Approaches to Assessment of Technology Education in Taiwan

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Abstract

Located in the Pacific Ocean about 160 kilometers across the Taiwan Straits from Mainland China, Taiwan is an island country where Confucian-heritage culture remains. In the past few decades, technology has driven the massive development of the economy in Taiwan, therefore the technology education in Taiwan's schools aims to help all students towards a lifetime of technological engagement. The trends of technology education reform all over the world indicate that more and more concerns have been focused increasingly on student assessment (Custer, Valesey, & Burke, 2001). Leung (2000), for example, stated that assessment incorporates emerging ideas in the understanding of learning. That is, if technology teachers make good use of assessment, they can help students in learning technological literacy. This paper backgrounds the national technology education curriculum and explains the approaches to assessing students' technology learning in Taiwan.

Key words

assessment, technology, Taiwan, education, curriculum

1. National technology education curriculum

Curricula for elementary and secondary schools (grades 1-12) are prescribed in national curriculum guides promulgated by the Ministry of Education (MOE). As shown in Figure 1, it is anticipated that curriculum guides, courses of study and instructional plan are aligned with each other (Lee, 2003).

Technology Education is a required course in Taiwan's elementary, junior high, and senior high schools with the official name "Living Technology." In fact, the name had been changed several times from Arbeit, Industrial Arts, and finally to Living Technology since 1990s. Specifically speaking, Living Technology is a required course for grades 1-10 and a selected course for grades 11 and 12 (Department of Elementary and Junior High School Education, 2007; Department of Secondary Education, 2007). The national technology education curriculum can be divided into two major parts as "the elementary and junior high level" and "the senior high level." The former represents grades 1-9 and its official name is "the nine-year articulated curriculum guides." The latter represents grades 10-12 and its official name is "the senior-high-school curriculum guides."

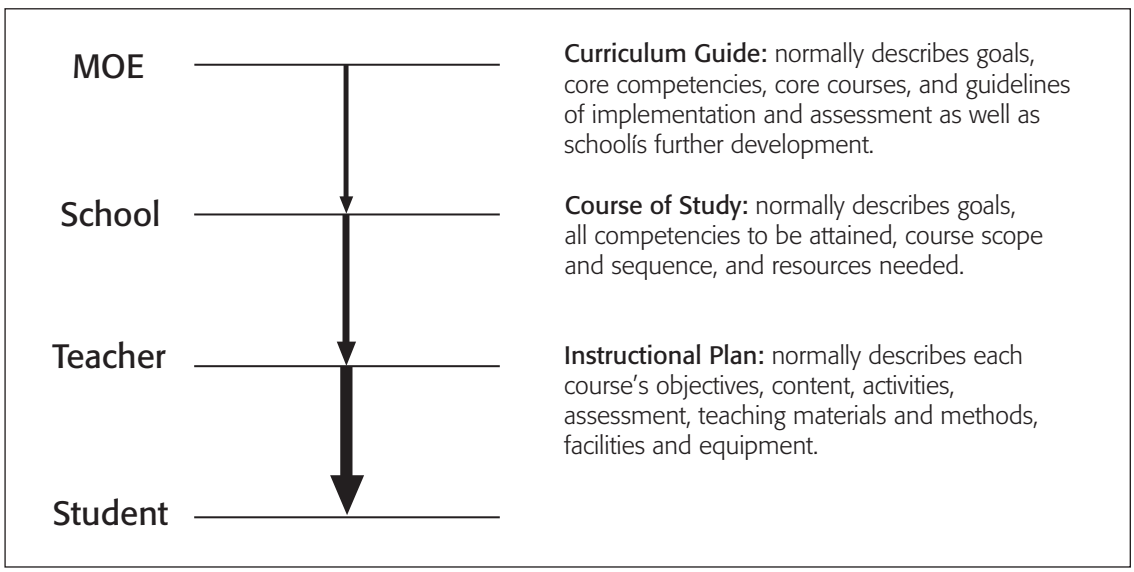

Figure 1. The alignment of the three levels of curriculum documents.

