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ABSTRACT

Technology education focusing on technological literacy is provided to Taiwanese students in grades 1-11, primarily through the secondary school subject Living Technology (LT). Taiwan's newly promulgated national curriculum for grades 1-9 has integrated LT with natural science for the key learning area (KLA) Natural Science and Living Technology. Taiwan's national curriculum for grades 10-12 is also currently under revision. The hope is that technology will become an independent KLA. The following are among current efforts to promote technology education in Taiwan: (1) cross-country studies of teaching strategies, learning assessment, and methods of identifying and assessing technological literacy; (2) development of numerous technology unit plans; (3) publication of the practitioner journal "Living Technology Monthly"; (4) implementation of technology teacher professional development workshops; and (5) numerous activities sponsored by the Industrial Technology Education Association, Taiwan, R.O.C. The following issues facing technology education in Taiwan have been identified: (1) technology is not well understood; (2) technology education at the elementary school level is still not universal; (3) further study examinations caused a lack of teaching vitality at the secondary level; (4) differences exist between the curriculum standard and the actual learning environment; and (5) technology teacher education programs are diluting their professional roles. (MN)

Running head: TECHNOLOGY EDUCATION IN TAIWAN

Technology Education in Taiwan

Lung-Sheng Steven Lee
National Taiwan Normal University

Paper presented at
The International Technology Education Forum, Stockholm, Sweden,
Sponsored by the Technical Foundation of America,
July 30, 2001

