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ABSTRACT

Technology education (TE) in Taiwan is implemented in elementary, junior high, senior high, and comprehensive high schools. Since 2001, the new curriculum syllabus for grades 1-9 reflects the call for educational reform in such areas as articulation, integration, and flexibility of reform. The national curriculum for grades 10-12 is being revised; technology is being considered as an independent subject at the upper secondary level. TE programs are not institutionalized in teachers' colleges for elementary teachers. Secondary school living technology teachers are certified after four years of on-campus training and a one-year field internship in a secondary school. In the future, the internship will be shortened to a half year and more course credits will be required. Technology teacher educators are working on these efforts to promote present and emerging TE: research projects, unit plans with technology learning activities, TE periodicals, a students' technology performance contest, teacher's professional development workshops, and a technology professional association. Major problems in TE and technology teacher education that need to be resolved are that technology is not well understood; TE at the elementary level is still not universal; TE is not considered as important as other courses; differences exist between the curriculum standard and the realistic learning environment; and technology teacher education programs are diluting their professional roles. (YLB)

Running head: TECHNOLOGY EDUCATION IN TAIWAN

A Profile of Technology Education in Taiwan

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December 11-14, 2002

Abstract

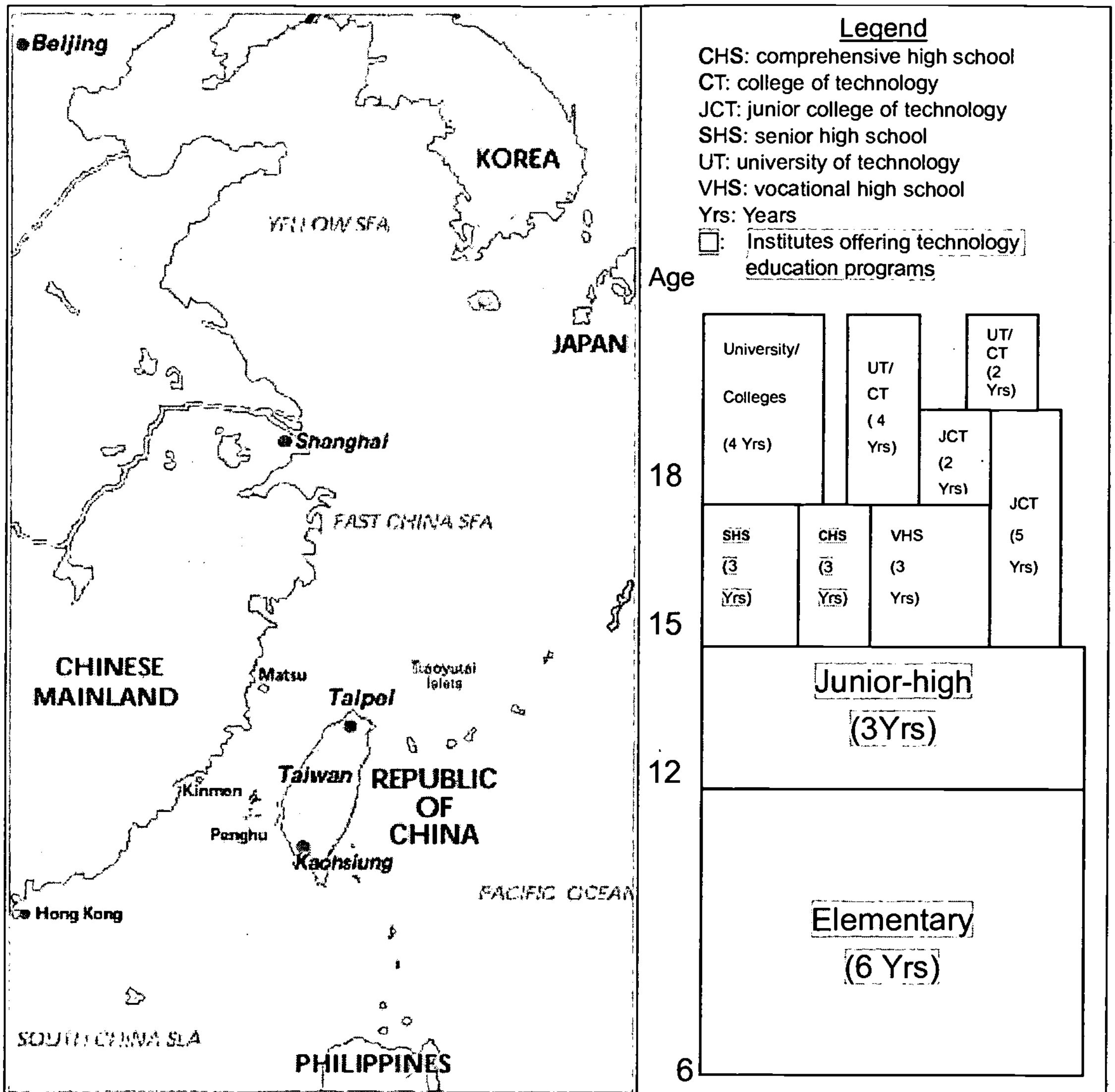
The purpose of this paper is to describe the technology education (i.e., technological literacy education) profile in Taiwan as well as to identify the development dynamics of technology education. The structure of the education system, the curriculum of technology education, instruction in technology education, and technology education teachers are described in the profile. The development dynamics include main efforts and major problems.

