. 1998). For example, Abd-El-Khalick et al. (1998) and Lederman (1992) pointed out teachers' conceptions of the nature of science do not necessarily influence classroom practice.

Many factors influence the formation of teacher beliefs and practices. Among these are experiences in personal life, learning and teaching histories, subject knowledge and pedagogical knowledge. The relationship between beliefs and practices are highly complicated. Some studies showed the consistency while others were not consistent.

CHAPTER 3

METHODOLOGY

I conducted a case study (Stake, 1994, p. 237) of three science teachers in a Chinese school, which focuses on holistic descriptions, analysis, and explanations of the phenomenon under study, rather than hypothesis testing. Stake (1994) noted the "case that seems to offer the opportunity to learn [the most]" (p.243) should be used. Case study is an approach that relies on "interviewing, observing and document analysis" (Denzin & Lincoln, 1994, p. 14) and provides a "deeper understanding of science teachers and their development" (Anderson & Mitchener, 1994, p. 28).

The study was grounded in socio-constructivist theory, which is a set of beliefs about the nature of knowledge and learning. A socio-constructivist perspective focuses on the learner and the social processes. It is assumed that although every individual has to construct knowledge by herself or himself, the construction process and individual meaning is, at the same time, always mediated within a certain social setting. We share our everyday lives as we communicate with others, and social interaction helps us construct meaning of the world around us. According to Wertsch &Toma (1995), "key aspects of mental functioning can be understood only by considering the social contexts in which they are embedded" (p.159). My worldview is aligned with social constructivism; I assume that Chinese science teachers construct their own understanding and beliefs about assessment in science teaching within the context of the culture of their school, classroom and society.

Research Design

In this section, I describe the research processes, including descriptions of the school setting, the participants, data collection methods, and data analysis processes. To secure confidentiality, I use pseudonyms for the city, the school, and the participants.

School Setting

The study was conducted in Nan Yu School from mid-May 2003 through to mid-August 2003 in Zi Jin City, China. Nan Yu School is a typical Chinese middle/high school. The school is a compound in which both a middle school (7-9 grades) and a high school (10-12 grades) are included within the same walls. The school has approximately 2700 students and 260 faculty and employees. Students generally have to attend eight 40-minute class periods each day, five days a week. The subjects of biology, chemistry, and physics represent all major science courses offered in this school. The subjects of physics and chemistry as well as other subjects such as Chinese, foreign language, and mathematics are considered “major subjects” by teachers; the subject biology and other subjects such as geography and history are called “minor subjects.” A “major subject” is usually assigned more teaching time and resources than a “minor subject.” A “major subject” is often included in the local high school entrance examination and the National College Entrance Examination.

The school had recently developed a new science course—Comprehensive Practice Activity—to emphasize hands-on activities, problem solving, and development of science concepts. The course was designed to seek an integration of the knowledge and skills across science disciplines and to enhance students’ ability of the application of knowledge. Students meet once each week for this course (a period of 40 minutes).

Each regular class has approximately 60 students. Lower grades (7-9 grades) are located in an old building where the classroom is so crowded that the aisle only allows one person to pass through. In contrast, higher grades (10-12) are in a new building where classrooms are much bigger than classrooms in the old building “because the high school stage is crucial for the future NCEE. The school offers better conditions for high school students” (Conference, 6/10). I noticed that student desks in classrooms are arranged as columns and rows with a teacher’s podium in front of the chalkboard. Every classroom has an overhead projector and the school bought a laptop computer for every teacher. Laboratory rooms are separated from classrooms, either in the same building or different building. Hence, students have to move to another room to do lab activities.

Participants

The participants for the case study were purposefully selected (Patton, 1990). The goal was not to represent the “typical” teacher but rather to describe and explain how Chinese science teachers can perceive assessment within the current reform background and cultural context. I made initial observations once or twice with each of 16 teachers who gave me permission to observe out of a cohort of 20 science teachers in the school. The final selection of three participants was made by taking into account that: (a) they were willing to share their views and practices in all aspects of data collection, (b) the courses—chemistry, physics, and biology—they were teaching covered all major science subjects the school offered, (c) they had had experience in teaching at both middle and high school levels that would allow me to collect a rich set of data. Two males and one female were chosen and their pseudonyms were Wu Jun, Pan Ling, and Wang Ying.

Teachers Wu Jun and Pan Ling received their bachelor degree in chemistry and physics, respectively from two different normal colleges. Normal colleges/universities are major institutions offering a teacher training program in China. Generally, students (pre-service teachers) learn science subjects such as those in a research university. Therefore, they have strong background in a science field. They may take fewer science courses than students in a research university; on the other hand, they have to take several courses about foundations in education, psychology, and one subject matter-specific teaching method (e.g. teaching methods in biology, physics, or chemistry). In addition, they have to complete a six- to eight-week teaching internship. Teaching methods courses usually cover ten to twelve chapters; only one chapter is about assessment with focus on paper-and-pencil test. The pre-service teachers learn assessment skills from the textbooks, their teachers, and their own teaching practices as well as their colleagues after entering teaching profession.

Wu Jun, a chemistry teacher with 8 years of experience in teaching, was teaching 11^{th} grade chemistry in the semester that the study took place. He believed that students learn and understand scientific concepts best by listening to lectures, reading textbook, then applying their knowledge, and performing on written assessments. His teaching was teacher-centered in which he took major responsibility to organize and transmit content knowledge to students, stressed the factual nature of science, allowed few student-student and student-teacher interactions, and focused on written assessments, such as frequent homework, quizzes, and tests to reinforce and check on students' understanding of important concepts. (Interview, 6/25)

Teacher Pan Ling was a physics teacher with ten years of teaching experience. His major task was to teach 11^{th} grade physics. He also taught 10^{th} grade comprehensive practice activity in which students met once a week (last 40 minutes). He believed that students learn science best by reading and doing. He believed that students can show their understanding of scientific concepts by demonstrating their learning on paper-and-pencil tests and projects. His physics class was teacher-centered in which his teaching action included presentation of information to students with the use of textbook, drill and rehearsal of information, and paper-and-pencil quizzes and tests with little emphasis on applications of knowledge. On the other hand, in his comprehensive practice activity class, he employed student-centered instructional methods and investigations which focused on students' ideas, hands-on activities, project work and lab investigations. (Interview, 6/28)

Unlike Wu Jun and Pan Ling, Wang Ying graduated from a two-year teacher training program of a research university, which was designed to meet a then desperate need for middle/high school biology teachers. She earned a Master's degree equivalency by taking various biology-related courses at graduate level after she became a teacher. She taught biology for 13 years and was teaching 8^{th} grade biology in the semester of this study. She viewed the teacher as the transmitter of knowledge; on the other hand, she stressed the responsibility of students to acquire and process their own knowledge. She organized some activities for students to gain experiences that would lead to learning; in these activities, she became the "facilitator and guide". She used a variety of assessment methods from paper-and-pencil test to alternative approach, from group work to individual work. Her principal praised her as an "exemplary teacher" and one of her colleagues saw her as "very creative and active" (Conference, 6/25).

Data Collection

Although beliefs cannot be directly observed, they can be inferred from belief statements, intentions to behavior, and actions relative to the belief (Pajares, 1992).

In order to investigate the Chinese teacher beliefs and practices about assessment, a case study was employed and multiple data sources were obtained. Data sources mainly included (a) interviews, (b) observations, and (c) documents.

Interviews. To probe the teacher beliefs about assessment, three semi-structured interviews were conducted in China at the participants' school and ranged from 60 to 80 minutes. Interviews were auto-taped and transcribed verbatim in Chinese. Transcription excerpts (phrases, sentences, and paragraphs) quoted to support interpretation in this paper were translated into English and checked by a Chinese classmate. A sample of the interview guiding questions was included in Appendix A.

Observations. To investigate classroom practices, observations were conducted from late May of 2003 through early July of 2003. Observations provided the context for the discussions with each teacher regarding their beliefs. The observations lasted for the duration of the lesson, which was 40 minutes, and recorded in field notebooks. I observed Wang Ying for a total of 10 classes, Pan Ling a total of 12 classes, and Wu Jun a total of 9 classes. My observations focused on their teaching practices, particularly in assessment.

Documents. Instructional and assessment documents to which teachers referred in their teaching and conversations were collected. These documents informed me of the context within which the participants' teaching and assessment activities were situated. These data told me what really happened in the school. Document data could corroborate my observations and interviews and thus make my findings more trustworthy. A master list of sources of document data was developed (Appendix B).

Other data sources. After observations I conducted discussions with the teachers when time was available regarding issues that emerged from each specific observation. Views expressed by the teachers during discussions were recorded in a field notebook. In addition, data from informal conversations with the participants, other teachers who did not formally take part in this project, principal, and administrators were recorded in the field notebook.

Data Analysis

Inductive analysis was employed for data analysis. Inductive analysis is intended to aid an understanding of meaning in raw data through the development of summary themes or categories by constant examination of the data, such as interview transcripts, documentary and archival data, and field notes of observations (LeCompte &Presissle, 1993; Miles & Huberman 1994; Schwandt, 1997).

The analysis procedures for this study followed the major steps of constant comparative method as Merriam (1998) described:

> The basic strategy of the constant comparative method is to do just what its name suggests—constant comparison of piece data. The researchers begins with a particular incident from an interview, field notes, or document and compares it with another incident in the same set of data or in another set. These comparisons lead to tentative categories that are then compared to each other and to other instance. Comparisons are constantly made within and between levels of conceptualization until a theory can be formulated. (Merriam, 1998, p. 159)

I used this approach to formulate a set of assertions that described the teachers' beliefs about and practices of assessment.

Analytic procedures. During analysis, data from interviews, field notes, and document were coded into categories representing emergent themes. This process began with reading the first interview transcript, the first set of field notes, and the first document collected in the study in detail several times to be familiar with the content. As the reading progressed, I recorded down the notes and comments in the margins. These notations, which I call codes, were next to chunks of data that struck me as interesting, potentially relevant, or important to my study. Each of these codes was put on the code book and assigned a number indicating its position. In this way, I could easily compare and contrast the interviewee's description of the event for each of the codes and find their positions.

After working through the first entire transcript in this manner, I went back over my marginal notations and tried to group those codes that seemed to go together. I also kept a running list of these groupings attached to the transcript. Then, I moved to the second and third interview transcripts and scanned them in exactly the same way as outlined above. I also made a list of codes for each transcript. Then I compared these three lists and merged them into one master list of codes. The next step was to identify recurring patterns or regularities and create categories and their properties. Once the categories were created, all chunks of the data were organized and sorted into relevant categories. The following process was theorizing about data. Theorizing is defined as "the cognitive process of discovering or manipulating abstract categories and the relationships among those categories" (LeCompte, Preissle, & Tesch, 1993, p239). On the basis of the processes described above, a set of assertions were developed, which are presented in the finding section. Although I have described the data analysis procedures in a linear format, the actual procedure was not as linear one, rather a cyclic one as Merriam (1998, p191.) pointed out that constant comparative method involved integration, modifications, and refinement of categories, properties and hypotheses.

Trustworthiness

In order to establish trustworthiness for this study, I used a number of methods suggested by researchers (Erickson, 1986; Merriam, 1998; Patton, 1990; Seale, 1999; Wolcott, 1994). First, I approached data triangulation by collecting data from numerous sources: multiple participants, interviews, observations, and documents. I relied on data triangulation to search for confirming and disconfirming evidence from multiple data sources in order to obtain a holistic understanding of the situation and to construct plausible explanation about the phenomena being study. Through combining multiple data sources, I hope to overcome the weakness or intrinsic bias and the problems that can occur from single source. Second, as the study progressed, I presented and shared with the three teachers the collected data, data analysis procedure and tentative interpretations derived from the data by means of person-to-person conferences, e-mail communication, and/or talks over telephone for clarification and refinement. Third, three classmates (one of them is a Chinese) were invited to check interview transcriptions and translation and to help analyze data. I also asked a couple of professors from College of Education in China to comment on the findings as they emerged. Fourth, I kept a research journal to describe in detail about the processes of data collection and analysis as well as decision making so that others can understand how I arrived at my results.

CHAPTER 4

FINDINGS

In this section, I present a set of assertions about what teachers' assessment beliefs are about assessment and how they practice assessment, and what influences their beliefs and practices. The findings are organized into five assertions. I first address the teachers' purposes of assessment. Then presented is the influence of the goals of science education on teacher beliefs and practices. The third assertion is teachers believed that the National College Entrance Examination has impact on their teaching and assessment. The fourth assertion illustrates the impact of teacher's role vs. student's role. Finally, I present the influence of school culture on teachers' beliefs and practices about assessment.

Assertion 1: Teachers Believed that the Major Purposes of Assessment Were Evaluating Student Performance, Guiding Instruction, Giving a Grade/Score.

The three science teachers employed assessment for a variety of purposes. They all believed that assessment should be mainly used to evaluate student performance, guide instruction, and give students grade/score. Other uses of assessment one or two of them suggested could be a way to meet student ability, an opportunity for students to demonstrate their learning, and a motivator for learning.

Evaluating Student Performance

The three teachers believed that assessment can be used to evaluate students' performance in learning scientific knowledge and skill development, although they had different emphasis. Teacher Wu Jun believed that science consists of unambiguous knowledge and that one of the major goals of learning science is the acquisition of knowledge. His teaching structure illustrated this belief. His normal teaching structure was to ask students to go through notebooks or review sheets to review the content taught in the last class, then to introduce a new topic, give students a couple of test-type problems to solve, and to administer a quiz or test after finishing a unit or chapter. The following excerpt is based on an observation of his class.