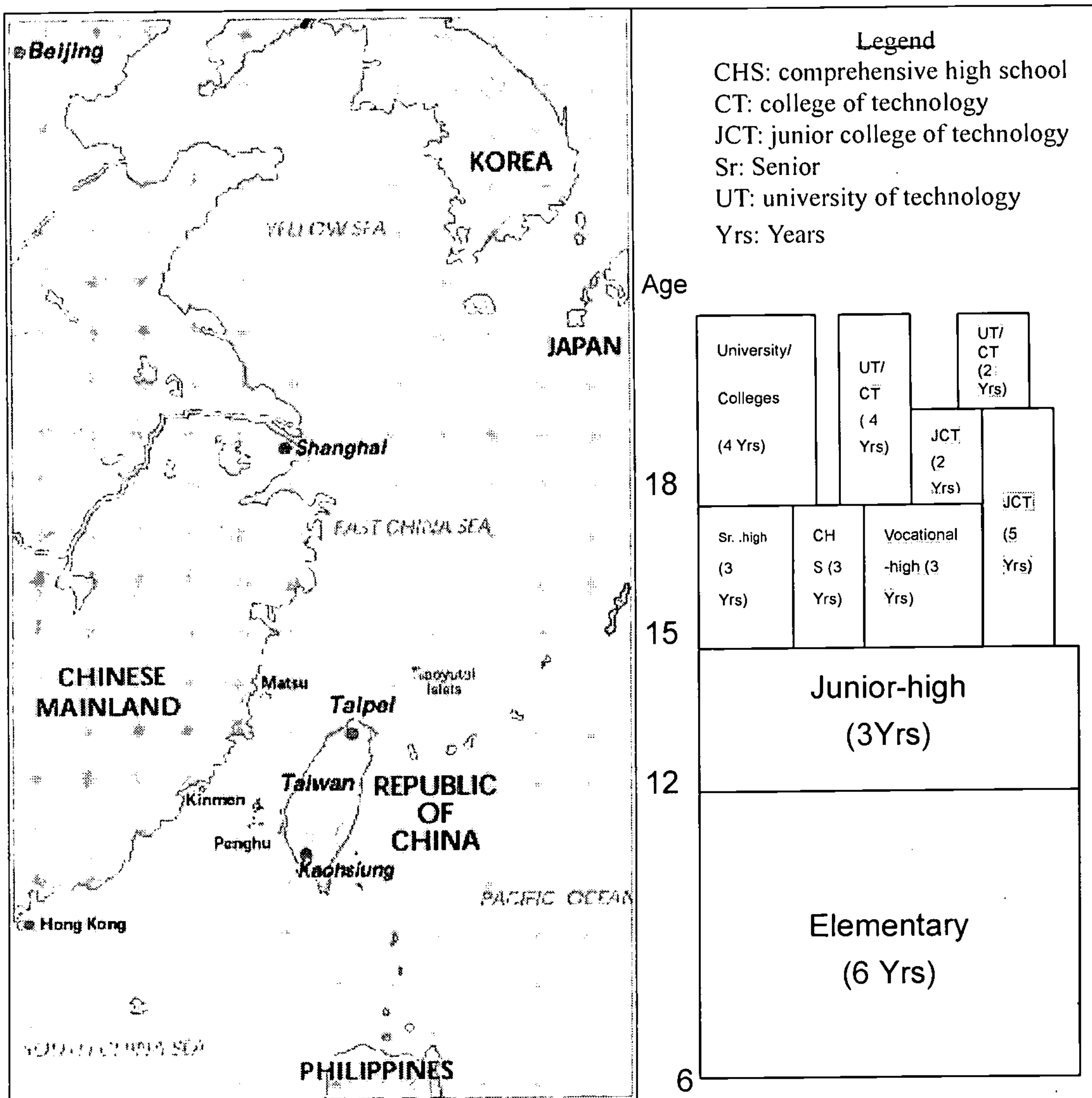
Abstract

Both technology and education are cherished in Taiwan. Technology education, focusing on technological literacy, is provided to all in grades 1-11 and mainly offered in the secondary-school subject named Living Technology (LT). The newly promulgated national curriculum for grades 1-9 has integrated LT with Natural Science (NS) to form the key learning area (KLA) called Natural Science and Living Technology (NS&LT). The national curriculum for grades 10-12 is under revision. Hopefully, technology will become an independent KLA. At a minimum the following challenges in technology education and its teacher education need to be resolved: (1) Technology is not well understood, (2) Technology education at the elementary school level is still not universal, (3) Further-study examinations caused a lack of teaching vitality at the secondary level, (4) Differences exist between the curriculum standard and realistic learning environment, and (5) Technology teacher education programs are diluting their professional roles

Technology Education in Taiwan

Situated in Eastern Asia, the islands of Taiwan border the East China Sea, Philippine Sea, South China Sea, as well as the Taiwan Strait, with the main island located north of the Philippines, as well as off the southeastern coast of China (see Figure 1a). Because of its geographical location, Taiwan has been influenced by both "ocean culture" (also called blue culture) and "continental culture" (also called yellow culture). From a historical viewpoint, Jwo (2000) pointed out that the following ocean and continental cultures were successively infused into Taiwanese culture: Indigenous culture (before 1624), Dutch culture (1624-1662), Spanish culture (1626-1642), Ming-Jenq culture (from Mainland China) (1662-1683), Maan-Ching culture (from Mainland China) (1683-1895), Japanese culture (1895-1945), and Gwo-Fuu culture (from Mainland China and influenced by contemporary American culture and Japanese culture) (1945-present). Due to the mix of "ocean" and "continental" cultures, Taiwanese society has been remarkably open and dynamic, and values both trade and Confucianism.

A lack of natural resources and a relatively small domestic market have made Taiwan dependent on international trade where both technology and education are strongly emphasized. The purpose of this paper is to introduce what is happening in technology education (i.e., technological literacy education) in Taiwan as well as to identify the challenges for technology education in the years ahead.



a. Geographic Location of Taiwan | b. Educational System of Taiwan

Figure 1. The geographic location and educational system of Taiwan, Republic of China (ROC).

