Facility design and development in secondary technology education on the Chinese mainland

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ABSTRACT: The facilities that provide material support for the technology curriculum on the Chinese mainland have grown from nothing since the middle of the past century. With the rapid development of technology education on the Chinese mainland, the requirements and needs for related facilities have changed greatly. The development of facilities has started to display their educational role. In reviewing the past development of facilities for technology education, the authors in this article attempt to identify the gaps and shortages that still exist. Further, considering the different levels of development of the social economy and education from south to north in China, the city of Nanjing in this article is taken as an example to illustrate the birth of a facilities standard through document reviews, interviews and observations. Ultimately, it is expected that the facility design will be developed into a universal standard that other cities can follow.

INTRODUCTION

Facilities are essential and important to promote students' technological literacy in secondary technology education. The facilities are not only cognitive tools, as well as subjects, but also a learning platform and environment for cognitive development for secondary students. Proper facilities can satisfy the practical learning activities, for example, tech-designing, tech-testing, tech-making and tech-exploring. And, they also provide an environment in which to cultivate technological thoughts. In addition, the design of facilities should conform to the curriculum standard so they can perform their full educational role.

Recently on the Chinese mainland, technology became one of the eight key learning fields in general education [1]. Compared with other subjects, it is based on designing, testing and exploring practices as a means to improve students' technological literacy to enhance the students' overall well-being, as well as their individuality [1]. Due to its unique curriculum characteristics and objectives, technology education needs to be equipped with up-to-date facilities, not simply some traditional equipment such as hand-tools [2]. In this sense, the production of new equipment and the design of a facility standard or guide have become urgent issues to be solved.

In light of multi-dimensional teaching and learning objectives, the design and creation of tools, instruments, equipment, and the space of workshops should meet basic and general requirements to keep pace with the ever-changing curriculum content. In general, the design of the standard or guide for facilities can be classified into two directions. The first is modifying the outdated standard, while the other one is designing an entirely new standard. The focus of this article is to discuss the latter direction.

Through the document reviews (e.g. policy papers, curriculum documents, study and research reports, other academic publications), interviews with persons related to technology education (e.g. curriculum planners, school heads, teachers) and observations in schools, the design process of the standard or guide for facilities is illuminated. Considering the different levels of the development of the social economy and education from south to north in China, it is difficult to lay down one national standard. Thus, taking the city of Nanjing as a start, a regional standard or guide is designed and then developed into a universal one. Based on this universal standard, other provinces and cities can adjust it to adapt to the local situation.

Since the new technology curriculum was implemented, new secondary technology education has undergone approximately 10 years of development. During these 10 years, the development of facilities also started from scratch. By reviewing the past 10 years of the development of facilities for secondary technology education, this article attempts to identify the gaps that exist on the Chinese mainland, which are worthwhile for consideration and, in turn, to propose future guidelines.

THE SITUATION IN THE ERA OF LABOUR-TECHNICAL EDUCATION

After the foundation of the People's Republic of China and since the 1950s, technology education has been influenced by the former Soviet model of polytechnic education [3]. The so-called polytechnic education was a concept exacted from Marxism-Leninism, which made a tremendous impact on education in China. Politically, polytechnic education must serve the political needs of the proletarian class. Economically, from the 1950s to 1970s, in order to satisfy basic life needs, teachers and students were also members of a productive labour group, that is, workers [4]. Based on these two major historical reasons, labour-technical education emerged in the early 1980s.

As a separate school subject, labour-technical education is different from other school subjects. Its teaching content is much wider and less clear. Regarding the subject name, it is obvious that the subject mainly consists of two parts: labour education and technical education. Labour education is intended to make students possess an appropriate attitude toward labour; while technical education is to master technologies related to agriculture and industrial manufacturing. Although labour-technical education serves political and economic needs, its development was stuck in a predicament mainly for three reasons: assessment, shortage of labour-technical teachers and few formal or official textbooks. Thus, labour-technical education has little attraction for students, their parents and teachers [5]. Despite these existing negative effects, labour-technical education has undergone significant transition over the past two decades [6][7]. The emphasis on labour-technical education has transferred to a technological dimension, which is especially apparent in the city of Shanghai, the biggest modern metropolitan city in China. The curricular goals focus on *hands-on activities* and *technological skills* to make some products used in daily life [8].