6/12/03

3:12 Teacher Wu Jun got into the class and stood in front of the classroom behind the podium, operating his laptop. Students were getting into the classroom.

3:15 The bell rings.

Wu Jun: Class begins. (A student says loudly “stand up”. All students stand up.) Good afternoon, students. (The students respond in chorus, “Good afternoon, teacher.”) Please be seated. Last few classes, we studied carbohydrates, focused on monosaccharide . Let’s review the content and see if you have obtained the knowledge. (He turns on the overhead project. Review content appears on the screen, including definitions, terms, and physical and chemical characteristics of monosaccharide as well as chemical reaction equation. He goes through the content on the screen line by line.)

(10 minutes passed.)

Wu Jun: You understand? I am going to give you a quiz on the last unit.

(He hands out the quiz to students. Students are quiet doing the quiz.)

(12 minutes passed.)

3:37 (Quiz is over.)

Wu Jun: We will start learning new content about polysaccharide and cellulose. (He clicked the mouse and the words “Unit 2. polysaccharide and cellulose” are on the screen.) I am going to give your five minutes to read the material on the textbook, and then ask you some questions about the content.

(Students are reading.)

(5 minutes passed.)

Wu Jun: What are the common characteristics of polysaccharide? (He called on a student to answer the question. The student read the relevant content on the textbook.)

(He clicked the mouse and "1. The common characteristics of polysaccharide" appears on the screen. He clicked the mouse again and "2. Starch" appears on the screen. He introduced the physical characteristic of starch, followed by the chemical characteristic of starch.)

3: 55 The bell rings. Class is over.

(Observation, 6/12)

Teacher Wu Jun started the class with a review of previously taught content followed by a quiz on the content, and then began teaching new content. This teaching structure indicated that teacher Wu Jun emphasized the acquisition of scientific knowledge, so it is not surprising that his assessment priority was content knowledge and formal summative assessments of content, such as quizzes and tests. As he said:

> I think knowledge, content should be the most important domain we need to focus on. Through unit or chapter quiz, mid-term test, final test, these are ways to know student performance on content learning. I don't see any other ways can do like these tests. (Interview, 6/25).

Teacher Pan Ling believed that students entered classroom with a lack of knowledge and skills about physics. Students would get "more knowledge" and abilities by listening to his lectures, reading textbook and other content-based materials, solving problems and doing experiments. Assessment was a means for determining what knowledge students had learned and what skills students were able to perform. Due to the pressure from the NCEE, his approach to teaching physics was similar to teacher Wu Jun's. Assessment in paper-and-pencil form was used to help him know about "How much and how well they have mastered the content". In contrast, he'd like to get information about "How did they process information and draw conclusion?" in his comprehensive course (Interview, 6/28). Observations found that his physics class often ended with handing out an in-class or take-home quiz or test; on the other hand, in the comprehensive course, his students were involved in some research/investigations.

For teacher Wang Ying, one of the important tasks of learning biology was to gain knowledge because "without basic knowledge it would not be possible for students to develop other skills" (Interview, 6/29). Her subject was a "minor subject", one in which she was not allowed to administer more than one test each semester in order to reduce students' workload and give students more time on those "major subjects." She usually obtained information about "What percentage of the material and what skills, for example, using equipment, did they learned?" and "How well did they learn?" by giving students' homework (Interview, 6/29). Every student had a practice exercise book which comes with the textbook. Teacher Wang Ying required students to complete corresponding part of the exercise book after each teaching section. The homework assignment generally included two types one of which is to check basic knowledge, such as multiple choice, fill-in-blank, definition, terms, and short answer questions. This type of assignment was easy to complete; all of the answers could be found in textbook and notebook. The other part needs some thinking, such as filling out chart or/and table analysis, drawing picture, knowledge application, comparison and contrast, and such.

Sample homework assignment from Ms. Wang's class is shown below:

Unit 3 Ecosystem

1. Foundation and its reinforcement

Explain the following term:

Producer, Consumer, Decomposer, Food Chain, Food Web

From the following items, choose all that are producers

Wolf Radish Bacteria Carrot Deer Snake Rice Fungi Toad Tulip

From the following items, choose all that are consumers

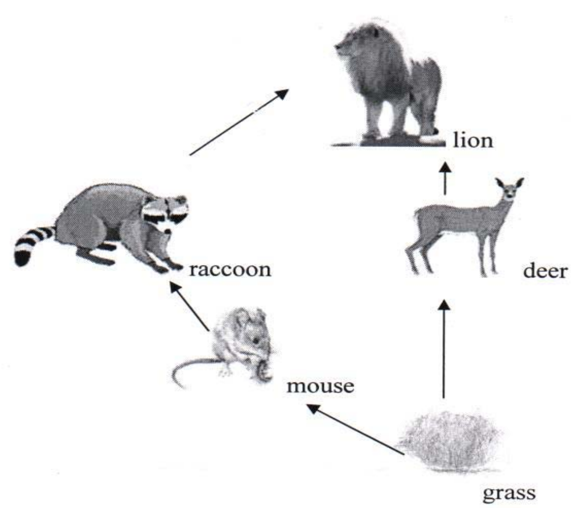
Wolf Radish Bacteria Carrot Deer Snake Rice Fungi Toad Tulip

From the following items, choose all that are decomposers

Wolf Radish Bacteria Carrot Deer Snake Rice Fungi Toad Tulip

2. Extension and enhancement

The picture below is a food web, please write P by the organism if it is a producer, C if consumer. Also, use one sentence to explain why it is a producer or consumer.



According to the food web above, which would **MOST LIKELY** happen if the weather caused the grass to grow well? Please explain why you chose it.

- The deer population would decrease.
- Only the number of raccoons would increase.
- None of the animals would have enough to eat.
- All of the animals would have plenty of food to eat.

If a raccoon was removed from the above food web, how are other organisms affected?

Please construct a food web using a set of organisms given below (if you'd like to draw pictures of these organisms to construct the food chain/web, do it please. But you don't have to.)

Snake, rabbit, grass, bird, grasshocker

(Document, 6/18)

In the first section of this sample homework, she asked students to recall some definitions about the components of ecosystem, and then to use the information to identify some specific components from a number of given organisms. The second part of this sample homework required students to predict what would happen if one of the members of a given food web changes. In addition, one item asked students to construct a food chain/web using a set of certain organisms. This homework indicated that teacher Wang Ying focused not only on students' acquisition of knowledge, but also on knowledge application, as well as on students' skill development, such as thinking critically.

Guiding Instruction

The second purpose that the teachers had for assessment was guiding instruction. Through informal class observation or/and formal assessment, the teachers gained clues of what their students had learned about a topic to be taught, what they were struggling with and what difficulties students had in understanding the science concept, and then adjusted their instruction accordingly. As teacher Wu Jun said:

> Through asking questions, observing, giving homework, quizzes, tests, I could gain a sense whether or not I should go over a certain topic again, and how much to go over again. Sometimes, you know, I did go too fast or too far in class. Some students might not have got it. But through assessment I could learn that. (Interview, 6/25)

Teacher Wu Jun also believed that students often possess preconceived ideas regarding chemical concepts and phenomena. One of his teaching goals was to "correct students' misconceptions on these concepts", so he used assessment to obtain information about "what view that students bring to the classroom, these views do not necessarily correspond to the laws of science being taught in the classroom" (Interview, 6/25). He described an example of his use of oral questioning to assess his students' preconception:

> Last year, I taught 8th grade chemistry. One day, I planned to introduce the concept of burning to students. At the beginning of the class, I called some students, about four or five, to tell me what would happen when we burn materials. Guess what? The results surprised me. They, these students believed that burning always produce gas. Because the gas would be released into the atmosphere, the weight of the burned material reduces. Nearly all other students agreed with that idea. (Conference, 6/20)

In order to correct the misconception, he designed experiments for students. The students found that burning does not always produce some kind of gas, then result in a decrease in weight. Through the experiment, teacher Wu Jun helped the students rectify the old perception about burning and learn that burning is a process of combination of a substance with oxygen to form new substances. The new substances could be gases or others.

For teacher Pan Ling, one of the ways that he guided instruction was to find "what problems the students have." According to the assessment results, he adjusted his teaching "either going faster, or slowing down, or giving individual help" (Conference, 6/28). His assessment informing instruction also revolved around lab activities. As he stated:

> Prior to each lab activity, I would take a few minutes, generally speaking, to ask a couple of questions about theories or knowledge we discussed in class related to the lab activity. If they misunderstood, forgot, maybe, some don't know at all, I'd review them and make sure they got the knowledge. Doing so, that assessment can help students do lab work smoothly. Otherwise, if we go over the relevant knowledge in the middle of lab work, that would waste lab time. (Interview, 6/28)

Teacher Pan Ling believed that it was worth spending several minutes reviewing related knowledge prior to lab activities. The review would refresh students mind and could make the lab activities go smoothly. The following excerpt based on an observation of teacher Pan Ling's lab activity section supports his statement above:

> 2:20 The bell rings. (Students are getting into classroom.)
>
> Teacher Pan Ling: Class begins. (A student says loudly "stand up". All students stand up.) Good afternoon, students. (The students respond in chorus, "Good afternoon, teacher.") Please be seated. Next week, we have one more experiment: oscilloscope. This year's NCEE had an item about oscilloscope. (He talks a little about oscilloscope.) Today, we're going to learn how to measure electric current, electrical resistance and voltage using electric current meter. We have already learned about electric current, electrical resistance

and voltage. Let's take a few minutes to review these. (He is reviewing the content taught and the students are listening.)

(Three minutes passed.)

Teacher Pan Ling: Any questions? (Only one student raises his hand.) Since we are on a tight schedule, I am going to answer your question in the lab while other students do the experiment. OK, let's go to the lab.

2:35 (Students walk to the lab which is about 30 meters away from the classroom.)

(The principles, procedures, and materials to be used have already been written on the board. Students go to the table to begin the experiment in a group of two. Teacher Pan Ling goes to the student who had question while others are doing their lab work.)

3:00 Lab activity ends.

Teacher Pan Ling: don't forget to hand in your lab report tomorrow. (Students go back to the classroom.)

(Observation, 6/12)

Prior to students' lab work, teacher Pan Ling spent time on writing lab guide on the board and going over relevant theories and knowledge about electricity. He gave individual help student who had problem with the content. This excerpt supported his belief that a review of content before lab activities was necessary.

Teacher Wang Ying held a belief that scientific research in the real world is seldom done in isolation. For the most part, science is "a cooperative enterprise" in which scientists are expected to share their ideas and findings with others. Students should develop positive attitudes and skills to work in small teams as well as individually. She found that group work in the science classroom facilitated communication among students, increased understanding of scientific phenomena, developed the spirits of cooperation and responsibility, and improved problem solving and task completion. As she said, “Sometimes, peer instruction is more effective than teachers…therefore, I like to take group approach if possible” (Interview, 6/29). She used what she called “pre-assessment” to help her make decisions about group formation. She believed that students with similar ideas or characteristics would work better in a group. The following statement illustrated this idea:

> Although I encourage students to be friendly to one another, to be cooperative with others, because today’s world is one full of cooperation, but often they are not, you know, teenagers frequently cause a variety of problems. If you put rather different students in the same group, the group work might not go well. Sometime, even terrible, you might take time to deal with their fighting, constant arguing, and things like that. (Interview, 6/29)

Similar to teacher Wu Jun, teacher Wang Ying also believed that students’ prior knowledge in biology might have certain impact on what to be learned. Some naïve conceptions or misconceptions that students bring to class were resistant to change. Ms. Wang assessed these ideas and helped to guide her instruction. She stated:

> For example, many of my students think normal chicken eggs can hatch out chickens if providing appropriate condition, like temperature. They don’t know the eggs have to be fertilized ones. I asked them to try out their ideas, to bring a couple of eggs to school to hatch, then to see if there are chicken coming out. Of course, no chickens. Then I provided some fertilized eggs I bought from a farm. You can guess the result. Then I let them see a video of a chicken farm. Sometimes, if budget

> allowed, I even took them to the farm to see in person how an egg hatches a chicken. (Interview 6/29).

In this example, Ms. Wang determined what approach to take and what kinds of activities to select according to what students had in their mind. She used hands-on activity, video, and even a visit to farm to correct students' naïve conception about hatching. In addition, for teacher Wang Ying, assessment before instruction may also be useful "in learning how much students know about the tools. If half the students have never used a microscope, some extra help may be required before the equipment is used in a lab activity" (Conference, 6/23).

Grading/Scoring

One of the purposes of assessment for Ms. Wang, Mr. Wu and Mr. Pan was grading. The three teachers expressed the notion that giving grades was an essential part of teaching, although they valued grades differently. Teacher Wu Jun viewed grades and scores as important for selection of most able students and prediction as he said:

> They are indications of students' academic competence. They are the mark of students' academic achievement and indicate students' current situation and potential in study of chemistry. (Interview, 6/25)

He selected students for chemistry knowledge competitions at local, provincial, national, or international level mainly based on students' scores obtained during a given period of time and trained them. Being selected to participate in such competitions would make the students "much more competent" in applying for admission to university or college. Therefore, teacher Wu Jun and his students took it "very very" seriously. He also used scores to predict how well his students would perform in the NCEE and accordingly, to help students adjust their expectations for higher education. He stated:

> If a student often gets higher scores in classroom chemistry tests, he or she will have higher possibility, 80-90 percent, to get higher score in the NCEE, then he or she will have higher possibility to be accepted by a university chemistry department if he or she applies to the department. I keep on informing students of their grades or scores. Although not 100 percent accurate, but, basically useful and practical. (Interview, 6/25).