From "Umbrellas" to "Space Shuttle Components": Taiwan Has Tries to Become A "Green Silicon Island"

The technological contributions of Taiwan have often been noted in American movies. In the movie "Fatal Attraction" released in 1987, when the actor and actress failed to open their umbrella in the rain, they joked that was "Made in Taiwan." About a decade later, in the movie "Armageddon" released in 1998, when the actor had trouble repairing the complicated navigational equipment of his space shuttle, he complained, "American components…Russian components...All made in Taiwan." From exporting daily items to advanced electronic products, the products made in Taiwan indeed have changed in both type and quality.

Today, Taiwan is the world's third largest producer of microcomputer hardware products, after the United States and Japan. Moreover, Taiwan ranks first in the production of notebook computers, monitors, motherboards, and scanners, supplying over one-half of the world's market of these products (GIO, 2000). The development of the information industry has kept Taiwan's economy flourishing and has helped the diplomatically isolated island boost its much needed international profile (Reuters, 2000).

The dominant political issue in Taiwan continues to be the relationship between Taiwan and mainland China and the question of eventual reunification (CIA, 2000). In order to achieve sustainable economic development and offer a better investment and business environment, Taiwan is seeking more stable relations with mainland China and is in the process of upgrading its financial system as well as infrastructure, including water, electricity, transportation and communication. Related important issues such as high-tech human resources, land use, capital management, government efficiency, environmental protection, tax reform and international cooperation, are also being improved (Chang, 2000).

The new central government, which took office in May 2000, has named the development of a knowledge-based economy as its goal for Taiwan. This new economy emphasizes research and development (R&D) in knowledge- and information-based technology, and the diffusion and application of these technologies to increase production and drive rapid economic growth. As a result, knowledge has taken over the position previously held by traditional factors of production. Accordingly, Taiwan has already launched an initiative to establish a mechanism for stimulating innovation and venture capital. It will lay the foundation for a wide-bandwidth Internet environment and strengthen the application of information technology, thereby raising Taiwan's overall industrial competitiveness (Chang, 2000).

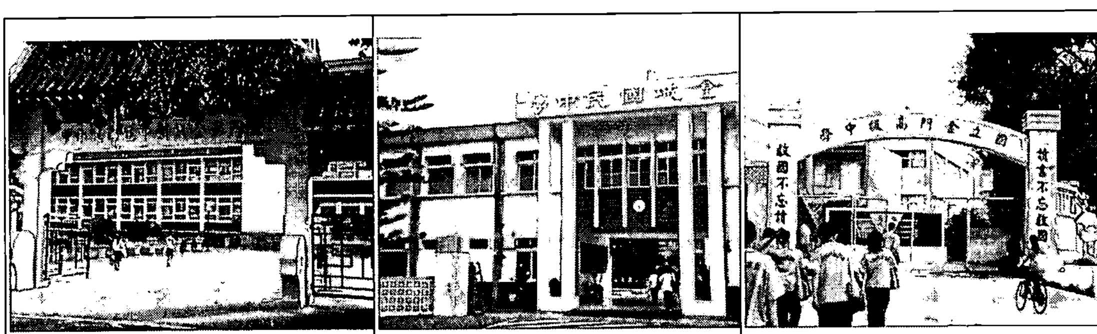
In recent years, the people of Taiwan have demonstrated their creativity by becoming the fourth-largest U.S. patent holder in the world. With its current economic foundation and continued diligence, Taiwan is determined to establish itself as a "green silicon island," respected for environmental friendliness, a high quality of life, and advanced industrial development (Chang, 2000).

Technology Education is Offered in Grades 1-11, While Its Teacher Preparation Is Being Diversified

The educational system in Taiwan is shown in Figure 1b. Nine years of compulsory education has been the rule since the 1968-1969 academic year, and there is a wide range of other educational options for all ages. In the fiscal year of 1999, government expenditures were about 6.57% of the GNP or 18.80% of government funding for education, science, and culture. In the academic year 1999 (August 1, 1999-July 31, 2000), the enrollment rate of elementary school was 99.68%; with 99.89% of those that graduate continuing on to junior high; and 94.73% of all junior high graduates continuing their studies in upper/senior-secondary schools (GIO, 2000).