Source: Lee, 2003, p.79.

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The major purpose of the national technology education curriculum is to focus on developing students' level of technological literacy, and the official/documental as well as taught technology education curriculum can be described as follows:

The nine-year articulated technology curriculum
Students have to bring many textbooks to their schools everyday in Taiwan, but not all students excel through the use of textbook learning. Therefore, the Ministry of Education proposed the ideal of "Let our children be equipped with moveable competence instead of heavy textbooks!" Therefore, the national curriculum reform was launched.

In the national curriculum for grades 1-9, taken into effect in 2001, Living Technology at the elementary and junior high level is combined with Natural Science as a new learning area called "Natural Science and Living Technology", which is assigned with the mission of developing student's competence in: (1) the process of skill, (2) the cognition of science and technology, (3) the nature of science, (4) the development of technology, (5) the attitude of science, (6) the intelligence of thinking, (7) the application of science, and (8) design and making. Among these categories of competence, the mission of Living Technology focuses on the "development of technology" and "design and making". Due to the new curriculum change in Taiwan, the content of the national technology education curriculum puts more emphasis on students' basic competence instead of technical training or knowledge teaching.

The senior high school technology curriculum
In the national curriculum for grades 10-12, brought into effect in 2006, Living Technology at the senior high level is still an independent subject instead of combining with Natural Science, which is assigned with the mission of developing students' technological literacy with one to three different courses. The senior high school curriculum guides prescribed courses and each senior high school has to offer one required core course and two advanced courses at most.

For the required core course there are four major content organizers, as follows: the nature of technology; technology, science and environment; technological world; and creative design and making.

For the other part of advanced courses, the Ministry of Education developed six advanced courses for senior-high schools to offer, which are "Communication Technology," "Construction Technology," "Manufacturing Technology," "Transportation Technology," "Energy and Power Technology," and "Technology and Engineering."

According to the above, the presentation of the national technology education curriculum in Taiwan has the following two different forms: (1) presenting the basic competence that elementary and junior high students need to demonstrate, and (2) presenting the content that senior high students need to learn. No matter what forms are presented, the major purpose of Technology Education in the national curriculum is to emphasize developing students' fundamental and necessary technological literacy at different schooling levels.

2. Student assessment suggested in the national technology education curriculum

In order to increase students' level of technological literacy through the enhancement of technological learning, more and more countries adopted different approaches to assessment in enhancing technological practice. Taking New Zealand as an example, the Technology Assessment Framework (TAF) was developed as an organizational tool for increasing students' technological literacy (Compton, 2003). In terms of the approaches to assessment in national curriculum in Taiwan, the Ministry of Education has developed guidelines of student assessment in the nine-year articulated and senior high school curriculum guides, respectively. These guidelines are to guide technology teachers to effectively assess students' learning, but teachers' flexibilities remain. These assessment guidelines can be described as follows:

The assessment guidelines in nine-year articulated technology curriculum guide

The following nine student assessment guidelines are presented in the national technology education curriculum:

a. The purpose of assessment is to realize students' learning as the basis of improving teaching and to facilitate learning.

b. Assessment should have the function of encouraging students' reflection, teachers need to be aware of students' mental maturity, deal with their learning achievement fairly, and understand their strengths and weaknesses. Assessment should also encourage students to believe that they can make a difference if they study harder.

c. Assessment should take in curriculum goals as its reference, and understand if students have been equipped with basic competence in each learning stage; furthermore, learning assessment should be infused into learning activities.

d. Assessment should not be limited to one way, and students' self assessment and peer/mutual assessment should also be adopted as well as teacher assessment. The approaches to assessment can be observation, inquiry, experimental report, project exhibition, project report, paper and paper-and-pencil test, hands-on operation, design experiment and learning portfolio for the purposes of understanding students' learning and improving teaching. For example, if the learning goal is developing students' problem-solving skills, then the project exhibition or project report can be utilized instead of just using paper-and-pencil test.