For the past 20 years, the development of facilities for labour-technical education has gone through three stages:

- In the 1980s - without any well-established standard: In this stage, there was no standard and related list for the facilities. Educational departments and schools did not have a definite scheme for what should be provided and how to map it out. Besides, there was also no professional manufacturer (or well-monitored or recognised manufacturer) to supply the facilities. The teaching aids and learning kits were mainly made or bought in the market by teachers themselves. As a matter of fact, the scattered and disorderly layout hindered regular teaching.
- In the 1990s - tool-box standard: In 1989, the Ministry of Education issued the standard of teaching equipment for secondary labour-technical education. The equipment was classified into different catalogues according to the types of activity. In each catalogue, corresponding equipment was divided into three levels in order to adapt to different regions. In accordance with the standard, some manufacturers produced several sets of tool-box equipment, for example manual kits, wood-making kits, metal-making kits and bench-work kits. However, due to diverse types and specifications, it brought inconvenience to the management.
- From the late 1990s to date - workshop style: After being equipped with the tool boxes mentioned above, schools found that they should provide special operating consoles and space for students for the normal progress of their projects. This situation caused the birth of *special workshops*. Students can finish their projects related to all the compulsory modules in the special workshop (in each school). Although the birth of the workshop solves many problems, after three to five years' implementation, some new shortages and limitation have emerged. For example, the console is used for different kinds of projects. After home economics teaching, students also use it for their metal-making project, which may damage the console. Moreover, too many students use the console at the same time and that may reduce the hands-on opportunities for each student.

Reviewing the above three stages of development, it is obvious there is no definite facility layout standard. Teachers purchase or design the equipment on their own. Since the standard issued in 1989, the situation has been mitigated a little. This backward complexion is a little related to economical factors. However, the essence of the problem has not been identified. There is a general lack of awareness that facilities are the material guarantee and premise for hands-on activities and normal teaching. In this sense, a well defined (and justified, approved) standard and layout of facilities seem highly crucial.

Besides, the content of technology education must reflect relevant technological activities [9]. Thus, facilities for technology education should create possibilities for students to realise diverse practices and not simply in a limited range of materials in the designing and making activities. In short, what is important is to design several special workshops for different types of hands-on activities, and the facilities should match the objectives and function of the special workshops.

In addition, with the fast development of information technology, the officials from educational departments and some principals from secondary schools have begun to transfer their conventional technology subjects to information technology. According to observations, one of the major reasons is that through information technology, students can master preliminary programming and make some simple robots. Most of the time, these learning outputs can bring opportunities to participate in various international competitions. Students can gain a huge sense of achievement if they win a prize. Schools, school heads and teachers can also gain a good reputation. In fact, for the past decade, the mass media has also liked to report on this kind of achievement made by schools, and individual teachers. In view of this attractive added value, secondary and also some primary schools invest a lot of money to purchase high configuration computers and other related teaching aids.

Furthermore, schools even allot an additional special classroom or convert a conventional classroom for the special needs involved in the teaching of information technology. This over-emphasis on information technology most of the time leads to the subject appearing in the teaching timetable of nearly all the senior secondary schools. By the end of 2001, 12,000 senior secondary schools on the Chinese mainland offered information technology, amounting to 92% of all secondary schools [10]. This extreme tendency caused the facility design and development for the traditional hands-on activities to stagnate.

THE STANDARD OF FACILITIES FOR TECHNOLOGY EDUCATION

Since entering the 21st Century, the wave of basic education reform has been whipped up on a large scale. Labour-technical education and information technology have become two parts of the curriculum *Integrated Curriculum of Practical Activity* for both primary and secondary schools. In fact, information technology has developed into a separate subject because of the high priority. Meanwhile, in April 2003, the Ministry of Education issued *The Standards of Technology Curriculum in Senior Secondary Schools (Experimental)*, in which general technology became an entire new part in the curriculum. In 2004, four provinces (i.e. Guangdong, Shandong, Ningxia and Hainan) were chosen as the first batch of pilot regions and started to implement the new technology curriculum. To date, almost all the provinces have this new technology curriculum.

As for the new senior secondary technology curriculum, the curriculum goals have transferred to *promoting technological literacy for each student* [1]. Therefore, existing facilities for the original curriculum *Integrated Curriculum of Practical Activities* may not be suitable for this new technology curriculum, especially for the part named *general technology*. Under general technology, there are nine modules: two compulsory and seven elective modules as follows:

Compulsory modules:

- Technology and Design I
- Technology and Design II

Elective modules:

- Electronic Control Technology
- Architecture and Architectural Design
- Making Simple Robots
- Modern Agricultural Technology
- Home Economics and Living Technology
- Garments and Garments Design
- Automobile Driving and Maintenance

The new technology education is one of eight key learning areas and is becoming compulsory for senior secondary students; it has developed at high speed for nearly 10 years since the beginning of this century. Design becomes the core content, which provides more opportunity to cultivate students' initiative, creativity, problem-solving skills and practical design competence. Besides this, strengthening information technology learning becomes another objective.