After nine years of compulsory education, junior high school graduates may choose to continue their upper-secondary studies in the following three tracks: (1) academic education track—three-year senior high schools, (2) technological and vocational education (TVE) track—including three-year vocational high school (VHS) and five-year junior college of technology (JCT), (3) comprehensive education track—three-year comprehensive high school (CHS). All upper-secondary graduates have several options for entering university/college.

Curricula for elementary and secondary schools (see Figure 2) are prescribed in national curriculum standards published by the Ministry of Education (MOE). As shown as in Figure 3, it is anticipated that curriculum standards, course of study and instructional plan are aligned with each other. Table 1 indicates the present technology education in national curricula.



a. Elementary School (Year 1-6)	b. Junior-High School (Year 7-9)	c. Senior-High School (Year 10-12)

Figure 2. Glances of elementary and secondary schools.

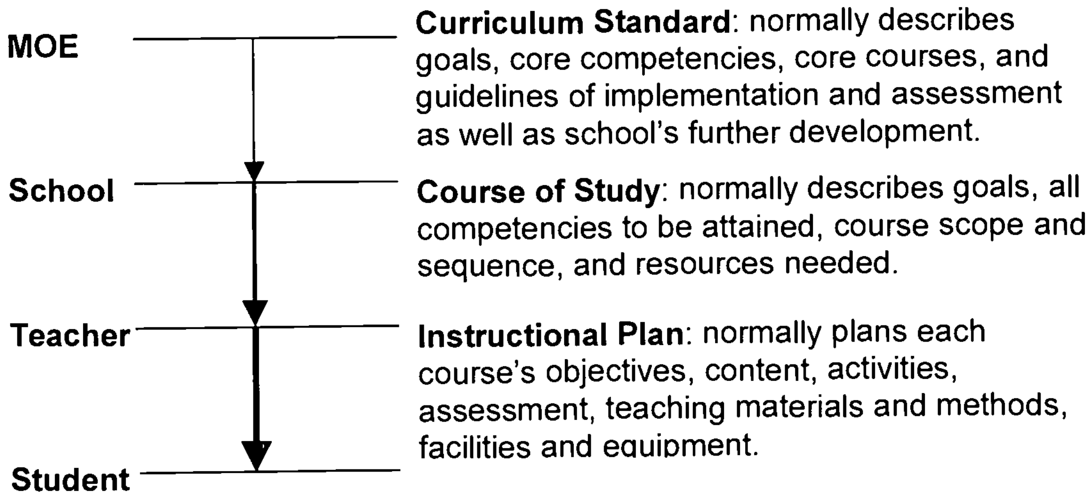


Figure 3. The alignment of the three levels of curriculum documents.

Table 1. Technology Education in National Curricula.

	Elementary School (Grades 1-6)	Junior High School (Grades 7-9)	Senior High School (Grades 10-12)
Subject Title （Beginning Year/Month）	Craftwork (1996/8-)	Living Technology (1997/8-)	Living Technology (1999/8-)
Teaching Period*	Grades 1-2: 2 period/week Grades 3-6: 3 periods/week	Grades 7-9: 1 semester/ academic year; 2 periods/week	Grades 10-11: 1 semester/ academic year; 2 periods/week
Target Student	All students	All students	All students
Program Goal	To enhance the pupil's presentation, appreciation, and practical application abilities. At the level of grades 1-4, it emphasizes intelligent image and functional	To understand technology and its impact, to apply technological products and means, to understand careers related to technology as well as identify pupil's interests and	To understand technology and evaluate its impact on individual/social environment and human civilization, to pursue well-developed technological capabilities and problem-solving