He believed that grades/scores could be a "practical and useful" indication for a student to adjust his or her expectation for higher education. He believed that if a student constantly achieved good scores in classroom chemistry tests, he or she would have higher possibility to pass the NCEE and be admitted into a college.

In contrast, teacher Wang Ying saw grades "useless" because "nobody cares about that due to being 'minor subject'". Grades were used for no more than to fill up the report card as she stated, "But you can't leave the report card empty in the 'biology' space" (Interview, 6/29).

Finally, teacher Pan Ling believed that "everyone thinks that students' grades on physics reflect their performance and achievement in learning". So he had to carefully assess students' performance and gave a "proper grade" to an individual student. However, he gave only "satisfactory or unsatisfactory" to students for the Comprehensive Practice Activity course because it was not seen "as important as a regular physics course" (Conference, 6/12). Review of report cards found that for the subjects of physics and chemistry, teacher Wu Jun and Pan Ling used hundred-mark system, while teacher Wang Ying gave letter-grade. When asked why different subjects employed different grading systems, teacher Wang Ying stated the reason:

> All "minor subjects" give letter-grade. Because we have to reduce students workload. Because in the hundred-mark system, a student who gets 98 points is considered to

> be a better student than the student with a score of 90, 91 or even 96. You know, in the NCEE, one point could determine your whole life. So they need to get used to this system. However, letter-grade, no such a problem. Anyway, 90 or 100 would be given an “A”. So, students don’t need to consider 90 or 100. You know, getting 100 points means more effort than getting 90 points. (Interview, 6/29)

Since the NCEE adopts the hundred-mark system and even one point could make a big difference, students have to get familiarized with this grading system. Students have to make efforts and do their best to earn every single point. On the other hand, the adoption of letter-grade in “minor subjects” such as biology could reduce students’ workload, because in a range of scores, even up to 10 points, for instance, 90 and 100 would not make any difference. Therefore, students need not put much effort to earn every single point.

Evaluating student performance, guiding instruction and grading were used by all of the three science teachers. Other uses of assessment by one or two of them included meeting student ability, providing opportunity for demonstration, motivating learning.

Meeting Student Ability

Teacher Wang Ying and Pan Ling believed that it was important to take student ability into consideration when selecting assessment approaches. They believed that different students may have different learning and thinking styles. Giving a variety of assessment activities can ensure students with specific learning problems or styles to success. The following statement illustrated this belief of teacher Wang Ying:

> From my many years of teaching, you may have the same experience, I found that sometimes, not very often, but it did happen, some students may not know the

answer to a given question, but if you reworded it, or in another way, I mean, say, using picture to address the same question, they may know the answer. So I have to give them chance. (Interview, 6/29)

A sample test item of teacher Wang Ying showed that she considered student ability in her assessment activities. She encouraged students to show their understanding of scientific concepts with alternative ways other than words.

Item 6. Please use whatever way (e.g. written sentences, pictures, chart, table, etc.) you'd like to show your understanding of the structure and function of a human heart (10 points). (Document, 6/18)

Teacher Pan Ling believed that different students learn best from different learning activities with which they felt most comfortable. His job was to provide students with various opportunities to learn and success. He stated:

You know, for instance, some do well with reading, some with lecture, some with experiment. Sometimes, especially in the selective course, the Comprehensive Practice Course, I let students to choose from multiple assessment activities what they feel fits the way of their learning and thinking the most. Every student has his/her own weakness and strength.

(Interview, 6/28)

The statement above demonstrated his belief that students have different learning abilities. Some may be good at reading, while others at listening to teacher's lecture. Still others may benefit best from doing an experiment. The differences in learning abilities should be considered into assessment activity; however, he seemed more likely to do so in his Comprehensive Practice Activity class.

Opportunity for Demonstration

Another use of assessment by both teacher Pan Ling and Wang Ying was to provide opportunity for students to demonstrate what they understood, learned, or investigated about a certain topic or to design something tangible to show. They believed that demonstrations could help students learn better or get deeper insight into certain concepts. Teacher Wang Ying said:

> My kids told me that they worked best and learned most when they made a product such as a cell model. When they presented their models to others, they, I think, understood more about the concept. I am sure about that. And making a model is fun. (Interview, 6/29)

She also provided opportunity for students to present their investigations on certain topics. The following excerpt is based on an observation of her teaching. The topic was environmental pollution.

> 1:25 Teacher Wang Ying enters the classroom. She puts her laptop on the podium and gets it ready for students' use.
>
> 1:30 The bell rings.
>
> Teacher Wang Ying: Class begins. (A student says loudly "stand up". All students get up.) Good afternoon, students. (The students respond in chorus, "Good afternoon, teacher.") Please be seated. Two weeks ago I asked you all to do some research in groups of four on the topic of environmental pollution. Today is the World Environmental Day. It's the right time to present your research results. Let's see what you have found. Which group would like to come up to report first? OK, the fifth group.
>
> (The fifth group introduces how they did research on the water quality of Dongcheng Lake. They use powerpoint slides to show the content of various pollutants. They also

compare the quantity of these pollutants with the National Water Quality Standards and conclude that the lake has been slightly contaminated.)

(10 minutes passed. The presentation of this group ends)

Teacher Wang Ying: use the rubric I passed to judge their work. Please take it seriously.

1: 45 Teacher Wang Ying: The next group is…, OK, the second group.

(The second group presents how they visited a petroleum refined factory where a group member's father works. They show some photos of this factory and introduce what products of these factory produce, what kind of pollution they may cause, and how they deal with the pollution.)

(11 minutes passed. The presentation ends.)

Teacher Wang Ying: please fill out the evaluation form. (2 minutes later) The next group is….the ninth group.

(The ninth group comes up to the front of the classroom. Their topic is about some unhealthy and uncivilized behaviors around their surrounding. They use powerpoint to show these behaviors, such as littering, spitting, …they also come up with some strategies responding to these harmful behaviors. The presentation lasts 8 minutes.)

2: 08 Teacher Wang Ying: we almost run out of time. We'll go on next class. Please hand in your evaluation form.

2:10 The bell rings.

(Observation, 6/5)

Ms. Wang believed that students could learn better from investigation and demonstration. She grouped students to investigate on certain topics and report their research results to the class. Through research students developed a variety of higher level cognitive skills and deeper insight into certain issues. For instance, one of student groups investigated the pollutants of a lake and compared them with the National Water Quality Standards, and then made a conclusion that the lake was slightly polluted.

For teacher Pan Ling, assessment activities could set “a stage” for students to perform and share their ideas with others. He believed that questions about a certain concept like “what is…” was “straightforward” and could not tell him whether or not the students really understood the concept. Instead, answering questions like “how do you know a phenomenon happen?” was “challenging” (Conference, 6/18). Assessment should provide an opportunity for students to demonstrate or design something to show what the concept is instead of just telling him what the concept is. “Showing is better than taking a paper test” (Interview, 6/29). The observation excerpt below shows how such “a stage” was used for students to share their ideas about nuclear industry.

10:25 The bell rings.

Teacher Pan Ling: Class begins. (A student says loudly “stand up”. All students stand up.) Good morning, students. (The students respond in chorus, “Good morning, teacher.” Please be seated. This is the last class of this semester. (He reviews the last few presentations.) We continue our presentation on the topic about nuclear power plants. (A student goes up to the front of the classroom and presents the theories on which a nuclear power plant is based and how a nuclear power plant looks like with some pictures.) Ten minutes passed.

Teacher Pan Ling: next one is ?

(Another student introduces the effects of an explosion on environment and human in one of the nuclear reactors at Chernobyl in the former Soviet Union.) (Observation, 6/10)

Test as a Motivator for Learning

Teacher Wu Jun defined learning as processing information and teaching as giving information; hence, “paying the attention and trying to draw the attention” is the prerequisite of successful learning and teaching. As he said:

> I feel they are learning if I can catch their attention; otherwise, my teaching, I don’t think, is good, learning might not have happened…. Test is a good way to get their attention. (Interview, 6/25)

Through observations I found that he frequently alerted students to pay attention and take notes for future tests. For example, “This content is very important and often appears in various tests, say, NCEE, high school entrance exam, you have to listen to my lecture carefully” (Observation, 6/12).

In this section, I described the purposes of assessment used by the three science teachers. They all believed that assessment should be used to evaluate student performance in learning scientific knowledge and skill development, though they had different emphasis. Through assessment, they gained information to guide their instruction, either to correct students’ misconceptions of certain concepts or adjust the pace of teaching. They all believed that one of the purposes of assessment was generating grades/scores. In addition, teacher Wu Jun used test as a motivator for student learning. Teacher Wang Ying and Pan Ling employed assessment activities to provide students with opportunity for demonstration of their understanding of science and to meet students’ different learning styles. In the following section, I explain the influence of the teachers’ goal for school science on this assessment beliefs and practices.

Assertion 2: Teacher Beliefs and Practices about Assessment

Were Shaped by the Goals for School Science

The National Standards of Science Education published by Chinese Ministry of Education (CME) in 2001 and other related teaching guidelines and standards for science subject courses (Document, 7/6) state that the overall goal for school science is to enhance every student's scientific literacy. These documents further elaborate that, through learning science, students will be able to know about and understanding basic knowledge of science, master basic skills, explain common natural phenomena, and solve practical problems; increase the understanding of scientific inquiry, form preliminary habit to doing scientific inquiry, cultivate the consciousness of creativity and the ability of application; maintain the strong curiosity and desire to learn about the natural phenomena and foster positive attitude toward natural world; develop the awareness of appreciating science and objecting to superstition; and pay close attention to the interaction of science, technology and society.

The three teachers' goals for science teaching generally followed the guidelines above. The following lesson plan excerpts illustrate this point.

Teacher Wang Ying's lesson plan excerpt:

Chapter 8 Metabolism

Teaching Objectives:

- Knowledge domain

Know the concept of metabolism and significance as well as the knowledge of body temperature

Understand the knowledge of transformation of substances and changes of energy in human body

- Ability domain

Cultivate students' abilities of thinking, analyzing and summarizing problems as well as communicating

Nurture students' ability of associating theory with reality

- Emotion and ideology domain

Develop the basic conception of dialectical materialism that there is a unity of structure and function and that there are harmony and contradiction between assimilation and dissimilation

(Document, 6/15)

Teacher Pan Ling's lesson plan excerpt:

Unit Four. The Relationship of Velocity and Time

Teaching goals

1. Knowledge objectives

Know what velocity-time graph is and how to use the graph to illustrate the relationship between velocity and time

Know straight line motion with constant velocity and the significance of v-t graph of motion with uniform acceleration in physics

Know what motion with uniform acceleration and non-uniform acceleration are.

2. Ability objectives

Compare displacement-time graph， students themselves analyze, discuss, foster the ability of teaching themselves.

Foster students' ability of using mathematical methods to solve physics problems from displacement graph to velocity graph.

3. Moral objectives

Nurturing a down-to-earth style of work of students and developing good habit for learning by emphasizing scientific reasoning in teaching.

(Document, 6/15)

Teacher Wu Jun's lesson plan excerpt:

Chapter 10 Petroleum and Its Products

2. Teaching goals

(1) Knowledge objectives

Know the components of petroleum and the wide uses of petroleum products;

Know the principle of atmospheric and vacuum distillation and cracking of petroleum.

(2) Ability objectives

The ability of observing experimental appearance, examining the essence of appearance through observation; knowledge transfer, drawing conclusions from learned knowledge, preliminary ability of designing experimental plan and device; the ability of associating theories to reality, linking subject knowledge to rich and varied daily life, making connection between perceptual knowledge and rational knowledge.

(3) Moral/affection objectives

Knowing the development of petroleum industry in China during the past 50 years, enhancing the sense of pride of motherland; fostering scientific traits of loving and valuing science and being determined to join science enterprise; developing the awareness of saving energy, preventing pollution and taking care of environment.

(Document, 6/16)

The teaching plan excerpts above illustrate that the teachers' goals of science teaching generally fall into three levels: (a) knowledge level, (b) skills level, (c) moral/affection level. For instance, in terms of knowledge objectives, Wang Ying requires students to "know the concept of metabolism;" Pan Ling wants students to "know what motion with uniform acceleration and non-uniform acceleration are." Wu Jun requires students to "know the components of petroleum." In Wang Ying's plan excerpt, she lists as skills objectives thinking, analyzing and summarizing problems, applying knowledge to daily life, etc. For Pan Ling one of skills objectives is "using mathematical methods to solve physics problems." Wu Jun requires students to develop the abilities of designing and observing experiment as well as making connections between knowledge and real life. Moral/affection domain is included in all of the three teachers' plans. Wang Ying wishes students to "develop the basic conception of dialectical materialism." Pan Ling wants students to develop good habits for learning. Wu Jun wishes to enhance students' sense of pride of motherland and attitude of loving science.