A Profile of Technology Education in Taiwan

Taiwan is located in the Western Pacific between Japan and the Philippines off the southeast coast of China and is separated from the mainland by the Taiwan Strait. With a total area of about 36,000 square kilometers, the island is 394 kilometers long and 144 kilometers wide (see Figure 1a). Because of its geographical location, Taiwan has been influenced by both indigenous and foreign cultures. The foreign culture comprises "ocean culture", mainly Dutch, Spanish, Japanese and American, as well as "continental culture", mainly from Mainland China (Jwo, 2000). Due to the mix of cultures, Taiwanese society has been remarkably open and dynamic, and values both trade and Confucianism.

Taiwan is the world's 16th largest economy, the 14th largest exporter and 16th largest importer, and the third largest holder of foreign exchange reserves. Taiwan's diligent labor force created an economic miracle in the 1980s. Over the past two decades, Taiwan has gradually made its industries hi-tech oriented. Today, it has the world's fourth largest information hardware industry and the fourth largest semiconductor industry. Innovative and high-quality "Made in Taiwan" products are sold around the world. With its attainment to the World Trade Organization (WTO) in January 2002, Taiwan is to make more significant contributions to the global trading system and economic prosperity (GIO, 2001).

Taiwan's population surpassed 22.45 million in June 2002 and about 60% of Taiwan's population is concentrated in four metropolitan areas—Taipei, Kaohsiung, Taichung, and Tainan. 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 describe the technology education (i.e., technological literacy education) profile as well as to identify the development dynamics of technology education in Taiwan.



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

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

Technology Education Profile

The Structure of the Education System

The educational system in Taiwan is shown in Figure 1b. Nine years of compulsory education has been the rule since the 1968-1969 school year, and there is a wide range of other educational options for all ages. In the fiscal year 2000, government expenditures were about 5.5% of the GNP. In the school year 2000 (August 1, 2000-July 31, 2001), the enrollment rate of elementary school was 99.71%; with 99.79% of those that graduate continuing on to junior high; and 95.31% of all junior high graduates continuing their studies in upper/senior-secondary schools (GIO, 2001).

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 (SHS's), (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). Of the 336,893 junior high graduates in school year 1999, 39.07% entered SHS's and CHS's, while 48.98% were in the TVE track (35.20% went to VHS's, 9.53% went directly into five-year JCT's, and 4.25% attended the Practical Technical Arts Program in VHS's), 7.26% studied at various supplementary schools. Only 4.69% of the students who completed nine years of compulsory education did not continue with their studies (GIO, 2001). All upper-secondary graduates have several options for entering university/college.

The Curriculum of Technology Education

Curricula for elementary and secondary schools are prescribed in national curriculum standards/syllabi promulgated by the Ministry of Education (MOE). As shown as in Figure 2, it is anticipated that curriculum standards, course of study and instructional plan are aligned with each other.