	presentation, and further emphasizes functional presentation at the level of grades 5-6. Thus, in the area of craftwork, the most important point of technology education is the practical application.	capabilities, and to enhance adaptability in the technological society.	competence, to establish proper technological attitude and enliven the interest in technology and study.
Subject Matter	Choosing toys/ clothes/ornaments, applying technological materials, using tools, etc., are common and the demands for synthesis of perception and creative problem-solving are also prevalent.	Technology and Life, Information and Communication, Construction and Manufacturing, and Energy and Transportation.	Technology and Life, Information and Communication, Construction and Manufacturing, and Energy and Transportation.
Instructional Focus	Unit teaching; Activity-oriented experimental discovery	Unit teaching; Activity-oriented problem-solving	Unit teaching; Activity-oriented problem-solving
Selected Courses Related to Technology		Occupational Disciplines: 1-3 periods/week for grade 7, and 1-5 periods/week for	Living Technology: 2 periods/week for grade 11, and 2-4 periods/week for grade 12; subjects

	grade 8; subjects include agriculture, industry, commerce, home economics, marine, etc.	include graphics, energy and power, and industrial material.
Remark	Computer classes are required for all 8th and 9th graders, 1 period/week.	Computer classes are selective course for 11th and 12th graders, 2 periods/week.

Note * : 40, 45, and 50 minutes per period respectively for elementary, junior-high and senior-high school.

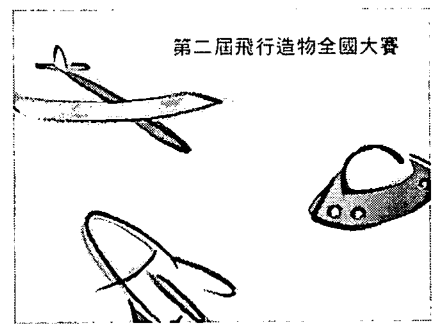
The junior-high students' Annual Living Technology Performance Contest, conducted by the Taipei City Government, might indicate what is most emphasized in the technology education in Taiwan. In January 2001, there were 222 ninth graders participating in the one-day contest. In the contest, multiple-choice items were utilized to test individual participant's technological knowledge, while every team, grouped by three participants from a same school, was required to solve a technological problem—in 2001, the problem was to design and make an intelligent flower container which warns the user of a lack of water. Figure 4a and 4b show a team conducting a design by means of a portfolio, and subsequently building their designs. Figure 4c shows some of their solutions. This shows that technological learning in Taiwan is hands-on and mind-on, problem-solving (PS) based, activity-oriented, etc.

a. Design | b. Making | c. Product

Figure 4. Junior-high students' living technology contest in Taipei.

Since technology is omnipresent, in addition to the technological literacy education introduced above, social education also embraces technology education for all. For example, the museums related to science and technology (S&T) have promoted technological learning through hands-on labs, web-based learning (WBL), etc. Figure 5a indicates a WBL homepage called Living Technology Paradise provided by the National S&T Museum. Government authorities or foundations involved in S&T or education also sponsor some contests and workshops which promote technological learning. Figure 5b is a part of nation-wide design contest for flight vehicles.

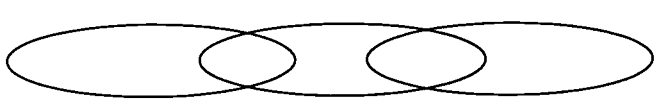
a. A WBL called Living Technology Paradise



b. A part of the nation-wide flight vehicles contest

Figure 5. Examples of social education activities embracing technological literacy education.

As show in Figure 6, the technological literacy needed by pupils, technology education in schools, and technology teacher education are all in a value chain. They are interdependent. Teachers in elementary schools are almost all graduates of nine public teachers' colleges, while most teachers in junior and senior high schools are graduates of the following three normal universities—National Taiwan Normal University, National Changhua University of Education, and National Kaoshiung Normal University. However, any university in Taiwan can offer a teacher education program if the university applies for it and passes an evaluation of the qualifications. At present, there are many qualified universities with programs for elementary and secondary teacher preparation.