Through pre-service and in service programs, the science teachers have learned about and discussed those above mentioned goals. Therefore, it is not surprising that they aligned their teaching and assessment with those goals "intentionally or unintentionally" (Conference, 6/29). A component of teacher Wang Ying's assessment was students' acquisition of basic biology knowledge, such as terms, definitions, and principles because "that's important. No knowledge, no skills" (Interview, 6/29). She also assessed students' abilities/skills which include

> To critically analyze a problem, develop thinking skills, so they can come to their own conclusions. Make a product and share with others to demonstrate their knowledge and understanding of science, and more, like discussing. (Interview, 6/29)

In addition, she believed that students should develop positive attitudes toward learning science, which should be a part of a grade. As she stated:

> Attitude toward learning is one of the factors that I consider for grading. I once had a student, one day, we did an experiment about the component of fish bone. He didn't get an expected result at the end of that lab activity. There were some other students, they also didn't get the correct results. But only he asked to do the experiment again. He not only got the right results but also asked me some questions beyond what we discussed in class. Some questions even I could not answer on the spot. I think he learned more than other students. So, though he should get a "B" grade according to all his work, I gave him an "A". I think he has a good attitude toward learning biology. That should be appreciated. (Interview, 6/29)

She counted students' effort into their grade to encourage students to develop positive attitude toward and put more effort in learning biology science. Teacher Wang Ying believed that good attitude toward learning could be helpful in bring a student's grade up to a high level.

Teacher Pan Ling's goals for science teaching included students' acquisition of "fundamental knowledge of physics science" and a perception of science "as a dynamic, creative, and fun process" (Interview, 6/28). He also wanted to foster students' higher-level skills as he stated:

> I wish, want, to foster the ability of students to debate, defend, argue for/against their own or others viewpoints on a particular topic, issue. Make prediction based on their knowledge learned. Demonstrate their product or work to audience, like their parents, classmates, other teachers, etc. I want them to develop the skills to think on their own because they have to think on their own after leaving school, I mean, graduate from

school, enter the real society, rather than being told what to think and what the answer is. I want them to think for themselves. Therefore, in general, knowledge, skills and abilities, and attitude toward science are the “targets” of his assessment activities. (Interview, 6/28)

Compared to the other two teachers, teacher Wu Jun seemed to emphasize more on knowledge domain of chemistry in terms of his teaching goals. He believed that enhancing students’ chemistry knowledge was “most important” and “biggest” teaching goal (Conference, 6/20). Although he admitted that, besides students’ acquisition of knowledge, he also considered other factors when giving grades, such as lab skills, the ability of application of knowledge, and attitude, these factors served for students to learn knowledge better or/and easier. He stated:

> Another thing is they need to learn how to relate what they are working or learning with their daily life. Knowledge around them. How to use chemistry in their life. In addition, lab skill is also important. …..Without a good attitude, they could not learn chemistry knowledge well. All these can help them to remember some important concepts. Therefore, I grade them based on these aspects. (Interview, 6/25)

In this section, I described the influence of goals for science teaching. The National Standards of Science Education (CME, 2001) and other teaching guidelines (Document, 7/6) state that the overall goals for science teaching include three domains: (a) knowledge, (b) ability/skill, and (c) affective/moral. The three science teachers generally followed these goals and aligned their assessment with these goals, though they had different emphases. In the next section, I illustrate how the National College Entrance Examination influenced teachers’ assessment beliefs and practices.

Assertion 3: Teachers' Beliefs and Practices about Assessment Were Greatly Influenced by the National College Entrance Examination (NCEE)

The three teachers believed that the educational system in China has been dominated by an elaborate system of testing, especially the National College Entrance Examination. The examinations have affected all aspects of their teaching and learning.

Scores as Determinant for Future Life

The public examinations, primarily the local high school entrance examination and the National College Entrance Examination, determine the students' future. Throughout their schooling students take rigorous examinations in order to decide all the stages of child's educational experiences which affect the students' future career. A student' score in the examination is the major criterion for selection of further education. A couple of points often determine a student's whole life. Students and their parents must take it seriously. Teacher Wang Ying described how the NCEE affected her life:

> Since I didn't perform very well in the National College Entrance Examination, I had no choice and I had to attend the two-year program. In fact there were only two or three points short in politics subject to meet the requirement for the regular 4-year program. I didn't know this program designed for training teachers until I entered this program….Actually, I never thought of pursuing a job as a teacher. After graduation I was assigned a job for a middle/high school. (Interview, 6/29)

Although teacher Pan Ling's case was not exactly the same as Wang Ying's, his teaching profession was also determined by his scores in the NCEE:

> My first choice was physics major of a research university, you know, research universities, usually is more prestigious, more competent, require higher scores than

> other kinds of colleges or universities. My total score was not good enough to reach the cut score set for the research universities. As a result, I was enrolled by a normal college, now this college has become a research university. (Interview, 6/28)

Due to the fact that their scores earned were not good enough to meet the requirement for their targeted programs, teachers Wang Ying and Pan Ling had to choose teacher training programs, which were thought as less superior to scientist training programs. This indicates how powerful scores gained from the NCEE affected students' professional career.

Teacher Wu Jun described a different situation, but the essence that the score determines a student's future life remains the same. He stated:

> Then, I evaluated my potential that year when I would take the NCEE. I guess that I might not get enough total score required for entering a top research university. But I liked to be a teacher, so I applied for admission to a top normal university. I was accepted. (Interview, 6/25)

Despite his statement of being willing to be a teacher, he did not apply for a teaching job after his completion of teacher training program. He decided to continue his study for a Master's degree in chemistry. He applied for admission to the most prestigious research institution of the Chinese Academy of Science. However, he was not admitted by the institution because he fell a few points short. He stated:

> I took the national graduate school entrance examination for general subjects, like English and Politics Science, and other chemistry-related subjects administered by the Chinese Academy of Science. Unfortunately, they didn't accept me because the score of one of the chemistry-related subjects was three points short. (Interview, 6/25)

Although he was not accepted by his intended research institution, he felt "happy and lucky" because it was the relatively higher score he earned on the graduate school entrance examination that helped him get the current teaching job. He stated:

> Interesting is, after I became a teacher of this school, my principle told me it was my score of graduate school entrance examination helped him decide to offer me the job. Then, there were a lot of applicants to compete with me for this teaching position. You know, this school is very good. He felt that a student who made such good score in the very difficult examination, although not good enough being admitted to the most prestigious graduate program, must be a smart student. I must possess the broad knowledge of chemistry and deeper understanding. So he offered me the job. (Interview, 6/25)

Teacher Wu Jun's experience in the public examination shows the importance of score as well. First, he estimated that he probably would not get a score on the NCEE good enough to apply for an admission to a research university, so he decided to choose a less competent institution that offered the best teacher training program. The score in the NCEE determined his orientation toward higher education. After he was done with his undergraduate study, this score from the graduate school examination played a crucial role in his professional career again. He was denied by a graduate program due to a few points short, yet he benefited from this score—getting a teaching position of a very good school, which many applicants were competing with him.

Too Much Content and Time Constraints

Due to the powerful effects of the NCEE on students, it is not surprising that teachers must adjust their teaching to the orientation of the NCEE. The subjects of physics and chemistry are among what Chinese teachers call “major subjects”, which are assigned more teaching time, more resources, and are taught by the most experienced teachers, and always included in the NCEE. Therefore, the teachers who teach “major subjects” have to strictly follow the NCEE guidelines in order to well prepare students for the NCEE.

The NCEE guideline lists all knowledge content and skills students should develop and master in order to prepare for the examination. Both of teacher Pan Ling and Wu Jun believed that the NCEE guidelines cover “too much theoretical content” and some of the content is “too hard” for students (Conference, 6/20, 6/23). Lack of time has become a major factor that affected teachers’ decision on what and how they taught and assessed students.

Due to the difficult and abundant theoretical content as well as the big class size, teacher Pan Ling had to take the lecture approach and spend most of his teaching time to teach those theories. That left him little time to deal thoroughly with assessment issue in class. He stated:

> In regular physics class, I lecture students almost from the beginning to the end. Because too much content I have to cover. I have about 60 students each class. I don’t have time to ask questions or assess students during the teaching. I don’t want to miss anything that may appear on physics subject of the NCEE. I drill my students to improve their skills in solving exam-type questions. In class, seldom questioning students, or questioning those I pretty sure they know the answers to save time, keep the pace of instruction. (Interview, 6/28)

He preferred to employ traditional approach to assessment when teaching physics course because a “paper-and-pencil test is easy to administer and grade, effective and time-saving in teaching theory-oriented content.” He gave homework and frequent tests which were “consistent with the

NCEE in both content and format" in order to train students' test-taking abilities and to build up their confidence to take more important examination with ease (Interview, 6/28).

Although he could do some alternative assessment in the comprehensive course, he and students "only meet once each week." He wished that he could "increase teaching time" for this course and expressed his concern that time pressure hindered what might have been his ideal assessment for both the physics course and the comprehensive course. He said:

> I wish to have more time in comprehensive class ….I even imagine how to integrate physics with comprehensive course into one course. It probably is more convenient. If given more time, I might have done differently in my assessment. I would like to spend more time on student activities, such as group discussion, presentation, lab work. (Interview, 6/28)

Traditional approaches to teaching and assessment in physics was not compatible with teacher Pan Ling's beliefs of teaching as he said, "this is opposite to all my knowledge about education". He believed that physics teaching "should raise students' abilities to use instrument/tools, to do experiment, to solve real problems, instead of pure theories, solving exam-type items, problems on paper". However, he felt that he had "no choice" due to the pressure from the NCEE. He had to cover the syllabus and focus on the content. (Interview, 6/28).

In order to cover too much already prescribed content in a certain time, Wu Jun had to take the same approach to teach chemistry as teacher Pan Ling: giving lectures, testing students, unquestioning students or asking recall questions or factually oriented questions, rather than thought-provoking or probing questions. In observations of his teaching, I found that, in most times, he tried to maintain an orderly and quiet classroom and to move through much material quickly so as to cover the content of the textbook. The following excerpt is based on the observation of his class:

Teacher Wu Jun: please look at the demonstration carefully. (He demonstrates the experiment of flame test)

(Twelve minutes passed.)

Teacher Wu Jun: the principle of colorful fireworks is based on flame test of alkali and Sr, Ba, Cu. Today, we are going to explore these metals' features. (He writes down alkali metal element on the board.) People call Li, Na, Ga, Cs alkali because their oxoacid are strong bases which can be resoluble into water. The reason we study them as a group is they have internal relations. What are these relations? This session we will explore them.

(He writes "the major physical features of alkali metal. He projects a table on the screen.) Please look carefully at the table and see if there are the differences and similarities among these metals. (Students look at the screen.)

(Five minutes passed.)

See any differences and similarities? We can find that…(He explains the differences and similarities. It takes him 7 minutes.)

Teacher Wu Jun: Then, why do they have these differences and similarities? (He writes "Atomic structure of alkali metal on the board.) Let's recall the element symbols and atomic structures of Li, Na, K. I'd like to ask three students to come up here to write them on the board. Li Ming, Zhang Mei Hua, and Xu Jing, please. (The three students stand up and leave their seats to the front of the classroom. They are writing on the board. Then after finishing they come back to their seats.) Did they write correctly? (Most

> students say “correct”, I hear some say “wrong”.) Yes, they are correct! What about Ga and Cs? (He waits for two second. Then he writes the atomic structures of the two on the board.) We can find that there are internal relations between the physical feature of alkali and their atomic structure. What about their chemical feature? We have already learned that the chemical feature of an element is determined by the outmost “what” of an atom (Students response “number of electrons”.) Right!
>
> (Observation, 6/25)

During the course of his instruction—textbook reading, lecture and demonstration, teacher Wu Jun interacted with the whole class. He posed questions to the whole class and accepted chorus responses or gave the answers himself. He also called on students who called out responses or who he felt would give responses that “were helpful for others’ learning and content coverage, so that we wouldn’t get stuck at a certain point and waste teaching time” (Interview, 6/25).

To prepare students for the NCEE, he had to ensure students to “master chemistry knowledge” and to search for a “correct answer”. The way of getting right answer was to drill students to solve exam-type problems through “daily homework, frequent quizzes and tests.” (Interview, 6/25). Document comparisons found that items appeared on homework, quizzes, and tests generally were similar to those on chemistry test of the NCEE.

The fact that teacher Wu Jun rarely used alternative approaches to assessment did not mean that he was not aware of or had no vision of this approach and the important role it could play in teaching. He said, “I know the reform documents call for a new approach. And I learned how nice the new method is from some material” (Conference, 6/23). He believed that, due to the pressure from the NCEE, he practically didn’t have time to use it even though he possessed an ability to use alternative approach. He said:

> Even you already learned this skill, do you think you really can use it in your class? I don't think so. Because even already required content, you don't have enough time to cover, do you have time to do the time-consuming assessment. Do you know how precious the class time is? Moreover, the new technique is inconsistent with the public examination; I must take the responsibility for students' future. I won't dare to take the risk. (Interview, 6/25)

Despite being unable to use alternative approaches, he was paying close attention to the practices of some of his colleagues as he said, "But I keep an eye on this and see what's going on with someone else's practice" (Conference, 6/18).

In addition, teacher Wu Jun didn't seem to consider asking questions in class as some kind of assessment, or he was simply unable to do that due to large class size. He said:

> Teaching is just teaching, no place for assessment. You can think about it. And a class usually has about 60 students, if for one single period, you ask question to 10 students, that only one sixth, one student takes two minutes, half class time gone. How I cover material. So, the best and efficient way is to give lectures, and give test. (Interview, 6/25)

Compared to teacher Pan Ling and Wu Jun, teacher Wang Ying was "lucky". This year she was teaching 8th grade biology, which Chinese teachers call "minor subject". The "minor subject" usually is assigned less teaching time, less resources, and not included in the local high school entrance examination. Middle school students have to take the local united biology test and pass it to meet the graduation requirements. It is, however, a paper-and-pencil test and students are given review guidelines before the test. Students must "memorize the questions and answers on the guidelines." Furthermore, most students only pursue a "pass" grade. In fact, failure on this test rarely occurred (Fieldnote, 6/29). As to the NCEE, only those students who choose biology-related major such as medical school, agricultural college, etc. have to take examination in biology. Generally speaking, students who take physics and chemistry examinations are much more than those who take biology examination in the NCEE. In the 2003 NCEE this school had 30 students who took biology examination in comparison to about 500 students who took physics or/and chemistry (Conference, 6/27).