e. In order to develop students' competence of analysis and analogism, technology teachers should offer related chart data to students instead of requiring them to memorize.

f. Technology teachers should continuously improve their performance in areas such as choosing materials, utilizing teaching strategies, and classroom management, according to the results of assessment.

g. Assessment should include cognitive, psychomotor, and affective domains.

h. The formative and summative assessment should be emphasized together.

i. The result of assessment should be utilized in helping students understand their strengths and weaknesses, and facilitate, through the above, students in reflecting and improving their learning.

The assessment guidelines in senior high school technology curriculum guide

There are three assessment guidelines presented in the senior-high school technology curriculum guide, which are listed as follows:

a. Student assessment should include cognitive, psychomotor, and affective domains; furthermore, students' individual differences should also be taken into account.

b. The formative and summative assessment should be emphasized together.

c. To assess students' learning achievement, alternative approaches such as cross-questioning, demonstration, operation, experiment, test, assignment, learning portfolio and report can be selected; furthermore, students' daily performance and behavioral habit should also be taken into account.

According to the guidelines suggested in the nine-year articulated technology curriculum guide and the senior-high school technology curriculum guides, both learning progress and learning outcome of students are obviously expected to be assessed.

3. Approaches to student assessment

The real purpose of student assessment is to effectively help students in learning technology, so more and more position papers put their emphasis on enhancing technological practice through student assessment (Compton, 2003; Doppelt, 2003; Leung, 2000; Moreland & Jones, 2000). Guba and Lincoln (1989) pointed out that there were four important stages of assessment, that is, "measurement," "description," "judgment," and "alternative approach." The alternative approach can be also called "responsive constructivist evaluation." The ideal of an alternative approach is to believe that the learner plays the most important role during the process of learning. Therefore, the purpose of assessment is not to assess the learner, but to analyse all the information throughout the learner's learning process. In order to collect all the information of the learner's learning process, both formative and summative assessments are required for the purpose of collecting the qualitative and quantitative data. According to this viewpoint, there are the following two important aspects of technology education in student assessment in Taiwan:

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The formative assessment

In the past, student assessment always focused on the summative assessment, often conducted at the end of the program. That is, the teachers normally neglected the process of students learning. Without the information of students' learning process, the teachers find it hard to see students' real problems in learning. Therefore, the formative assessment, often done at the beginning or during a technology education program, has become more and more important as well as more and more approaches have been developed in order to collect students' information during learning. There are many approaches applied in the formative assessment in Taiwan, but the most important approaches are as follows:

1. Learning portfolio

Highly valuing experiential learning and problem-solving, problem-based technology learning activity (TLA) is the core of thr technology education curriculum in Taiwan and the learning portfolio has been widely used as an assessment approach. Coupled with problem-based learning (PBL), the learning portfolio in technology might avoid leading to formulaic and unimaginative designing. Fang (1999) reviewed related literature of problem solving and proposed an optimum process of problem solving for technology education curriculum in Taiwan. The process includes the following seven steps:

- Verify the problem;
- Sketch the initial idea out;
- Collect and analyze the data;
- Draw three different projects out;
- Choose the best project;
- Plan the detailed process of work;
- Test, evaluate and improve the product.

Many technology teachers in Taiwan follow the process similar to Fang's to design their learning portfolio to examine the learners' learning process.

Taking Step 5 for example, students have to utilize Table 1 in choosing their best idea. According to this table, the technology teachers can understand how their students choose their best idea and what kinds of mistakes they need to improve.