Technological Literacy Needed by Pupils | Technology Education in Schools | Technology Teacher Education

Figure 6. The value chain of technological literacy, technology education and

technology teacher education.

As shown in Figure 7, those who graduate from university/college and complete the teacher education program are qualified to become interns. They can receive the teacher license after passing the assessment of a one-year internship. Only licensed teachers can be formally employed by schools. Both initial and final certifications are based on the applicant's transcript review.

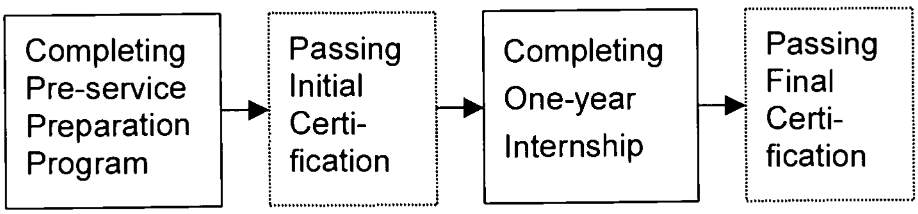


Figure 7. The procedure to be certified as a school teacher in Taiwan.

Liberal, specialty, and pedagogical courses are required for prospective teachers. There are 26 pedagogical semester credits in the teacher education program for secondary schools and 40 for elementary schools. The pedagogical courses in the programs are composed of 3-4 educational areas include fundamentals, methodology and practical teaching.

Teachers in elementary schools are mainly graduates from a variety of departments of teachers' colleges, who then must take several required credits from departments to which they do not belong, for multi-subject teaching. For instance, instructional methods of craftwork, keyboard-instrument music, children's literature are required for being a well-rounded teacher.

Technology is not taught as an independent course in elementary schools at present, similarly, technology education programs are not institutionalized in teachers' colleges. Nevertheless, in these colleges, there are some faculty members majoring in Industrial Education or Technology Education, so the prospective teachers still have the opportunity to study technological learning. There are few technological courses in teachers' programs of other universities.

For elementary school teachers, the most common type of in-service training should be the "study time" which regularly takes place on Wednesday afternoons. Advanced studies for technology education usually conducted by arranged lecture or seminar, with professors, or experienced teachers are encouraged. Formal degrees of master/doctorate are also provided by normal universities to these teachers as well as teachers in secondary schools.

In the past, the majority of secondary-school Living Technology teachers were graduates of the departments of Industrial Technology (formerly Industrial Arts) of National Taiwan Normal University and National Kaohsiung Normal University. Every year, these two departments accept more than 100 students who pass the joint entrance examination for colleges and universities. The students can earn a B.Ed. degree and become a certified teacher in Industrial Arts/Living Technology after four-years of on-campus training and a one-year field internship in a secondary school. Most of them work as junior-high or senior-high school teachers in living technology after graduation. They comprise the majority of the current teachers in Living Technology. Prospective teachers in the Living Technology/Industrial Arts teacher program previously took specialty courses such as metal working, wood working, electricity, electronics, plastics, information and computers, graphics, design, and modeling, while current prospective teachers take systematic courses in the following four domains: construction, manufacturing, communication and transportation. Generally speaking, teachers who graduated from the two normal universities receive thorough training in teaching and thus have more technological knowledge and better learning abilities.

Both National Taiwan Normal University and National Kaohsiung Normal University supply graduate-level degree and non-degree programs to in-service teachers to satisfy their need for advanced studies. In 1991, both normal universities started their master's program in Industrial Technology Education. Many in-service teachers and university graduates compete for the opportunity to enroll in these programs every year. Other authorized universities and teacher professional development centers have been organizing various courses or workshops for in-service teachers. To promote academic research and professional development, National Taiwan Normal University established a doctoral program in Industrial Technology Education in 1998.