Due to the lack of examination pressure, teacher Wang Ying did not "very much" consider time issue. She used "whatever tools I think appropriate to assess my students" (Interview, 6/29). She believed that the development of students' abilities should be at the center of science teaching and learning processes. She said:

> To develop students' abilities must be the most important aim of school biology teaching, the ability to explore biology knowledge by experiment and to apply the biology knowledge in daily life, and the ability of analyzing, thinking, and experimenting. (Interview, 6/29)

Her assessment practice reflected her belief that biology teaching should focus on both knowledge acquisition and ability development. She believed that a traditional approach to assessment has some advantages such as "ease of administering, scoring and analyzing", particularly when used to assess factual knowledge and some certain limited higher level skills (Interview, 6/29). Therefore, she gave homework assignments some of which were based on the knowledge learned in class and final test which was paper-and-pencil format. Preparing students to take the local united test was "a good opportunity to check on students' basic knowledge about biology. Anyway, they need to memorize things about biology" (Interview, 6/29). However, she believed that a traditional approach was not enough in assessing students as she said:

> I felt this kind of assessment, I mean, paper-and-pencil test, was too simple. Basically it depends on recalling knowledge. I don't think paper-and-pencil test can be appropriate to assess a variety of students' abilities. It tends to assess students' general knowledge in science, and at a relatively low level. (Interview, 6/29)

In order to assess higher level learning, she encouraged students to experiment, investigate and observe, and present their findings. She assessed the processes and the outcomes of these activities and gave students grades based on paper test and activities. The following informal lesson plan illustrates her belief that biology course should emphasize on and assess students' higher cognitive learning.

Topic: Observing the Germination of Wheat Seeds

Purposes: the abilities of measurement of seedlings, prediction of length, graphing, communication of results

Procedures: show students how to plant wheat seeds in class, what to do.

Observation and record: fill out the form below.

Seed	Mon.	Tue.	Wed.	Thu.	Fri.	Mon.
1						
2						
3						
4						
5						
6						
Average						

What conditions do the seeds need to germinate?

Draw a graph of seedling height (using average height).

What do you think the seedling height will be on Monday? Write the answer in the last column marked Mon.

Prepare for presenting your observation results to the class.

(Document, 6/24)

In this informal lesson plan, she wanted her students to observe the germination of wheat seeds and measure, record as well as predict the length of seedlings. She also asked her students to draw a graph of seedlings height and prepare to communicate their results.

Teaching 8th grade biology course gave teacher Wang Ying much flexibility to deal with her teaching method including assessment practice because she and her students had no pressure from the public examinations. However, her teaching was not always the same case. When she taught 11th grade biology a couple of years ago, she had to follow the NCEE guidelines and cover “lots of material in a certain period of time”. She had to give “first priority to students’ ability to solve test-type problems, which is not what I really want my students to develop and biology science is supposed to do” (Interview, 6/29).

Due to the powerful effects of the NCEE, which usually was theory-oriented and traditional paper-and-pencil test, Pan Ling and Wu Jun had to use lecture approach in order to cover as many contents as possible in a limited time of a period and a big class size. They had to align their assessment activities with the NCEE both in format and content. In contrast, Wang Ying had no pressure from the NCEE; she had flexibility to adopt a variety of assessment to evaluate students’ abilities at various levels.

Theory, Experiment and Application

Confucianism emphasizes the importance of book knowledge, especially knowledge related to personal perfection, interpersonal relationships, or social relationships (Gao, 1998). Confucians neglected knowledge about nature and daily life or laboring technique (King, 1992). Confucius once said that scholars who work with their brains should govern laborers who work with their physical strength. Confucians looked down upon physical/technical work. The names of the discoverers and inventors never appeared in the official documents (Gao, 1998). Such a value that work with mind is superior to work with brawn has run deep in Chinese education and the climate of the schools (Zhu, 2002).

Generally, testable subject-matter or content dominates in Chinese schools. Science classes are not characterized by frequent laboratory work, demonstrations, and “hands-on” investigations. Students are expected to learn the necessary subject matter through lecture and textbooks. Drills and practice-oriented worksheets are common as well. An analysis of teaching guidelines of the subjects of biology, physics, and chemistry shows that less than one tenth of teaching time are assigned to lab work (Document, 6/10). I found only 7 periods of lab work out of 50 periods of observations with the three participants and other science teachers. This implies that experiment is not as important as theory in this school.

Since the high school entrance examination and the NCEE usually cover theoretical knowledge, not other skills, the teachers’ lecture always focuses on information retention and analysis of theories that are contained in textbook. Science learning has become solely book learning. As a result, students trained in this manner know many facts and theories about a subject and can get high scores in examination, but their practical problem-solving skills are limited (Wang, 1997). In recent years, in order to change this situation, the Chinese Ministry of Education (2000; 2001; 2002; 2003) has issued many reform documents, calling for a change in science teaching from the emphasis too much on theoretical knowledge to paying appropriate attention to the application of knowledge and practical skills. In response to the call of the reform documents, science teachers have had to “adjust our teaching and assessment” (Conference, 6/17).

The three teachers believed that one ability that students should possess was how to use the application of science knowledge. They believed that science was part of everyday life; hence, students should know the principles of science around them. “In fact, in recent years, some items of the NCEE are based on everyday life” (Conference, 6/19).

Teacher Wang Ying believed that a student’s ability to apply knowledge to explain biological phenomena is “more important than acquiring knowledge itself” because “everyday life, everything you do is science, deals with biology, chemistry, physics. You can’t avoid science” (Interview, 6/29). She could get information about how well students have learned about certain concepts through students’ application of knowledge. As she stated, “I always try to let students associate the biology knowledge with their daily life. From doing that, that is connecting, I can see if they really understand the knowledge I taught” (Interview, 6/29).

One example of how she got her students involved in everyday biology was the activity, “observing furry flying things.” She described that activity as the following:

> You once lived in this city before. You must know this phenomenon. In every late spring, lots of trees on both sides of streets in this city begin blossoming. Before long, millions of millions of the furry seeds fly everywhere. It is very annoying. In recent years, this situation has been eased. The situation is better than before. I let students observe in groups “the furry flying things”. Tell me what they are. Why do they fly? Think about ways to deal with these annoying things. From their discussions I can know how well they have learned about this section. (Interview, 6/29)

Wang Ying asked students to observe and think about the furry flying seeds around them. Through this activity, she learned whether or not her students understood the concepts about seed formation and transfer.

Teacher Pan Ling believed that physics touches every single aspect of student's life. Associating the knowledge learned in class with students' daily life often helped them understand theories more deeply; therefore, he encouraged his students to relate what they saw or heard to what they had learned in physics class. Through such an association he was "able to know if his students had really understood and could transfer classroom learning to outside world" (Interview, 6/28). He gave an example to illustrate the importance of associating theory to daily life to his students and his teaching:

> For example, one day when I began to teach about friction, a television channel was broadcasting the National Bicycle Championship. I think many students might be spending some time to watch it. I posed a question for them to think about, that is, why the cyclists form a single file line when they ride. That is a question related to air friction. In fact, things like that, everyday science, exist everywhere. (Interview, 6/28)

Pan Ling believed that science existed everyday and everywhere. For example, the National Bicycle Championship was taking place when he taught the topic of friction. He posed students a question "why the cyclists form a single file line when they ride." He encouraged students to associate the concept of friction with this event. Through the association, he learned if students could apply a studied concept or generalization in class to unstudied examples in real life.

Teacher Wu Jun viewed that chemistry was composed of “a body of factual information and abstract concepts”; therefore, connecting abstract science concepts with concrete application in students’ everyday experiences could assist students “to remember things better” (Interview, 6/25). He believed that students would learn best by seeing things related to the real world and/or things with which they are very familiar. For instance, he once asked students to observe as homework at home “what will happen when water is boiling” to help students understand molecule expansion when heated. He believed that applying theories to concrete things makes classroom learning interesting and relevant to the students’ lives as well as more effective as he said, “I used examples of real world to drag them attention when they (students) felt bored or difficult. It worked.” (Interview, 6/25)

The three teachers believed that hands-on activity is an effective teaching method. Students’ physical and active involvement could help motivate them to learn, remember, and understand better. One type of hands-on activity in common for the three teachers was to engage students in doing the experiments listed on the experiment guidelines of the national curriculum. In the lab students were required to conduct the same experiments at the same time, use the same methods and equipment, and were expected to come up with the same results. The teachers believed that basically, the experiments served auxiliary purposes, including reinforcing the information, and verifying the theories, formulae, results written in the textbooks. On the other hand, the experiments also provided “concrete experience” that would contribute to students’ understanding scientific concepts, which is sometimes “pretty dry, boring”. Teacher Wu Jun stated:

> All these experiments are designed to prove theories I taught in the class. Sometimes, the lab work may make the theories more concrete. That is good for students to

> understand. However, usually, the students know the conclusions before they begin the experiment. They are just repeating what others already have conducted. These lab activities are not mysterious. (Interview, 6/25)

Another purpose that the teachers cited for conducting the experiments as listed on the teaching guidelines of the national curriculum is that one or two of the experiments always have a chance to appear on the subject test of the NCEE. For instance, the physics test of the year of 2003 had two items related to "Experiment 16: Practicing the use of "oscilloscope" and "Experiment 17: Using multi-purpose electrical current meter to explore the electrical parts in a "black box" in the teaching guideline of physics (Document, 7/15). Therefore, teacher Pan Ling wished to go through "as many experiments as possible to get students well prepared for these possible items." However, students did not seem to care about doing experiments because these items only accounted for about one tenth of the total score (14 out of 150 in 2003). They felt that one hour of working on test-type items could be more practical, beneficial, than one hour of experiment in preparation for the NCEE. (Interview, 6/28)

Due to a small proportion of experiment items, which consequently lead to disregard of students, and the time-consuming nature of lab work, when teacher Pan Ling and Wu Jun felt that they didn't have sufficient time to cover textbook content, they would cut out some of the lab work and require students to read the labs after school instead. They would ask students to "memorize" the procedures and how to use the materials and equipment in case items about these experiments appeared on the chemistry or physics test of the NCEE. "Anyway, reading them is better than doing nothing" (Interview with Wu Jun, 6/25). Because the purpose of experiments was to verify the theories, "getting correct and expected results is crucial to lab experiments and the major criterion to assess student performance in lab work" (Interview with

Wu Jun, 6/25). They believed an increase in quantity of experiment items in the NCEE could change the current situation that students have been focusing on theory learning and neglecting lab works.

With no need to consider the NCEE, the teachers could take different approaches and attitudes to lab activities. Although teacher Wang Ying followed the biology experiment guidelines "most of the time", she felt "a little flexible" in choosing topics for lab works when she thought the topics might be more "proper" for students to understand important concepts or when she found it difficult to obtain the resources for lab activities. The following statement indicated her flexibility:

> But sometimes, you know, the activity is not appropriate, for example, the material, sometimes, you can't find, say, one kind of animal, insects, or you can't get it from market. So I have to change it. My students and I are not afraid of not doing the prescribed lab activities. Who cares? Anyway, we don't need to think about if it will appear in the local examination or the NCEE. For example, I let students investigate how the earthworms behave. You know, the earthworms are easy to find. My purpose is to get students to research how environment affects the earthworms, like light and darkness, hot and cold, wet and dry, seawater and fresh water, sound, vibration, etc. This experiment is not in the guideline, but it is easy to find the materials, easy to do, and cheap. But the results are very good. Students said it's much better than some of the prescribed experiment and really helpful to understand the relationship between environment and living things. (Interview, 29)

With no worry about the experiments that might appear on the NCEE, Wang Ying could change the experiments as needed. She could arrange an experiment that was not in the guideline but easier to find materials and to conduct with cheaper cost.

Teacher Pan Ling implemented lab instruction for his regular physics course according to the experiment guidelines with the same purposes as teacher Wu Jun, which were to meet the course requirements and prepare students for the NCEE. He, however, did it rather differently in his comprehensive course. He stated:

> I feel that present physics content, probably all science content, consists of concepts, principles, and facts of science, but little consideration about how they are generated. I think students should know how scientists go about science, how scientific enterprise looks like. They should view science as a way of thinking, a way of investigating. I hope through the comprehensive activities they learn how to think, how to ask relevant and important questions, rather than reading textbook, solving paper problems. They need to do science. (Interview, 6/28)

He placed high value on hands-on activities. He believed that school science should focus on how scientific knowledge was generated. Through comprehensive activities, he wanted students to develop the abilities to ask relevant question, to think and solve real problems.

Therefore, he provided a variety of conditions and created an atmosphere for students to do hands-on activities and develop higher-order thinking skills. He found that students benefited from these activities. As he stated:

> I think students understand more from comprehensive practice activities than typical lab activities. I open the lab, provide materials, and offer help when they need. It makes a lot more sense to them. These activities help students develop critical

> thinking skills, analyzing data, and interpreting data. That's what the physics course is supposed to do. The cookbook labs, I am afraid, only make sense to the person who wrote them. (Interview, 6/28)

He seems to recognize that some importance of the students' role in learning, that is, they have to expend some of the mental effort, not just following the procedures as they did in regular physics lab. In comprehensive practice course, he did not give any test because it was "very difficult to judge what is right or wrong"; instead, he required students to submit or present work report and/or products about their investigations. Although teacher Pan Ling and his students "valued and liked this course very much", they frequently could not do such time-consuming activities.