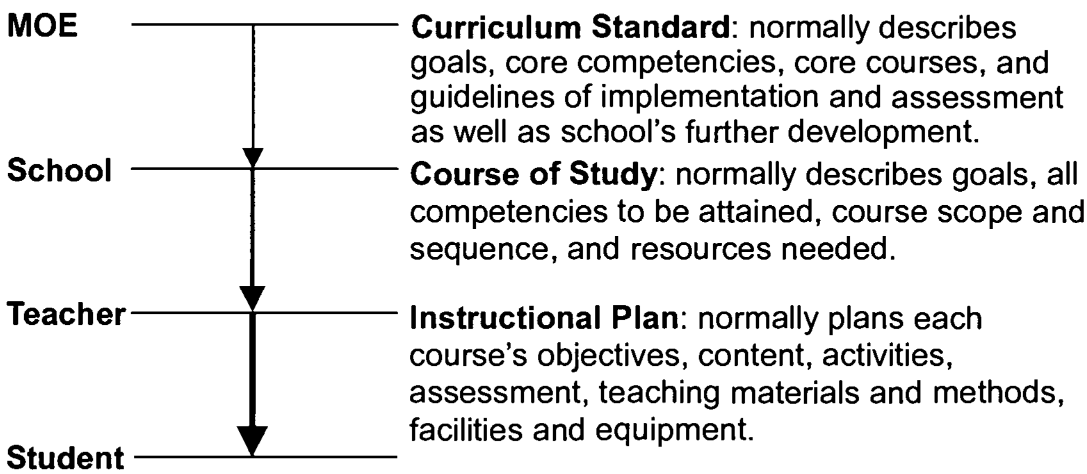


Figure 2. The alignment of the three levels of curriculum documents.

Technology education, is normally implemented in elementary schools, junior high schools, senior high schools and comprehensive high schools and eligible for grades 1-11(see Figure 1). Table 1 indicates the present technology education in national curricula, which are still suitable for grades 3, 5, 6, 8, 9, 10, 11 and 12. It should be noted that the technology education content prescribed in CHS's is similar to that in SHS's but only one semester credit is required.

Table 1. Technology Education in National Curricula.

	Elementary School (ES, Grades 1-6)	Junior High School (JHS, Grades 7-9)	Senior High School (SHS, 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 periods/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 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.	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 capabilities, and to enhance adaptability in the technological society.	To understand technology and evaluate its impact on individual/social environment and human civilization, to pursue well-developed technological capabilities and problem-solving competence, to establish proper technological attitude and enliven the interest in technology and study.

Table 1. (continued)

	Elementary School (ES, Grades 1-6)	Junior High School (JHS, Grades 7-9)	Senior High School (SHS, Grades 10-12)
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 grade 8; subjects include agriculture, industry, commerce, home economics, marine science, etc.	Living Technology: 2 periods/week for grade 11, and 2-4 periods/week for grade 12; subjects 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.

In the school year 2001, the new national tentative curriculum syllabus for grades 1-9, which reflects the call for educational reform in areas such as the articulation, integration and flexibility of curricula, was taken effect from grade 1. At present, this new national curriculum is suitable for grades 1, 2, 4 and 7. In this new curriculum, Living Technology and Natural Science (including biology, physics, chemistry, and 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 grade 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 3 will be promoted. However, many measures such as teacher training and re-training, sample programs, teaching materials, and instructional strategies need to be developed.