Decision-making Items	Idea 1		Idea 2		Idea 3	
	+	−	+	−	+	−
1. Could you solve the problem according to this idea?						
2. Could you finish the product in time according to this idea?						
3. Could you use the assigned materials according to this idea?						
4. Could you achieve the evaluation criteria according to this idea?						
5. Could you allocate different task for all members in team according to this idea?						
6. Could you get all the materials you need according to this idea?						
7. Could you get all the tools you need according to this idea?						
8. Is your design creative according to this idea?						
9. Is your data sufficient according to this idea?						
10. Are the expenses cheap according to this idea?						
Total						
Rank						

Table 1. Decision-making table.

Source: Fang, 1999.

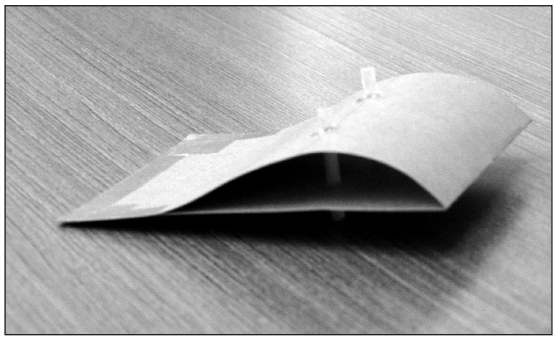

Figure 2. Aerofoil model

Figure 3. A test of an aerofoil model

2. Design experiment

Gloeckner (1991) believed that technology education can help students learn the "doing part" of engineering and natural sciences. It is necessary for instruction to include relevant "real world" problems that cause students to practice and extend their mathematics and science skills. Therefore, technology teachers design many experiments for students in helping them to learn related knowledge. Taking the common project "glider" for an example, the students have to design and make an aerofoil model (Figure 2), and test it with white smoke in order to observe the flow of air (Figure 3).

Through the experiment, technology teachers can realize the students' learning process in applying scientific knowledge to a technology learning activity. Besides, this is also a kind of integration of science and technology.

3. Hands-on operation

As Gloeckner (1991) mentioned above, the value of technology education was the "doing part." However, the practical doing part is not only used to train students' manual skills, but also to integrate their scientific knowledge during the process of operation (Figures 4 & 5). Besides, it is also a valuable chance for students to learn how to use different kinds of machines and tools. They can achieve hands-on experience, and equip themselves with the ability to solve problems using their knowledge and creativity as well as machines, and tools.

Figure 4. Students' hands-on operation

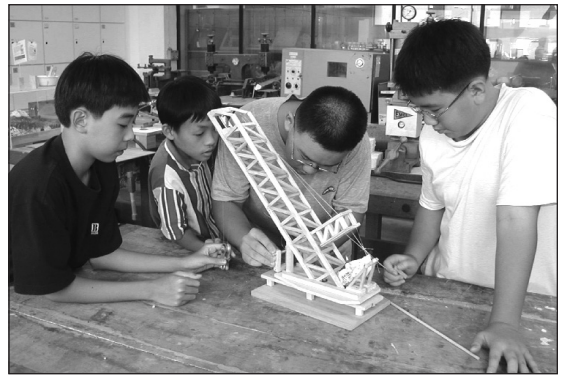

Figure 5. Students' project

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The summative assessment

In addition to the formative assessment, there are many approaches to the summative assessment employed in technology education in Taiwan. They at include the following

1. Self and peer/mutual assessment

Technology teachers have always played a dominated role in student assessment, but with the shift of the ideal of assessment, the learner became the core of assessment. That is, more and more technology teachers let their students assess themselves and let other students assess their peers. Through the design of self and peer/mutual assessment, both teachers and students find they can gain more information to help improve their teaching and learning.

2. Project report

The best chance to reflect the learning process is to finish a project report. Through the completion of a project report, students have to recall the whole process of learning and reflect on ways to improve their process of design, making, and testing. Technology teachers can also understand the learning process taken by students' within the learning activity, and offer further guidance and advice for inprovement.