The NCEE greatly influences science education in China, which these teachers call "a wind vane" (Interview, 6/29) or a conductor's wand (Interview, 6/28). The teachers had to align their teaching and assessment with the NCEE to ensure students' success. With pressure from the NCEE, Pan Ling and Wu Jun used teacher-centered approach to cover as many contents as possible. Lab activities and/or relevance were used to remember "boring" scientific knowledge and prepare for experiment items that may appear on the test. In contrast, due to no pressure from the NCEE, Wang Ying and Pan Ling in his comprehensive activity class used different teaching methods and assessment approaches---hands-on activity and alternative assessment.

Assertion 4: Teachers' Beliefs and Practice about Assessment Were Formed by Teacher Role vs. Student Role

Historically, Confucianism advocated social hierarchy, an orthodoxy which was promoted and reinforced by the dynasties of past ages. It required unconditional sacrifice of oneself to an authority. To maintain an orderly society, everyone should obey the person higher up, and all should obey the emperor. To achieve harmony in a family, according to Confucian thought, a son should obey his father. Wives must obey their husbands. A younger brother should obey his elder brother. Teachers have long been regarded as authority figures second only to parents. Such saying as “once my teacher, forever my parent” is common expression based on Confucianism. Such a value system nurtured the Chinese characteristics of absolute obedience to, and dependence upon, authority (Elman, 1991; Menzel, 1963; Miyazaki, 1976).

Furthermore, in the Chinese tradition, teachers are also viewed as models of good conduct and learning for students (Lee, 2000). An ancient outstanding scholar and educator said, “A teacher is the one who shows you the way of being human, teaches you knowledge and enlightens you while you are confused.” Confucius emphasized the importance of the exemplary effects of teachers and was honored as a model teacher for ten thousand generations. The days of Confucianism are gone, but its influences are still very much with us. In today’s China, teachers have been glorified as “the engineers of the human soul” and “the gardener of the nation’s flowers” by mass media (Lewin, 1999). Good teaching is viewed as educating students in terms of both intellectual and moral aspects. The teacher should serve as a model in both academics and conduct, both inside and outside of the classroom for students to follow in their learning and development (Gao, 1998).

The Confucian social hierarchy was transplanted into the classroom (Fu, 2001). With teachers’ exemplary model and absolute authority, teaching activities are generally carried out smoothly in the Chinese classrooms and students obey teachers’ demand unconditionally. The teacher has sole authority in the classroom and therefore should not be questioned, interrupted, or challenged. For the students, raising many questions would mean disturbing the class and showing disrespect for the teacher. They tend to stay quiet. Students do not dare or seldom discuss with, argue with, doubt, and challenge their teachers. The teacher's words are always truth which is to be parroted and memorized, but not questioned. Academic inquires, such as scientific exploration and critical thinking, are discouraged. (Fu, 2001; Li, 1990; Wang et al, 1996; Wang, 1997)

Teacher's dominant role as knowledge holder and transfer vs. student's limited autonomy

Teachers' perceptions of the role and responsibility of a teacher or a student had an impact on teachers' beliefs and practice about assessment. The three teachers held a common belief that a teacher is a holder of knowledge and should function as a knowledge transmitter; at the same time, learners' role should be receptive to the knowledge presented. Most observations I made showed that the classrooms of the three teachers were teacher-centered where information was presented and students received knowledge. The teachers were responsible for providing and controlling the flow of content (Observations, 6/2, 6/4, 6/5, 6/10, 6/11, 6/13, 6/17, 6/18, 6/19, 6/23, 6/25).

Teacher Wu Jun viewed learning as receiving information from authority, such as books and experts. He believed that books are the major sources of knowledge; therefore, learning content of textbook was "most important". The students' task was to listen carefully to his lecture, write down as much as possible, practice repeatedly and get the right answer when taking exams. He saw himself as an expert in chemistry because he majored in chemistry. Teaching, for him, is a process in which the primary role of teacher is the transmission of knowledge. The fact that he used drill-and-practice to deliver and reinforce knowledge to student further indicated that his belief that students learn by being told (Observations, 6/4, 6/18). He played a central role in teaching—managing and controlling students' actions in the classroom. It was “natural” for him to “make decisions on the matters of testing, such as the form, content, grading criteria, and the use of the results” (Interview, 6/25).

Teacher Pan Ling believed that students have no or little or wrong knowledge and learning is a process of “absorbing knowledge”. Learning and teaching is “a matter of transferring and receiving content” (Conference, 6/12). He stated:

> They don’t know much about physics or have wrong information about certain physics phenomena. Therefore, in my class, the first thing, my responsibility, is I must teach them, give them, the knowledge that I have mastered and practiced, for example, the basic terms, principles, etc. I must tell them. Most of the students’ physics knowledge comes from my teaching, my knowledge, textbook, other materials. My role is to organize my instruction around problems and ideas with clear, correct answers, so that most students can grasp quickly. (Interview, 6/28)

He held such a view that knowledge can be transferred from him or other types of authority sources to the students. In his conception, the teacher’s responsibility was to give knowledge that he possessed in an elaborate and deliberate way. However, teacher’s role is not only giving knowledge but also aiding students in using knowledge.

He continued:

> This is not enough. I must help them use what they have learned to concrete examples. Students are expected to apply their received knowledge to concrete examples or to the real world. That is one of the ways to show their understanding. In order to check if they have learned, I also give tests at a time that I think is proper. (Interview, 6/28)

Observations found that he followed a “three-step” teaching process in the subject of physics in which he was responsible for transmitting knowledge, providing students with applications, and testing them. It seems that his assessment in physics course mainly involved students’ knowledge about physics and its application. His statement that he gave tests at proper time implies that he determined the matter of testing.

Teacher Wang Ying believed that a teacher should have deep and wide knowledge to earn students’ respect. She said:

> I think students respected me because of my in-depth biology knowledge. Sometimes, I feel that the respect for teachers is sort of equal to teachers’ knowledge. The teacher should have enough content knowledge. We have an old saying “if you want to give a bowl of water to students, you should have a barrel of water”. In the classroom, the teacher, that is me, is expected to be knowledge authority. I, indeed, have more knowledge than students. (Interview, 6/29)

She viewed teaching as a profession that is somewhat similar to parenting. She likened students to her son for whom she should take responsibility in his academic development and supervise his learning. She viewed classroom management as “household management” in which she should “play a central part in most times…including assessment” (Interview, 6/29).

While teacher Pan Ling and Wang Ying viewed themselves as the holders of knowledge and spent most of their teaching time transmitting knowledge, they also relinquished some of the control that they had and gave some autonomy to students to a certain degree in certain times and settings.

Teacher Pan Ling believed that it is also important for students to learn to take care of their own learning. In his comprehensive course, he felt that he had opportunity to change his role that he usually plays in physics class. His role in this course could change into a good “watcher” to identify students’ needs, to ask the “right question and more questions”, and to encourage them to come up with questions. He felt that learning is no longer a linear process in which students learn the abstract and apply that. He had the students brainstorm frequently and used students’ ideas to direct some activities through which he could “get information about how well his students are learning and how they used their knowledge” (Interview, 6/28). He described an example as follows:

> I asked them to prepare a presentation about friction, about 5-6 minites, to share their ideas about friction with the whole class. A group of students read a piece of new from a local newspaper about wear of the Ningseng Highway. The news said that the highway had worn more seriously than it is supposed to. The main reason was many overloaded heavy trucks run on the road. The students came to me asking if they could use the example. They thought it could be related to the concept of friction. I told them it’s their rights, responsibility, to choose. If they think so, then go ahead. They made an extended investigation…. I think they enjoyed these activities. Because I gave them opportunities to choose topics, design the experiment. They were aware of exactly what they are going to do and why they need to do so. I am listening, watching, not like a boss. For me, this is a new role. In fact, I think that this new role is called for by the reform documents. (Interview, 6/28)

This example indicated that he gave students some autonomy on their learning. When students began learning friction force, he let students choose relevant events to introduce to their peers how useful the knowledge of friction was and what they had learned

Teacher Wang Ying held a belief that there is value in the voice and opinion of students. Therefore, at times, she willingly gave up her role as a knowledge authority. She said:

> Most time in teaching, or in assessment, you know, often, teachers seem to be viewed as their enemies by students, or controller. I just try to be nice. I would like them to feel that they are not ignored. I'd like to use what they came up with themselves….So, sometimes, I let them to seek or write their own answers to questions or problems. I don't want them to become a flock of parrots, parroting my words. I want them to be able to represent ideas in a variety of ways in their own words. (Interview, 6/29)

Wang Ying tried to take a new role as a "friend, helper, listener, guider or observer" (Interview, 6/29) that would give students more responsibility for their learning. She wanted to create a democratic and friendly learning setting for students to express their ideas. She believed that students' engagement in assessment, such as developing criteria for some projects and peer evaluation, created a friendly, warm classroom environment in which "they would learn better, become more open and communicate to each other more effectively". For instance, she invited students to participate in the compromise, negotiation and sharing of power in the development of assessment tools for the project "Environmental issues around us." During the development of the criteria, she did not totally let go of her control as she said, "I gave some guidelines and took responsibility to keep an eye on classroom order and monitor the criteria they set to prevent them from unrealistically too high or low" (Interview, 6/29).

The following is a copy of the criteria generated by students:

Criteria	Score			
	0	1	2	3
Problem Statement (Not Stated---Well Stated)				
Topic (Not Interesting---Very Interesting)				
Investigation (Unplanned/Unreasonable---Planned/Reasonable)				
Presentation (Not Understandable---Understandable)				
Picture (None or Not Well Used---Well Used)				
Knowledge (Inaccurate---Accurate)				
Creativity (None---Very Creative)				
Total Score				

Observation data showed that students actually used the criteria they developed in class (Observation, 6/5). Although students were not used to grading their peers because “students never gave grades because that’s supposed to be teacher’s job”, she encouraged her students to do so “because I think that it’s an opportunity to engage them in assessment to voice their concern about assessment” (Interview, 6/29).

All of the three science teachers held a common view that a teacher is holder and transmitter of knowledge and that a student should be a receiver of knowledge presented. While Wu Jun played a central role in teaching and assessment, Wang Ying and Pan Ling sometimes gave students opportunities to involve in some teaching and assessment activities, such as choosing topics to investigate and present in Pan Ling’s case or creating assessment criteria in Wang Ying’s case.

Assertion 5: Teachers’ Beliefs and Practices about Assessment Were Affected by School Culture

The teachers believed that although alternative assessment is important, they faced problems implementing this approach. In addition to the constraints that they perceived due to the NCEE, they identified several other major factors that influenced their thinking and practice about assessment. These were class size, administrative involvement, colleagues' viewpoints and reactions.

Although these teachers expressed that ample time was a critical component for a successful implementation of alternative assessment, they were also concerned about class size. Teacher Pan Ling's statement illustrated this point:

> I have to face more than 50 students, and it is very difficult to keep them involved in activities and, at the same time, keep the class in order and make sure that everyone is on task. (Interview, 6/28)

Normally, each class he taught had approximately 60 students. Pan Ling felt that it was difficult to manage such a large group of students in order and ensure every student working on an alternative assessment activity.

Paper-and-pencil tests would become "much easier" to deal with assessment with "lots of students" as teacher Wu Jun said, "Of course, it is easy to give students the same test at the same time" (Interview, 6/25). Teacher Wang Ying also expressed the belief that smaller class size might make a big difference in whether she was more willing to implement alternative approach. She stated:

> It will be nice to have a class of about 30 students. We have almost 60. If I have fewer students, I think I would have more of a willingness to use more of the alternative strategies because that requires more time. Smaller classes can make a better atmosphere. The students have more rooms. They can spread out a little more. You have seen how crowd our classrooms are. I can get to the same students

> or groups at lease more than once. It makes a difference. I can see it. (Interview, 6/29)

Wang Ying believed that alternative approach required more space, more time and more interaction between students and her. Unfortunately, a large class size would make it impossible to meet these requirements.

Pressure or expectation from school's administration is another factor that influenced teachers' beliefs and practices. School administration, for example, set minimum requirement on "minor" subjects, such as biology and geography, to ensure that students have more time on "major" subjects. Teacher Wang Ying stated:

> My school requires that "minor subjects" must give only one formal test at the end of each semester in order to reduce students' workload and pressure from tests. Basically, I followed the rule. (Interview, 6/29)

She observed the school rule giving only one test as school administration expected. With reduced workload and test pressure from biology subject, students could spend more time on other "major" subjects. If she did not follow the rule, she might suffer from complaints and/or blame from administrators, parents and students.

As teachers of "major" subjects, such as physics and chemistry, Pan Ling and Wu Jun had more autonomy to determine their assessment. Teacher Pan Ling said:

> There are no hard test rules for those "major subjects". I and other physics teachers work together, make decisions on how many and when tests will be given. In fact, we have take-home test every day, in class test every week, and frequent NCEE-type imitation tests. (Interview, 6/28)

Teacher Wu Jun usually consulted about the assessment with a group of his colleagues who teach the same subject at the same grade. The way he assessed students was similar to teacher Pan Ling. “In fact, several major subjects take the same approach to assessment, that is, test, test, test” (Interview, 6/25).

