Reforming Science Assessment in Shanxi Province[1]

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This paper describes a project being undertaken in Shanxi province to help teachers with the reformed curriculum in Primary science (as well as in Junior Secondary biology, chemistry, geography, and physics). The project is developing and testing new mid-year and final examinations using the experience of a similar project in the Canadian province of Ontario. We hope that, once teachers see these new forms of assessment, they will understand better the new methods of teaching required for the new curriculum. Before describing the project, however, I will explain the changes in science curricula around the world and why assessment reform is an essential aspect of curriculum reform.

Changes in the Curriculum

All new curricula represent change but in the past most of the changes in curriculum have been changes in the scientific knowledge to be taught to a particular grade level, what can be called the *content* of the curriculum – *what* science should be taught and learned. In the past decade however, a new type of change has been introduced in many countries of the world and that is a change of *purpose* – *why* science should be taught and learned.

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The traditional purpose for learning science has been the mastery of scientific concepts, laws and theories: in other words, the development of students' scientific knowledge and understanding. Teaching methods and textbooks have focused on ensuring students' understanding (or at least memorization) of science concepts, and assessments have quite appropriately been written examinations that can test that knowledge.

Some time ago in the English-speaking world, and now in China as well, a second purpose was added to this basic one. "Science" is not only a body of knowledge; it is also a method for studying the world and scientists are people, who not only have an understanding of the world around us but are also trained in how to investigate it. Accordingly, curriculum policy now requires that science be taught and learned so that students understand the methods of science inquiry and acquire the skills required to undertake scientific investigations. In this way they will learn to *do science* as well as *know science*.

Much more recently, in the past 10 years, a third purpose for teaching and learning science has been added to the first two. Science is having increasingly important impacts on every aspect of our lives, from the food we eat to the energy we consume to the medicines we use to keep us healthy. These impacts are social, economic, technological and environmental and affect all of us in the world. Participation in this new world thus requires that we understand the relationship between science and the world around us and this brings us into the fields of values and emotions, as well as politics and economics.

Now students are expected not just to *know science* and be able to *do science* but they are expected to *know about science* in relation to technology, society and the environment.

These new purposes for learning science add much more than new science content to the curriculum. They add new dimensions of what is expected of teachers and students. No wonder then that teachers all around the world are finding that implementing their new curricula is very challenging and that they need help and support. This was the reason for setting up the Assessment of Science and Technology Achievement Project (ASAP) in Ontario (Canada) and also the Science Assessment Project in Shanxi (China).

Changes in Assessment

Traditionally, when the goals of science education focused simply on student's science knowledge, written tests and examinations were an adequate measure of how successful the students' learning had been. But however well examinations assess students' knowledge, they are quite inadequate when it comes to many areas of skill. Imagine, for example, a student's swimming ability being tested by means of an essay on swimming or a dentist's skills at filling teeth through a multiple choice test on teeth. Likewise, assessing a student's science inquiry skills require that he or she be given a real problem to investigate. Such "performance tasks" (as they are called) typically call for students to plan an investigation, carry it out, draw conclusions from data, and prepare a report on the task. They are simulating the role of the real scientist and the task calls on them to *use what they know* to complete a meaningful and authentic task.

Assessment in the values-laden areas of science, technology, society and environment is even more difficult but frequently students are called upon to think about the social implications of taking some action in connection with the science content. For example, how to solve an environmental problem, the consequences of adopting a new technology, or ways in which energy can be conserved, are all real problems faced by all societies and students can use the knowledge they acquire in science classes to debate ways in which these problems might be solved. Such participation calls on them to think about science and values and projects of this kind can be used as part of their assessment.

In Canada and in China too, teachers need to see what these new styles of assessment actually look like operating in their own classrooms in order to realize how their teaching needs to change to match the new curriculum. For this reason therefore, both in Ontario a few years ago and in Shanxi right now, projects have been designed to develop and test new assessment materials.

Shanxi Science Assessment Project

The project was approved and financed by the Shanxi Ministry of Education and implemented at the Shanxi Educational Research Institute. A project team of 18 teachers – 6 for Primary Science, and 3 each for Junior Secondary Biology, Chemistry, Geography and Physics – was assembled and for the month of November 2006, they worked together with my support and advice.

Following descriptions of how to develop performance tasks and examination papers, each team undertook to develop both a performance task and a written examination paper for one grade. The Primary Science team took Grade 5 as their starting point and developed a performance task for the unit on Materials. The task begins as follows:

> You and your friends are planning to set up a hot drink service for your teachers. The teachers have been complaining that their present mugs and cups are not keeping their tea very hot. You will need to choose several different types of drink container and conduct a test it to see which one will keep water hottest.

The team developed a set of outcomes (statements describing the skills that the task was attempting to measure), a set of general instructions for students about what they had to produce and an information sheet for teachers including a detailed marking scheme. They tried the task out themselves first – a very wise move as things never work out exactly the way you expect – and then took the task to a school for real students to try out. This pilot test enabled them to observe the task in action, to see how the students coped with it and what instructions were unclear or confusing, and also to obtain feedback from other teachers about the task and how it could be improved.

In addition the Primary Science team developed a written examination for Grade 5, focusing on the science knowledge in the curriculum. They first drew up a blueprint for the examination paper, identifying the numbers of minutes to be allotted to questions on each topic. Then they decided how many questions of various types – multiple choice, true/false, short answer, and extended response – were appropriate for each topic. Armed

with this blueprint, they developed a draft examination paper that was also pilot tested in a real school situation.

Pilot Test of Performace Task in Taiyuan School

Following the pilot test, the team conducted an analysis of the results. This included examining the difficulty of each item (the percentage of students getting the item correct) and also its "discrimination" – the degree to which it discriminates between students who did well overall on the exam and those who did poorly. In addition, the team collected comments from teachers in the school who reviewed the exam paper and performance task. On the basis of all this evidence, they made decisions about which items should be revised or deleted and which items could be retained in their present form. Deleted items were replaced with items on the same topic and all new and revised items were marked for future pilot testing.

Next Steps

The exams and performance tasks generated by the project will next be tested on a larger scale at about 10 – 20 schools in various parts of Shanxi province as part of the regular mid-year examination system in 2007 and, once again, careful analysis of the results will guide the team's decisions about any needed changes. For this trial, carefully prepared information for teachers will be required to ensure that the tasks and examinations are properly administered and marked. It is planned that in the summer of 2008 the team will developed more mid-year and final examinations and performance tasks for all grades.

Later phases of the project will include a systematic program of in-service teacher training in the uses of new assessment methods and in the teaching required for students to achieve the goals of science inquiry and "attitudes and values" in science education. Finally, we plan to prepare a book based on this project that can be of use for teachers throughout China, and to develop an on-line network of teachers who can share assessment ideas and materials in primary science.