3. Rubrics

In order to help technology teachers in assessing their students, the design of rubrics is becoming a major trend of student assessment in Taiwan. However, with the coming of rubrics, technology teachers have often developed some general and rough criteria. The shortcoming of this design is that technology teachers could not understand students' real performances. Therefore, as Kimbell (1997) mentioned, the evolution of student assessment has been transformed from a general and rough approach to be more specific in each part of the students development within the learning activities (Figure 6).

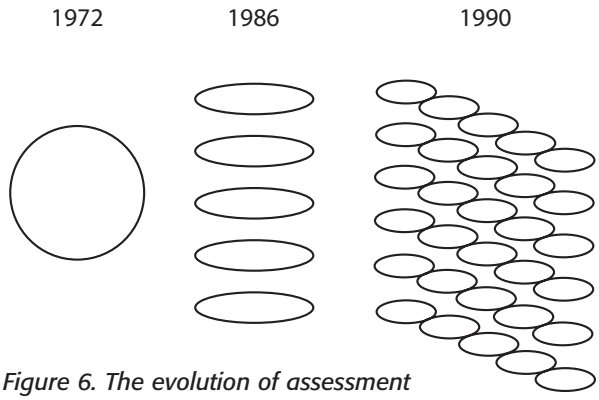

Figure 6. The evolution of assessment

Source: Kimbell, 1997, p.17.

According to this trend, technology teachers normally develop many statements for them to choose in assessing students' performance. Besides, they can help teachers to explore students' weakness and ways to improve their teaching. The example of rubrics in technology learning activity is listed in Table 2. Technology teachers have to develop statements in detail in each part. The more detail that the technology teachers develop, the more they can explore their students' real performance.

4. Technology competition

In Taiwan, technology competition can be viewed as a cross-school assessment approach for technology education. There have been many technology competitions held in different cities or counties. The purpose of holding technology competitions is to highlight the students' learning performance in other schools, and help technology teachers find ways to improve their teaching through inter-school benchmarking.

Table 2. The rubrics in technology learning activity.

Assessment Items	Scores
Document (60%)	
1.Design Brief Statement 1 .....0 Statement 2 .....5 Statement 3.....10	
2. Inquiry Statement 1 .....0 Statement 2 .....5 Statement 3.....10	
3. Solution Statement 1 .....0 Statement 2 .....5 Statement 3.....10	
4. Product Testing Statement 1 .....0 Statement 2 .....5 Statement 3.....10	
5. Assessment Statement 1 .....0 Statement 2 .....5 Statement 3.....10	
6. Whole Statement 1 .....0 Statement 2 .....5 Statement 3.....10	
Product (40%) Statement 1 .....0 Statement 2 .....5 Statement 3.....10	
Total Scores	

Taking the 2003 Taipei Technology Competition in Taiwan as an example, the topic for the 2003 Taipei Technology Competition was "Creative design in classification." Almost all junior-high schools sent students to participate in teams of three. Each team had to use the materials provided by the competition organizer to design and make a device that could divide plastic beads (with two different weights and size) into the two separate containers situated at the base, within a certain time period (Figure 7). There were two categories of bead, 10mm and 16mm in diameter, with 25 beads in each category. The completed device should not extend beyond the scope of the base with the input trough holding a capacity of 50 beads. The two containers had to be located on the base.

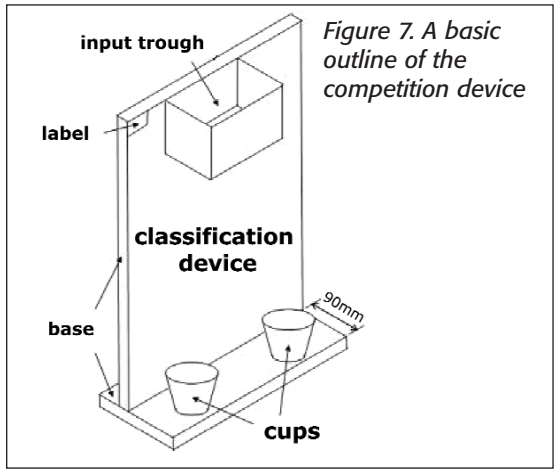

Figure 7. A basic outline of the competition device

After the competition, the judges, who were technology teacher educators from a technology teacher program, tested and evaluated all teams' products based upon the following three criteria categories: portfolio (20%), creativity (40%) and function (40%). The winning competition design is shown in Figure 8.