The teachers believed that support from the school administration important for a shift from traditional assessment to alternative approach. They wished that such support be practically reflected in the school policy and operation as teacher Wang Ying said, “Only saying support is not enough” (Interview, 6/29). For instance, she believed that a 40-minute class is too short to assess students in a more meaningful way:

> I often think about the way school time is scheduled, how time might be better organized to allow me to do alternative assessment. It does need more time. Sometimes, I think it would be nice to have a block scheduling. In a longer period of time students have more time to do, to think. They could be doing related reading, and creative research. They don’t need to hurry to finish within 40 minutes. Block scheduling could also allow for interdisciplinary focus. You could really build some interesting problem-based learning scenarios. (Interview, 6/29)

She suggested several times to reschedule teaching time from a 40-minute period into a block schedule. Nonetheless, the administrators did not approve her proposal because “it would bring troubles into the routine operation of the school where other courses are on a basis of a 40-minute session” (Conference, 6/29).

Teacher Pan Ling had the same problem of short class periods, especially for the comprehensive activity course. He said:

> In physics class, I seem not to feel time pressure too much. Anyway, I give lectures focusing on theoretical knowledge. But for the comprehensive course, it's totally different. A 40-minute class is too short. So I often have to let students do their work after school, weekends, or at home. I asked for more time, but they did not give. (Interview, 6/28)

He did not feel time constraints in teaching theoretical knowledge in his regular physics class. However, he thought that 40 minutes were not sufficient for a comprehensive class; therefore he frequently extended his comprehensive class outside of school time.

The teachers believed that non-traditional ways to assess students would take much more time than traditional ways. Accordingly, the teachers believed that the school should ensure that teachers have time to learn and develop alternative approaches, and recognize the time and effort they expend on the new approaches, rather than connecting teaching and assessment with college admission rates. Unfortunately, the school did not practically encourage teachers' innovation in assessment as teacher Wu Jun stated:

> But the problem is where to find time. First, this is a brand new method. There is no technique ready for teacher to use. So you have to sit down for the first time and figure out what the new assessment is about, how it works. It takes time. If you're going to create an activity from scratch you have to take time to learn these things. Personally, I don't have time to learn and the school does not give me the time to learn….Further, they evaluate teachers' teaching for bonus or/and promotion in terms of college admission rates instead of creativity in teaching including assessment. Who'd like to take risk? Consequently, that, more or less, dampen some of passion to try out new approach. (Interview, 6/25).

Wu Jun believed that non-traditional ways to assess students are new ways that might take him much time to learn and develop. Due to the fact that teachers gained bonus and promotion on the basis of college admission rates rather than creativity in teaching and assessment, he would not like to take a risk that spending much time on the development of new assessment might result in decrease in college admission rates of his students.

Teacher Wang Ying voiced a similar concern. She spent large amount of physical energy and time to create the relatively new, meaningful assessment tools. She said:

> I spent plenty of time to do this, to think about what skills I need to evaluate, what skills the students are showing, how to take in students' concerns into the assessment. Often after school time, spare time. I often stay pretty late in school. Other teachers go home, even on weekends. You know, evaluating a variety of student products, not like paper-and-pencil test, takes a lot more time. I have to use extra time both in school and at home. (Interview, 6/29)

She believed that the school administration should make policy for bonus compensation and/or promotion in terms of teachers' effort and time spent in the reform of teaching and assessment rather than student performance on the NCEE. She illustrated this point as follows:

> I put no less, maybe more, time than those who teach "major" subjects on teaching and assessment. It should be considered, counted into my workload, for promotion, for bonus. I have to see that it is worth doing. The administration should make policy to support, using incentive policy to promote its implementation; otherwise, I would not spend more (time and effort). I can't spend more time on it because I have other duties. The results of my time, effort are not at all associated with the college admission rates. But we, the school, seem to not have such a policy. Sometime, I

> feel my effort is just a waste of time. Sometimes, I just gave up because I have other duties, I can't afford putting too much time on it. (Interview, 6/29)

She believed that her time and efforts in developing and using alternative approaches were not entirely valued. The school administration had no policy to support such efforts; therefore, she sometimes would not like to do more.

In addition, teacher Wang Ying believed that resource distribution within the school was not fair. The resource inequities decreased her passion and possibility to practice alternative assessment more or/and better. She stated:

> Usually, alternative approach needs more resources, time, material, money, etc, you know, the school policy, actually not only my school, put more resource on "major" subjects. We, "minor" subject, are more difficult to request more. For example, we wanted to have more labs. We only have two labs each of which can accommodate 30 students. We have 1500 students who need to do experiments each semester. So we can't schedule more lab activities…. If sufficient resources had been available, I would have practiced alternative approaches more and better. (Interview, 6/29)

Wang Ying believed that alternative approaches usually need more resources than traditional ones. Unfortunately, resource distribution rarely considered the request from "minor subject", which unavoidably prevented her from doing more and better alternative assessment.

The last of the factors that could influence the teachers' action was colleagues' comments or evaluation. For example, during the first few years teacher Wu Jun started his teaching profession, he believed that he knew his students, and it was his responsibility to make decision on how and when to assess his students. He tried out new ideas about assessment. He said:

> I teach my students. I know them. I know my teaching. How to teach and assess them is sort of personal style. It should not be unified. It should have space for a teacher to practice on his/her own way. You know, when I took the teaching position for the first few years, I often tried new ideas. I tried to change test format. The main change was I didn't use only paper-and-pencil test to evaluate students. I used, student' presentation, investigation report, making models. I felt great, and students too. (Interview, 6/25)

However, his students performed poorly in the public examination that he felt the pressure from his colleagues. He suffered from "losing face" and finally decided to "follow the crowd." He said:

> But my students didn't get as good scores as those from other classes in the local unified examination. They performed not well in the local paper-and-pencil test, which focus on basic knowledge and skills. I felt "lost face", lose my dignity before others. Some of my colleagues, especially those elder, experienced teacher, administrators, blamed me. They said, we have taught like this many many years. Everyone did the same, how can you do differently. Look at the consequence. My peers said I had returned to the "right" track. I felt pressure from them. I had to change. So later, I would not any more use these ways. These years, although there is a call for shift in assessment, I have lost passion. It takes a lot of time. Other teachers don't do that. I would not do so. I don't want to be blamed again. (Interview, 6/25)

Wu Jun practiced non-traditional assessment during his first few years of teaching. Although he and his students liked it, the students didn't perform well in the public test which mainly focused on basic knowledge and skills. Preventing from "losing face" and being blamed again he chose to get back to the traditional approach, which most colleagues were using.

Teacher Pan Ling expressed the same concern about “keep face”. He said:

> If I use alternative approach in physics class, students will get low score, we, all Chinese, say “save face”. If my students cannot get higher scores in various public examinations, that’s a shame. You would be looked down. So, I seldom try alternative in physics, but in comprehensive class, completely different, you don’t need worry about it. (Interview, 6/28)

Pan Ling did not used alternative assessment in his regular physics class because he was afraid that students might get low scores in various public tests, which could result in being looked down. In contrast, he employed alternative approach in his comprehensive activity course as there was not any test on this subject either in or outside of school.
n teaching physics class, yet “keep face” did not worried him in terms of teaching comprehensive course.

Although Wang Ying was not afraid of whether or not her students get higher scores in public examinations, she also took into account how her colleagues reacted to her assessment approach, especially when she took different strategy than others. She stated:

> I must be very careful, careful not to criticize or comment others. Not saying, I am right, you wrong. It’s time to change their strategies. I have been attracted attentions. I don’t want to ‘sale my stuff’ to make others do it the same way, though I think my colleagues might benefit. If they ask, I would show them what’s out there and they can choose to pick it up or not. I felt, sometimes, sort of alone in my use and

> knowledge of alternative assessment. There have been people saying that I'm going too far. I think it would be a mistake to stick my neck out too far. (Interview, 6/29)

She actually was a leader of a group of biology teachers in her school and was respected by her colleagues as well as viewed as an "exemplary teacher" by her principal. All of these gave her confidence to go on new ideas about assessment. Regarding the fact that most of her colleagues still were doing most or all of their assessment with traditional way, she felt confident to have been ahead of her colleagues. However, she somewhat felt alone and humble at times among her colleagues in terms of her use of alternative assessments because she was not sure about how other science teachers thought about her practice.

School culture influenced teachers' beliefs about and practices of assessment. They believed that a smaller class size would favor alternative assessment, which normally is difficult to conduct with a large class. The administration involvement by appropriate incentives and equal distribution of resources would encourage teachers to make more efforts and time to learn, develop, and implement new ways of assessment. Friendly supports and encouragement from colleagues could be helpful for the adoption of alternative assessment.

CHAPTER 5

SUMMARY AND DISCUSSION

This chapter includes a summary of the findings, discussion, the implications and the limitations of the research.

Assessment Beliefs, Practices and Science Teaching Goals

The study found that the three science teachers' assessment beliefs and practices were formed by the goals for school science, which are prescribed by Chinese National Standards of Science Education (CME, 2001) and other related teaching guidelines. These prescribed goals generally are classified into three domains: (a) knowledge (such as scientific terms, principles, etc), (b) ability/skill (such as knowledge application, analyzing data, drawing conclusion, etc) and (c) attitudes towards science and learning. Although the three teachers generally followed the teaching goals and assessed students in terms of these three domains, the weight they put on each domain differed from one another. Wu Jun emphasized the knowledge domain of chemistry with respect to the teaching goals. He believed that enhancing students' chemistry knowledge was the "most important" and "biggest" teaching goal (Conference, 6/20). Although he admitted that, besides students' acquisition of knowledge, he also considered other factors when giving grades, such as lab skills, the ability of application of knowledge, and attitude, these factors served as mechanisms for students to learn knowledge better or/and easier. Pan Ling perceived science as "a dynamic, creative, and fun process" (Interview, 6/28); therefore, fostering student abilities became an integral part of learning science. Wang Ying believed that knowledge is the base on which students develop skills abilities as she said "no knowledge, no skills" (Interview, 6/29).

She very much appreciated a positive attitude in students toward science learning by counting it into their grades.

The Purposes of Assessment

The study found that these three science teachers used assessment for a variety of purposes. They used assessment primarily (a) to evaluate students' performance in learning scientific knowledge and skill development despite various emphases, (b) to gain information for adjustments and/or improvement for instruction, and (c) to give students grades/scores. Besides the common uses of assessment, the three science teachers employed assessment for some other different purposes based on their beliefs about what an assessment should be and their different situations. For example, teachers Wang Ying and Pan Ling believed that different students may have varied learning and thinking styles; thus, a teacher should take student ability into account when choosing assessment approaches. Based on the belief in the various abilities of students, they gave a variety of assessment activities to ensure students with specific learning problems or styles to succeed. In teacher Wang Ying's case, she encouraged students to express their understanding of scientific concepts using various means such as pictures, charts and tables other than words. Teacher Pan Ling let his students choose assessment activities that best fitted their learning and thinking styles in his comprehensive practical class. Both Wang Ying and Pan Ling believed that demonstration could help students learn better; thus, they provide students with opportunities to demonstrate their understanding of certain concepts or topics. In the case of teacher Wu Jun, he viewed learning as receiving information and teaching as giving information. Hence, a test could be used as a tool to draw students' attention to the information being presented.

The findings above are consistent with previous studies conducted by the United States researchers (Stiggins, et al, 1989; Stiggins, 1992; Raizen et al, 1999). This suggests that some main practices of assessment are in common across cultures, which are evaluating, improving instruction, and grading. However, the formation of these science teachers' beliefs about assessment embodied some nature of what is called socio-constructivism.

Assessment Beliefs, Practices and School Culture

Social constructivism holds that every individual has to construct knowledge by her or himself; however, the construction process and individual meaning always has a social component. The individual is situated within a social context (Adbal-happ, 1998). Knowledge is always constructed within a certain social setting. We share our everyday lives with others, and social interaction helps us construct meaning of the world around us. According to Wertsch and Toma (1995), "Key aspects of mental functioning can be understood only by considering the social contexts in which they are embedded" (p.159).

Previous studies have stated that school/classroom culture was a powerful environment for forming and constraining how teachers think and act (Kamen, 1996; Matese, Griesdorn & Edelson, 2002; Putnam & Borko, 2000). Teachers' actions are often modified because of perceived external circumstances and they often have to stay within expectation of the culture inside and outside of schools (Keys et al, 2001; Tobin, 1990) as Tobin (1990) stated, "When teachers act in the classroom, they do what makes sense to them in their circumstances." This study supported these statements. The study found that class size, the length of class period, colleague attitudes toward others' practices, and administrative interference, affected teachers' beliefs and practice about assessment.

The teachers believed that it was difficult to do alternative assessment with a large group of about 60 students and much easier to administer a traditional assessment to that many students. Relatively short class periods also posed a barrier to conducting usually time-consuming alternative assessment. As a result, Wu Jun usually administered paper-and-pencil test to assess students in his classes. Pan Ling employed alternative approaches only in his comprehensive class, while Wang Ying used after-school time to evaluate students with alternative assessments.

The social world of a learner includes the people what directly affect that person, including teachers, friends, students, administrators, and participants in all forms of activity (Dougiamas, 1998). Taking others' views into account is particularly apparent in Chinese culture. In the long course of historical development, the Chinese have developed several cultural bond characteristics (Biggs, 1996; Yin, 1988). One of these characteristics is obtaining high social status by winning the respect of others and his/her family. This unique concept "face" in Chinese culture and "keeping face" is very important to everyone (King, 1992). Chinese deeply care about how they are viewed by others, and how and what others are doing. They are used to comparing themselves with each other and wish not to be "dropped out of the crowd." This leads to another distinctive characteristic: "follow the crowd" (Yin, 1988). Chinese slangs,"Chu Tou De Chuan Zi Xian Lan" (the rafters that jut out rot first—one who wants to be to the fore will get into trouble) and "Shu Da Zhao Feng" (a tall tree catches the wind—a person in a high position is liable to be attacked), to name but a few, reflect the characteristic of Chinese people to "fit in with the crowd." They see themselves primarily as a part of a group or several groups. Without the group, there is no self. Therefore, the spirit of collectivism is valued and advocated within Chinese society.