This approach encourages students to use information technology to solve the problems they meet in their learning, and to use information technology to help them learn. In order to assure and assist the normal teaching and original intention of this new curriculum, facility design has become more urgent. Although there have been some best practices for facility layout in western countries, the practices cannot be applied on the Chinese mainland without modification due to its economic level, cultural background and different curriculum contents that are different from those of other countries.

Furthermore, there is a slight overlap between labour-technical education and general technology education. Thus, it is necessary and appropriate to have a specific facility standard regarding the particular social, cultural and educational characteristics of the Chinese mainland.

Designing and compiling the facility standard is a system of work that requires not only curriculum experts, but also facility design professionals, school administrators, teachers and students to participate in it. On the Chinese mainland, the city of Nanjing and Zhejiang province have issued facility standards, respectively. The following section has more detailed description and discussion, which aim to generate experience and reference for the facility development in other regions of China and provide avenues for further research.

FACILITY STANDARD OF GENERAL TECHNOLOGY IN SENIOR SECONDARY SCHOOLS IN NANJING

Nanjing Bureau of Education issued *Facility Standard of General Technology in Senior Secondary Schools in Nanjing (Experimental)* in May 2007. The standard consists of nine parts for all the modules. The design of the standard involved two stages: structure design and content design.

Structure Design

The standard is made up of four sections. The first section is to illustrate the specifications and standards in detail. The second section is the facility standard for two compulsory modules, and the third section is for the seven elective modules. The last section is the appendix, including government documents and guidelines. The structures of the second and third sections for the nine modules are the same. The structure of the standard is presented in Figure 1.
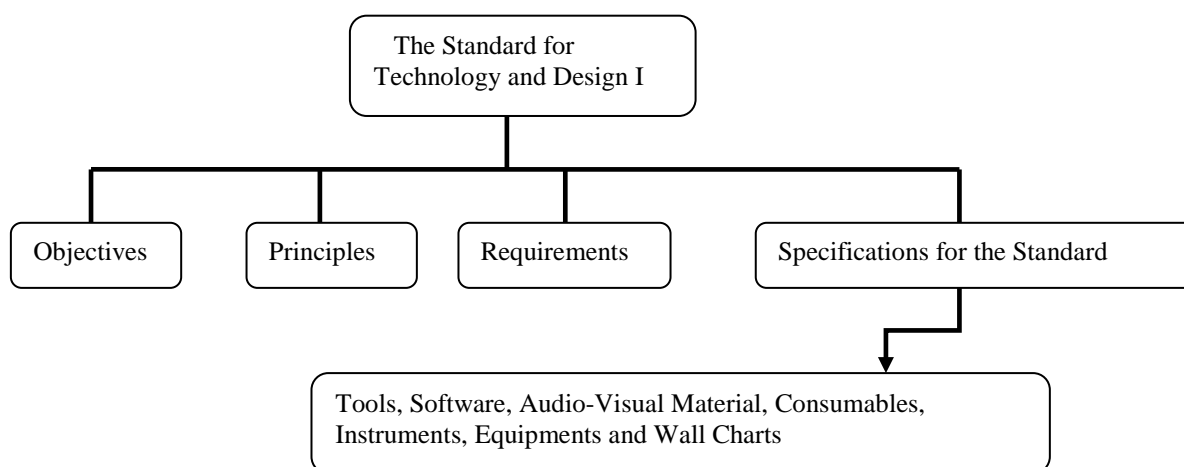

Figure 1: Structure design for a compulsory module in the standard.

Content Design

Although the contents of the nine modules are different, the method of content design of the standard is the same. The content in the first section includes the specifications of equipment, implementation requirements and the quantity, as well as the space requirement of the workshop. The second and the third sections are the specifications of standard details for the nine modules. The content of the standard is divided into six columns: number, item, unit, quantity, specific, and remark, shown in Table 1. In the column of quantity, there are three levels: I, II and III based on actual local needs.

Table 1: Content design in the standard, as an example.