Living Technology in the New National Curriculum for Grades 1-9 will be Integrated with Natural Science

In 1997, the MOE began the amendment of the national curriculum syllabus for grades 1-9, which reflects the call for educational reform in areas such as the articulation, integration and flexibility of curricula. The tentative syllabus, which included seven key learning areas (KLA's), was announced in September 2000, and will take effect in the academic year of 2001. In this new curriculum, Living Technology and Natural Science (including (biology, physics, chemistry, earth science) are integrated into the KLA named "Natural Science & Living Technology" (NS&LT). However, the three KLA's—NS&LT, Social

Studies and Arts & Humanities—are integrated into the broader area named "Living" for 1st and 2nd grades students.

The expected competency indicators for each KLA are specified in the national curriculum syllabus for grades 1-9. In NS&LT, there are at least 33 indicators pertaining to Living Technology. Thematic or unit instruction is strongly suggested in the syllabus. Thus, the following three types of unit will coexist in the KLA of NS&LT: (1) single-subject unit such as the unit "land transportation" mainly derived from the traditional subject, Living technology, (2) cross-subject units such as the unit "environmental protection" obviously derived from more than one traditional subject, Living Technology, Biology, Chemistry, etc., and (3) para-subject units such as the unit called learning skills primarily derived from one/more than one traditional subject(s) and non-traditional areas.

As a result of the emerging national curriculum for grades 1-9 and its NS&LT KLA, the visibility of technology education will increase and hopefully, the partnership of science and technology (S&T) shown as Figure 8 will be promoted. However, many measures such as teacher training and re-training, sample programs, teaching materials, and instructional strategies need to be developed.

After the national curriculum for grades 1-9 was promulgated, the MOE began started to revise the present national curriculum for senior-high-school (grades 10-12). Technology is being considered as an independent KLA at the upper-secondary level.

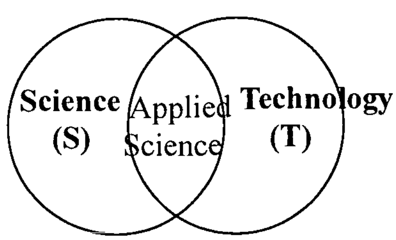


Figure 8. The ideal partnership of science and technology.

In Taiwan, there are no subject-specific supervisors and curriculum development institutes in educational authorities. Thus, teacher educators are often entrusted to work on national curriculum development and assist educational authorities as well as schools with educational practices. For example, after the seven KLA's for grades 1-9 were determined, this author was appointed by the MOE to lead a team to develop the national NS&LT-Living Technology (LT) curriculum.

This author and his colleagues have been working on the following efforts to promote present and emerging technology education:

1. Research projects of technology education

A series of research projects have been funded by the National Science Council (NSC). In recent years, those project themes include the cross-country comparative study on teaching strategies, learning assessment, the identification and assessment of technological literacy, the development of examination methods for technology teachers, etc. Supported by research results, technology might be included in the national assessment, mainly for students' further studies.

2. Unit plans with technology learning activities (TLA's)

In order to help teachers interpret the national curriculum, many packages of technology unit plans with TLA's have been developed and may be accessed from the web or on print media. Those TLA's emphasize the idea, "For the Teacher and By the Teacher".

3. Technology education periodicals

Sponsored by educational authorities, Living Technology Monthly (formerly called "Industrial Arts Monthly") has been published for over 30 years. School technology teachers receive it free of charge.

4. Students technology performance contest

Conducted by local educational authorities such as the Taipei Bureau of Education, the junior-high-school students' Technology Performance Contest has been held annually. In addition, various workshops regarding technology education for students are also held.

5. Teacher's professional development workshop

Technology teacher professional development workshops have been held at various levels in multiple locations. In the workshops, technology teachers are strongly encouraged to share their successful experiences.