A practical representation of the above characteristics in Chinese school systems is a collective mode of teaching. Teachers who teach the same subject at the same grade level usually form a group in which teachers exchange a variety of information. They are expected to teach with the same approach at the same pace. Teacher Pan Ling viewed as the "most important group activities" reporting to group leader and members about how much textbook content has been covered and discussing assessment issue to "ensure the same assessment applied to all students within a certain grade level" (Interview, 6/28).

This study found that colleagues' attitudes and reactions toward these science teachers about their use of new approaches often frustrated them and dampened their passion. They had to align their beliefs about and practices of assessment with expectations from others around them to prevent from "losing face" or "going too far." For example, in his first few years of teaching, Wu Jun believed that he knew his students better than anyone else, and thus he should take major responsibility for how and when to assess his students. He used a variety of assessment approaches other than paper-and-pencil test, such as investigation, presentation, and model-making. However, his students did not perform well on the public examination, and he felt pressure from other teachers. He suffered from "losing face." He eventually gave up his initiative and chose to "follow the crowd."

Pan Ling expressed similar concern about "keeping face." He used traditional methods to assess his students in the regular physics class to ensure that the students would receive higher scores in various public examinations, which primarily focused on theoretical content, so that he would not lose face. While Wang Ying was not worried about "saving face", she had to care about others' views. She used alternative assessment whenever possible, which most of her colleagues were not using. Because she was not sure if her colleagues were comfortable with her practices, she tried to avoid “sticking her neck out too far.”

Although the teachers realized the value of and advocated alternative assessment approaches, time constraints, peers, administrators, and public examinations often prevented them from implementing more in terms of alternative assessment according to their beliefs. The finding suggests that the factors that might lead to or encourage a successful implementation of rich assessments do not currently existing in the school. If Chinese teachers wish to make a successful transition to alternative assessments, they must create the culture of schooling that is supportive of the practices advocated by reform efforts.

The finding implies that administration’s appropriate involvement is essential for developing such a school culture. Some measures that may help teachers employ more alternative assessments are: (a) reducing class size to allow more contact time between the teacher and students, (b) rescheduling class periods into block sessions to ensure time-consuming assessment, (c) to empower younger teachers and experienced teachers working together to try out some of the creative ideas. Moreover, it is particularly important to stipulate an incentive policy for promotion and/or bonus compensation in terms of teachers’ effort spent in the reform in teaching and assessment rather than of mere student performance in the NCEE. When the teachers realize their extra efforts and time in developing and implementing alternative assessment are valued and rewarded the teachers will not feel that they are “losing face.” When the incentive policy encourages all of the teachers to try new assessments, the teachers who have already gone farther in implementing alternative assessment will feel that they now “fit in the crowd” instead of being alone in implementing reform-oriented practices.

Assessment Beliefs, Practices and NCEE

Beyond the immediate social environment of a school learning situation was the wider context of cultural influences (Dougiamas, 1998). The study showed a profound effect of national selection system on teaching, schooling and education. China has a long history of education and selection examination that can be traced back to 2000 years ago. The initial purpose of the Chinese examination system was through open testing to select loyal and capable civil service personnel from the public. The rigidity in form and content of the examination led to curriculum standardization across the whole country, requiring a mastery of Confucian tenets. The ancient selection examination had a dominant influence over the development of education in ancient China. It oriented people's educational goals toward a single end of becoming a government official because such a position carried more prestige, power, and reward than any other profession. Officials were the most honorable and worthwhile profession in the society. The desire for wealth and power motivated people to pursue success in the examination (Feng, 2001; Miyazaki, 1976).

Although the ancient selection system had been changed, modified, or even abolished several times over the long course of Chinese history, the influence of the selection examination on Chinese and the Chinese education system has been immense; for example, the creation of the National College Entrance Examination System. Despite its different content and form from the ancient selection system, it possesses a similar function, that is, to select students, train them to become elite for every area of Chinese society, and provide them with many important social and legal benefits (Feng, 2001; Thogersen, 1989). Since its reintroduction in 1978 after the end of the devastating effects of the Cultural Revolution, the NCEE has actually become "a wind vane that guides you where to go" (Interview with Wang Ying, 6/29) or a "conductor's wand that teachers have to follow" (Interview with Pan Ling, 6/28).

The study found that the National College Entrance Examination was the most powerful factor that influenced science teachers' beliefs and teaching as well as classroom assessment practices. From their personal experiences, the science teachers realized that every single point a student gained in the NCEE could significantly change his or her whole life. The teachers adjusted their teaching to the orientation of the NCEE in order to help students become well prepared for the examination and avoid putting their students at risk of failure in the NCEE. The subjects of physics and chemistry are often included in the NCEE. For physics teacher Pan Ling and chemistry teacher Wu Jun, due to an abundant amount of content to be covered, they took a lecture approach to cover as much material as possible to avoid missing something that may appear on tests. They usually did not have time enough to thoroughly deal with assessment issues in the classroom. They believed that they had to align their assessment (tests) with the NCEE in terms of both format and content.

On the other hand, with no pressure from the NCEE, teachers portrayed a completely different picture about their practices in assessment. Teacher Wang Ying was teaching 8th grade biology and felt free from direct pressure from the NCEE. She used a wide range of strategies to assess her students from the traditional paper-and-pencil test for knowledge acquisition to performance assessment for higher-level learning. She, however, admitted that when she taught 11th graders she had to follow the NCEE guidelines and cover "lots of material in a certain period of time." She gave "first priority" to helping students develop the skills to solve examination-type problems. Teacher Pan Lin was in a dilemma, however. While he taught physics, in which he employed traditional assessments, he offered a comprehensive practice course as well. He often used students' ideas and engaged students in investigation of real problems as well as provided students with "stage" to communicate their understanding. He took a different approach in his comprehensive class compared to his physics class.

Obviously, the NCEE in China plays a driving role in what and how the teachers assess. Due to the long history of selection examination and expectation of Chinese for success in public examination as well as the consequent rise in social and economic status (Feng, 2001; Liu, 1995), we do not, at least in the near future, expect radical changes in the NCEE system. Concerning its significant influence upon teachers' instruction and assessment practices, however, China must examine the NCEE carefully and make essential adjustments in order to embody the spirits advocated by Chinese National Science Standards and other reform documents. The NCEE must serve as a tool for promoting a shift from traditional to alternative assessments and more implementation of non-traditional assessments in classroom settings. One of the solutions may be to reduce the number of item focusing on theoretical knowledge and instead to add more items that assess higher cognitive learning. Another solution may be to develop a school-based alternative assessment system and include it as part of criteria for entrance into colleges.

Multiple and Inconsistent Beliefs

The study identified several contradictions and inconsistencies which are worthy of consideration. Some of the beliefs that the three teachers held and their practices contradict with what reform efforts have advocated. For instance, they all believed that science was composed of a set of factual information and abstract concepts. They used hands-on activities to help students understand scientific concepts, to reinforce information, to make science interesting, to verify the theories, formulae, and results written in the textbooks. Obviously, they were missing the epistemological underpinning of hands-on in its truest sense, that is, to help students generate and construct knowledge.

The study found that the teachers had more than one even conflicting beliefs about teaching, which was consistent with other researchers' arguments (Bryan, 2003; Gao, 2001; Larson, 1983; Marton and Saljo, 1984; Pratt, 1992). This research found that all of the three teachers held a notion that a teacher is a knowledge holder/expert and transmitter; teachers' responsibility is to deliver knowledge and students' is to receive knowledge. The fact that they took a teacher-centered approach in most of the classrooms illustrated this belief. However, teachers Pan Lin and Wang Ying also believed that science learning should include the development of student abilities to think critically and to solve real problems. They changed their roles in some given times and contexts. For example, Pan Lin believed that students should learn to take care of their own learning. In his comprehensive course he became a "watcher." He allowed students to come up with their ideas, to design experiments, and to present their investigation results. Wang Ying believed that she should value students' voices and opinions. She was willing to take a new role as a "friend, helper, listener, guider or observer". She encouraged students to involve in the development of assessment tools for a certain project. While teachers Wang Ying and Pan Lin indicated the notion of knowledge delivery and learning facilitation obviously, teacher Wu Jun implied this conflicting view by saying "I knew the advantages of new approach and am watching others" while keeping focus on traditional test.

The facts that teachers hold more than one conception about teaching, even conflicting with each other, and teachers do not always translate their beliefs into classroom practice indicate the complexity of teacher belief systems as well as of the interaction between beliefs and actions as Simmons (1999) stated that changing the actions of teachers might be more complicated than originally thought. This implies that to expect the teachers to make major, significant changes in their belief systems and their assessment practices in a short period of time may be unrealistic. Hence, it is incumbent upon science educators and teacher training program to provide the teachers with more opportunities to examine their beliefs and make their implicit beliefs explicit. Science educators should help science teachers identify the dissonance between their beliefs and the ideas advocated by the reform documents as well as reflect on their assessment practices. On the other hand, science educators must realized that beliefs change of Chinese science teachers may be more difficult than science teachers from other cultures. Traditional value system and the extant political system of Communism nurtured the Chinese characteristics of absolute obedience to and dependence upon authority. It is important for individuals to respect authority and act with authoritative guidelines instead of having their own ideas. Therefore, it is no doubt that the attempts to identify and change Chinese science teachers' beliefs as well as actions will be an unprecedented challenge to science educators, science teachers and Chinese culture.

However, examining and changing teachers' belief system is not enough. Science educators and science teacher training programs should provide science teachers with more opportunities to learn how to develop and implement assessment that reform spirits advocate. In China, science teachers have learned assessment knowledge and skills mainly from one chapter content of textbooks about teaching methods, other science disciplines teachers, and their peers. These experiences are not sufficient for arming science teachers with appropriate knowledge and skills to develop sound assessment tools. Offering an assessment course may be helpful for science teachers to begin developing deeper knowledge and skills necessary for employing new assessments.

The teachers have complicated beliefs system also have implications for further study. Some interesting questions might be: why and how these teachers held more than one even conflicting belief; in what situation which belief functions; how these conflicting beliefs interact and influence teachers' practices. The suggested research might inform science educators of some solutions for helping practicing teachers sealing the conflicts.

Limitations

The first limitation of the study may come from the selection of participants. The selection was based on the teacher's availability and willingness to be involved. Though I tried to choose the participants to represent a wider range of teachers, the use of a volunteer sample of three science teachers may limit its representation and may have affected the richness of data collected. The second lies in the fact that a case study does not seek generalization; therefore, care should be taken when making attempt to generalize from the results. A final limitation involves language deficiencies when interview questions designed in English were translated into Chinese for interviewing and when parts of interview transcription in Chinese into English for writing up the findings. The deficiencies could lead to misunderstanding in some certain contexts. One example is the term "assessment", which is defined in this study as a general term that includes the full range of procedures used to gain information about student learning. It is difficult to find a Chinese term that has exact meaning with the term "assessment", however. Hence, when I introduced this term to Chinese teachers it turned out to be "evaluation", "measurement", and/or "test" in Chinese teachers' mind.

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APPENDIX A. INTERVIEW GUIDE

1. When we say "assessment", what do you think of?
2. Tell me the most recent assessment you did to your student(s).
3. What are your purposes for assessment?
    - Did you use assessment to diagnosis student needs? How?
    - If you used assessment to group students in your teaching, how did you do that?
    - Did you use assessment to give feedback to parents? How?
    - Did you use assessment to evaluate your instruction? How?
    - Assigning grades to students is an important aspect, could you give me some example how you grades your students?
    - Did you use assessment to motivate students? How?
    - What abilities of students do you intend to assess? Please describe it.
4. How did you assess students' understanding of science?
    - What were the forms of assessment?
    - What were the sources of assessment instruments?
    - When did you assessment students?
5. What, if any, influenced your decisions on how to do?
    - How did your colleagues or administrations influence your thinking and practices about assessment?
    - How did your students influence your thinking and practices about assessment?

- How did the subject(s) or contents you taught influence your thinking and practice about assessment?
- How did the NCEE influence your thinking and practices about assessment?
- How did your professional knowledge or experiences influence your thinking and practices about assessment?
- What else do your think may influence your thinking and practices about assessment?

6. How do you think the ongoing reform in curriculum will influence or has influenced your thinking and practices about assessment?
    - How different do you think the new curriculum is from the old one?
    - How different are your assessment practices before and after the implementation of the new curriculum?
    - How will you implement alternative assessment in your teaching practices?
    - What are obstacles in implementing new assessment?
7. What changes will be necessary to increase the use of alternative assessment?

APPENDIX B. MASTER LIST OF SOURCES OF DATA

1. Documents about educational and curriculum reform and assessment generated by governments (national, provincial, and municipal) and schools
2. Public examination paper and its grading criteria: at national, provincial, and municipal levels
3. Teacher-made and commercially published test
4. Teacher-made and commercially published homework/assignments
5. Graded students' homework/assignments
6. Textbooks and lab work guidelines
7. Teachers' journals and/or logs of activities about teaching and assessments
8. Teachers' lesson plans
9. On-line materials (teachers used)
10. Newspaper articles and other publications relevant to curriculum reform and assessment
11. Class schedules
12. National Standards of Science Education