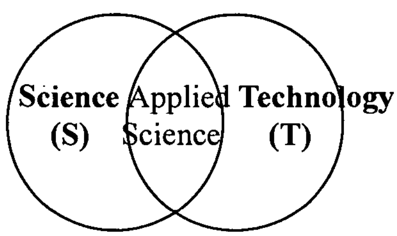
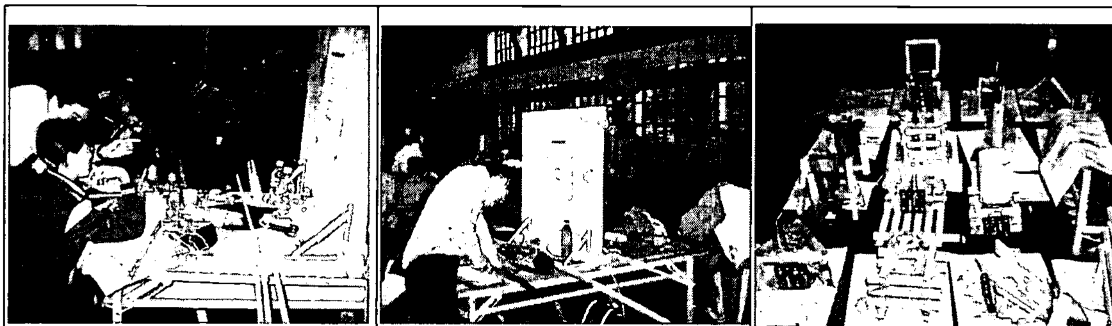


Figure 3. The ideal partnership of science (S) and technology (T).

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

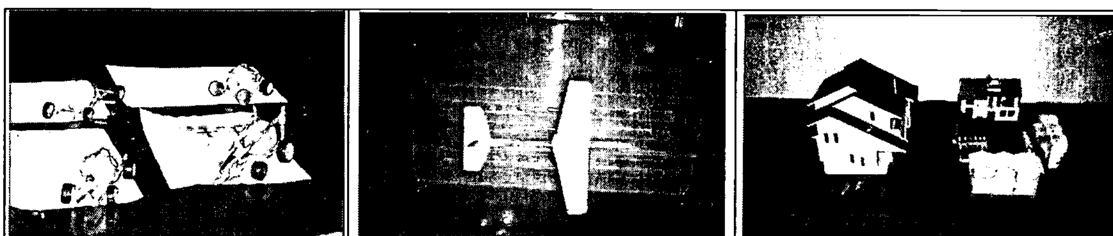
Instruction in Technology Education

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 the 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. Some Students' projects are shown in Figure 5.



a. Design	b. Making	c. Product

Figure 4. Junior-high students' Living Technology contest in Taipei.



a. An example of ES's LT project—Egg Carrier (Courtesy: Shiang-Rung Chien)	b. An example of JHS's LT project—Controllable Glider	c. An example of SHS's LT project--Housing

Figure 5. Some students' projects completed in Living Technology classes.

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 action labs, web-based learning (WBL), etc. Figures 6 indicates: (a) a fair teaching children to make traditional toys, (b) a WBL homepage called Living Technology Paradise provided by the National S&T Museum, and (c) a post of nation-wide design contest for flight vehicles. That is, government authorities or foundations involved in S&T or education also sponsor some contests and workshops which promote technological learning.

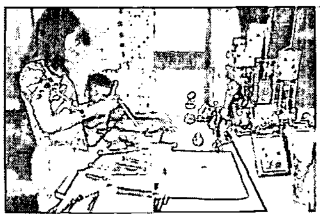
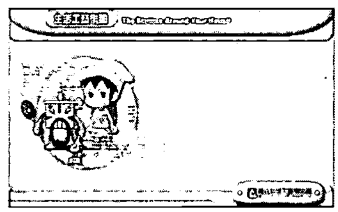
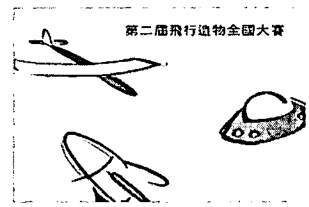
		
a. A hands-on activity on a fair	b. A WBL web page called Living Technology Paradise	c. A nation-wide flight vehicles contest post

Figure 6. Examples of social education activities embracing technological literacy education.

Technology Education Teachers

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.

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 their teacher license after completing 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.