6. Technology professional association

The Industrial Technology Education Association (ITEA), Taiwan, R.O.C. plays a vital role in organizing technology educators to work together in this field. For example, this association is a driving force behind the International Conference on Technology in the Asia-Pacific Region (ICTE), which is a professional group normally holding a biennial conference to promote communication and academic exchange. The coming ICTE 2001 will be held by the Korean Technology Education Association from October 29 to November 2, 2001 (see http://www.ktea.or.kr/icte2001/index.htm).

The Challenges for Technology Education in the Years Ahead.

Precursors to technology education in Taiwan were craftwork and industrial arts. Although the evolution of the discipline progressed from handicrafts to technology, today's living technology is still commonly seen as a subordinate subject. A new national curriculum also brings new problems which means there are some challenges in the technology education and technology teacher education that need to be resolved:

1. Technology is not well understood.

The popular culture confuses science with technology and unfortunately does not assign value to technological literacy (Hacker, 2000). For example, in the Chinese language, technology education is called "科技教育." However, "科技" (pronounced as *kejih* in Mandarin Chinese) is often interpreted as science and technology (see Figure 9a) or computer.

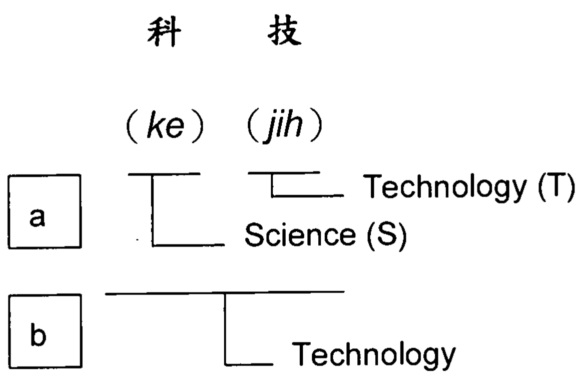


Figure 9. "科技" (*kejih*) is often seen as S&T (Concept a).

2. Technology education at the elementary school level is still not universal

Mainly caused by teachers' training background, technology education at the elementary school level is still not universal. Hopefully, the living technology in the coming new national curriculum for grades 1-9 will gradually make a difference.

3. Further-study examinations caused a lack of teaching vitality at the secondary level

In general, the junior high school or senior high school takes a preparative role in our educational system. The major goal in these lower- or upper-secondary schools is providing a further study opportunity at the upper-secondary or college/university level. However, living technology and other artistic as well as physical education courses are not included in the subjects on the entrance examination. These courses always play less important roles in school. In our traditional culture, people mocked these courses as auxiliary courses. This deep-rooted problem adversely influences our educational development. A lack of teaching vitality of those auxiliary courses is a problem in secondary school.

4. Differences exist between the curriculum standard and the realistic learning environment

In comparison with other general courses, living technology needs a more complicated and expensive teaching facility. It also requires a more intricate learning support system in the realistic teaching environment. However, due to the traditional cultural impact, many negative factors such as policy, budget and outdated thinking, prevent a harmonious development between the curriculum standard and the realistic teaching environment.

5. Technology teacher education programs are diluting their professional roles

More and more universities have been allowed to prepare school teachers. In this open environment, traditional normal universities and colleges have to transfer their responsibility from a single to a multifaceted mission. The departments of industrial technology education also provide multiple purpose curricula. For instance, they also provide specialized technology and human resource development (HRD) programs to fit the industry and corporation requirements. That is, traditional technology teacher preparation institutions have gradually diversified their programs. This might result in the dilution of their technology teacher training and related research and development.

Remarks

If school subjects are compared to vehicles, more traditional subjects such as natural sciences are like automobiles and living technology is still like a bicycle. A good bicycle rider must "look ahead" to do the right thing, "keep pedaling" to continue progressing, and "constantly adapt" to maintain balance. Every technology educator in Taiwan must do the same.

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