Serial Number	Item	Unit	Quantity			Specific	Remark
			I	II	III		
84	Hydraulic Control System Model	Set	1	1	1	To display the work flow of hydraulic control	Module II

The compilation of this standard started from 2006. In the first stage, some preparation work for the standard design was conducted, which was mainly investigations and surveys. In March and April 2007, some official staff from several educational departments in Nanjing gathered together to draw up the standard. At the end of May 2007, this standard was issued officially. Due to the consideration of the urgent requirement to offer the subject (including the construction of the workshops) in the secondary schools in Nanjing in September 2007, compilation had taken a short period of time. Up to now, the standard is not considered the final one, though its initial compiling work has been completed. This is because, due to some reviews after the compiling work, there are many shortages and limitations of the standard. Thus, the modification of the standard is still an ongoing process.

Compared with other school subjects, general technology is a relatively new subject. For the design of the standard and the creation of equipment, much more time and repeated processes are needed. In Figure 2, the *Preparation* stage illustrated by dotted lines is the optional one. The *Preparation* is the fundamental work for the design of the facility standard. For this stage, some research work should be conducted including the research of the curriculum, the status quo of the facility, present syllabus, standard and teaching situation. Following the *Preparation*, the next step is the *Drawing Up* of the standard. The personnel participating in this stage should be from different positions (e.g. curriculum planners, school heads, teachers) in order to obtain different suggestions and opinions. Then, the standard can be issued (published) for a trial run - *Pilot Study*. The stage of *Pilot Study* is essential and cannot be skipped since it is the only way to evaluate the standard and identify any problems. Moreover, the development of the related facilities needs to be conducted at the same time before the facilities are ordered by the schools for the construction of the workshops. After the *Pilot Study*, some modification work should be considered and it is better to go through these four stages again, that is, *Preparation*, *Drawing Up* the standard, *Publishing* and *Pilot Study*. Nevertheless, whether this repeated process needs the stage of *Preparation* depends on the actual need before the modification work.
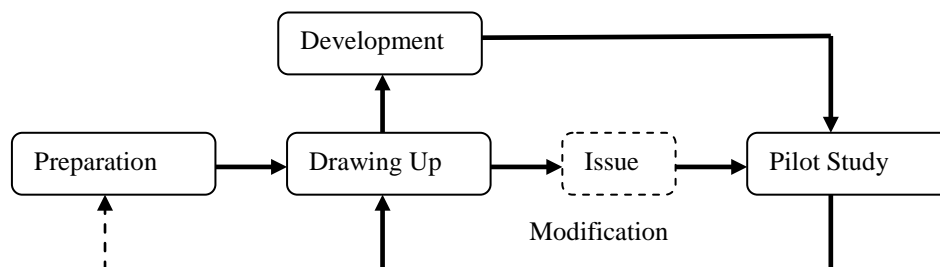
Figure 2: Design process of facility standard.

Actually, the birth of the facility standard is the first step in the whole process. The manufacturing of the equipment, the order, installation and utilisation of related facilities also need to be considered. Especially in some developing regions, due to their limited financial support, establishing industrial training centres in cooperation with selected industrial enterprises and universities is a good method that can kill two birds with one stone. On the one hand, students can taste the new technologies and learn some forefront information which can maintain the balance between theory and practice. On the other hand, many more schools can share the material resources at one or more common locations so that more students can obtain the opportunities to enrich their hands-on experience. According to the facility standard, these schools can equip with the fundamental facilities to meet the basic and daily teaching needs. For advanced content, they can conduct the teaching in industrial centres that provide shared facilities.

CONCLUSIONS

In reviewing the history of technology education on the Chinese mainland, it is not difficult to find that development of facilities for technology education mainly depended on political and economic factors at the beginning. Upon the birth of the new technology curriculum, the design and manufacture of facilities started to gain more attention. Officials and educators started to devote time to designing the facility standard.

Starting from scratch, facilities for secondary technology education on the Chinese mainland have developed into a workshop-style and industrial centre model. This development is a big stride in technology education history, especially the birth of some regional facility standards. Due to the different economic levels and curriculum implementation situations, the final universal standard must be designed in different grades to adapt to different regions.

In summary, considering the wide scope and rapidly changing curriculum content, the workshops should be designed in different styles that conform to the different modules. In addition, industrial centres should be established for the sharing of facilities, especially for sharing expensive facilities in more deprived regions. In view of the extreme tendency and over-emphasis on information technology, cooperation with some enterprises and designing some projects in combination with information technology and general technology are the ultimate solution on the Chinese mainland.

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