The importance of technology competitions is far beyond words. Sanders (1997) mentioned that "perhaps corporate sponsored technology competitions are our best shot at gaining the visibility we so desperately need" (p.4). From the experience in Taiwan, technology competitions can be utilized as an important summative assessment approachin education.

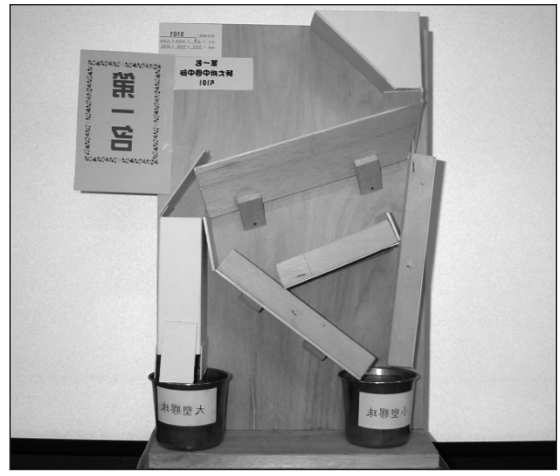

Figure 8. The winning design.

4. Issues in the assessment approaches to technology education

Obviously, the above description indicates that the technology education curriculum in Taiwan is standard-based. In this approach, assessment is anticipated to be aligned within the standards prescribed by the national curriculum guides and further developed within the schools individual curriculum. (Figure 9). In addition, both the formative assessment and the summative assessment described are expected to be conducted in multiple ways and by multiple assessors.

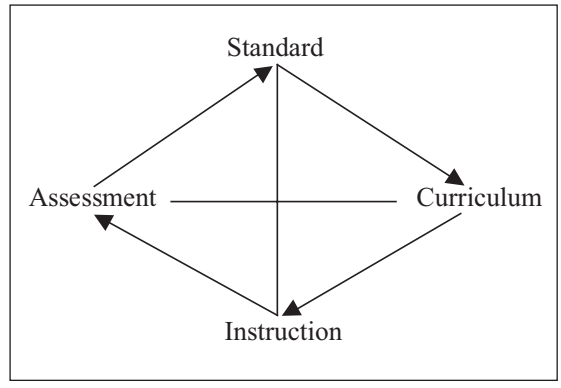

Figure 9. The alignment expected among technology education standard, curriculum, instruction and assessment.

However, at least the following two issues exist in the assessment approaches to the technology education in Taiwan:

1. *Lack of nation-wide technology assessment*
   Technological literacy is necessary for a holistic person, so technology education is a part of national curriculum in Taiwan. However, technology education is not included in the nation-wide assessment on which students' school choices for further study are based. Staying out of the nation-wide assessment, technology education is often considered a peripheral program and the technology education divide among schools and areas is unclear.
2. *Technology teachers suffer from the heavy work load associated with authentic assessment*
   Technology education is student-centered and activity-based, so authentic assessment is highly valued. However, the technology teachers who normally face a large class size, suffer from the increased work load associated with authentic assessment although they utilize assessment tools such as portfolio, rubrics, etc.

   In order to solve the above two issues, more effective research and developments must be conducted. Additionally, the professional association of technology education in Taiwan should take a lead to solve the issues.

5. Conclusion

Students' learning is the whole context of student assessment. That is, technology teachers should do their best in clarifying students' learning process and giving students what students need during their learning process. People in Confucian-heritage culture often say, "Never less than the best." It is believed that if we keep improving student assessment in technology education in Taiwan, our students will inmprove their learning in technology education and equip themselves with the technological literacy required to meet the needs within our present and future society.

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