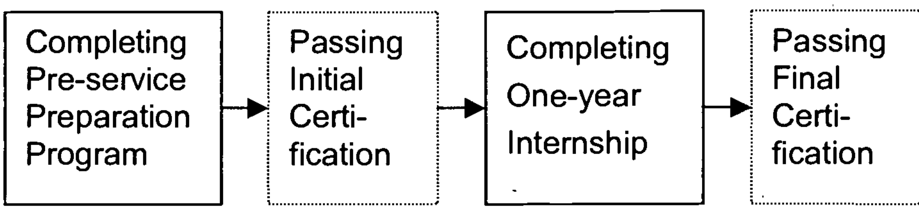


Figure 7. The procedure to be certified as a school teacher in Taiwan.

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 including 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, and 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 a 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.

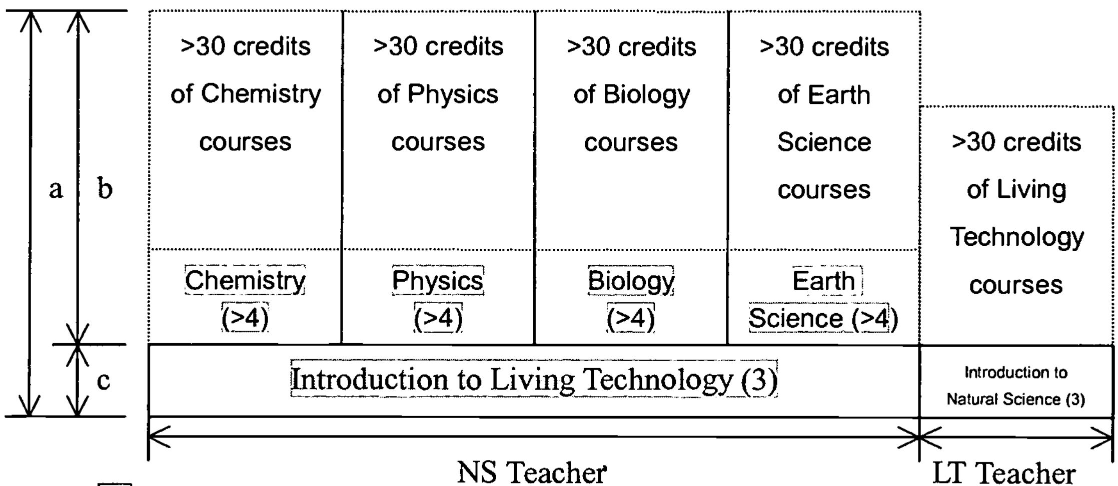
In the past, the majority of secondary-school Living Technology teachers were graduates of the departments of Industrial Technology (formerly Industrial Arts) of National Taiwan Normal University and National Kaohsiung Normal University. Every year, these two departments accept more than 100 students 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. Figure 8 shows a teacher training module and some teachers' projects at the Department of Industrial Technology Education, National Taiwan Normal University.

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, and National Kaohsiung Normal University established its own in 2002.

a. A screen printing module for technology teacher training	b. A preservice teacher's project—Maglev	c. Some inservice teachers' projects—Hydraulic Robot and mousetrap car

Figure 8. A teacher training module and some teachers' projects.

In order to follow a revised teacher preparation legislation, the procedure to be certified as a school teacher, shown as in Figure 7, is to be changed in the near future. The one year of internship will be shortened to a half year and a certification examination will be required upon completion. Additionally, in order to cope with the newly-implemented national curriculum, the prospective secondary-school Living Technology teacher will be required to complete three semester credits of Introduction to Natural Science and 30 semester credits of specialty courses, such as Introduction to Manufacturing Technology (including experiential practicum) (see Figure 9).



Note: ☐ required for NS teacher; a-at least 45 credits; b-at least 42 credits (but at least 30 for LT teacher) of specialized courses; c-three credits of core course.

Figure 9. New specialty requirements for NS&LT teachers.

Development Dynamics of Technology Education

Main Efforts

In Taiwan, there are no subject-specific supervisors (or curriculum specialists) 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.

Technology teacher educators in Taiwan 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 have included 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.

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 Education in the Asia-Pacific Region (ICTE), which is a professional group normally holding a biennial conference to promote communication and academic exchange.

Major Problems

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 major problems (or 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 or computer science .

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 teachers colleges have to transfer their responsibility from a single to a multifaceted mission. The departments of industrial technology education also expand the number of their programs. 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.

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