

Articles

Designing Technology Education at the Junior High School Level: Propositions from the French School Curriculum

By Lebeaume Joël

Joël Lebeaume is a professor at the École Normale Supérieure of Cachan. His research is focused on technology education from a didactic point of view at the Unity of Research in Scientific and Technology Education (UMR STEF ENS Cachan INRP). He has been a member of the "Technology" working group with the Ministry of Education and has participated in the examination and review of new programs in the area of technology education.

In France, technology is a compulsory school discipline at the junior high school level (ages 11-15). Technology studies were initiated at the beginning of the 1960s when school attendance until the age of 16 became mandatory and when it was decided to delay vocational training because of the irreversible drive towards technical modernity, a tremendous cultural and social upheaval, and a dire shortage of technicians in France. Designing and implementing this new discipline, however, could not happen spontaneously; it required the appropriate tools, in addition to ideas, in order to develop and coalesce the various suggestions, identify likely consequences, and propose a coherent structure. Across the world, technology education systems vary depending upon political, economic, and technical contexts, etc. (de Vries, 1994; Foster, 1997; Zuga, 1997). These differences are also tied to the historical forms of this subject matter, such as industrial arts, design, and arts and crafts, and the relationships held with other disciplines in the educational curriculum. Moreover, they depend upon the philosophical precepts inherent in the definition of the discipline, that is, content-oriented vs. student-oriented.

Within the French context, research on the history of this discipline (with a focus on manual work) provides insight into the fundamental issues of its place in the compulsory general school curriculum. Such research has provided the basis for suggesting a number of tools for

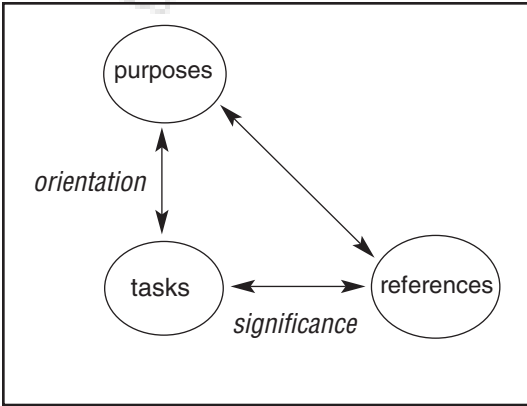
identifying relevant proposals from recent technology education programs (1996-1998).

This historical inquiry examines two main periods of school organization in France. The first concerns the period 1880 to 1960, during which primary schooling was opened up to the entire population. The second is the period 1960 to 2000, when the school became an educational system and when the junior high school progressively filled the role of middle school. During both periods, the technical world was represented first by means of manual work and then with technological instruction. This historical approach serves to develop a didactic frame of reference specifically regarding prescribed course content and curriculum organization (Lebeaume, 1996, 2000). The two aspects are indeed similar due to the context of compulsory teaching within the general education system.

Manual Work at the Primary School Level

For the past 100 years or so, manual work has been prescribed for boys and girls at the primary school level. The name of this discipline has been modified over the years: manual and experimental work, manual activities, manual educational activities, manual work, handicrafts, etc. These changes are the consequence not only of evolution in the pedagogical conceptions of children and pupils and of their learning, but also in the social roles of men and women. In order to identify the various forms of this discipline, it becomes necessary to characterize the predominant prototypical situations encountered in teaching-learning. A prototypical situation is characterized by the tasks, their significance, and their orientation: What exactly are the pupils doing? And why are they doing it? How do these tasks refer to actual practices? Figure 1 illustrates this coherence in the reciprocal relationships between the three components of this discipline: purposes, references, and tasks.

Figure 1. Representation of prototypical teaching-learning situations: Method.



The diagram in Figure 1 depicts the coherent structure present in each form of the discipline and represents a method, which is to be defined as the special methodology of the discipline. It is necessary to distinguish between the pedagogical and didactic meanings of the methods observed. This distinction does not pertain to the relationships between purposes and means, as do the active methods (pedagogical meaning). According to the didactics perspective, the term *method* draws attention to subject content. It indicates the special methodology behind a school subject, with its features and its specific knowledge. It has been used in the past for music learning, for example, to distinguish between the marked method and the numbered method.

The various forms of manual work at the primary school level are thus: the technical elements method (e.g., series of sewing stitches for girls, or technical elements of woodwork or metalwork), the everyday items method (creation of objects, such as pillowcases, boxes,

or tablemats), the geometrical elements method (drawing shapes, folding paper), the amusing things method (toys, dolls, etc.), the logical elements method (graphical representation of threads in braiding, weaving, etc.), and the technical projects method (process of producing technical objects). Each of these methods is represented in the chronological diagram in Figure 2.

The main differences between these historical forms of manual work depend on both the tasks and their references. Some tasks refer to domestic practices, whereas others relate more to workshop activities or industrial jobs and still others to entertainment practices. The significance ascribed to the tasks influences them via systematic exercises or practical activities. Task objectives are also contrasted when it comes to learning technical matters, scientific or mathematical knowledge, understanding the psychological development of children, and discovering the technical world. Without necessarily being aimed at pre-professional training, these purposes were all quite different. Coherence has thus been defined in each of these prototypical situations, as identified respectively by the corresponding methods.

Technology Education at the Middle School Level

The history of technology education since the 1960s also reveals the distinct methods employed at the junior high school level. In the past, it had been organized according to a succession of methods, each featuring special attributes (see Figure 3).

Figure 2. Successive methods throughout the history of manual work in primary schools.

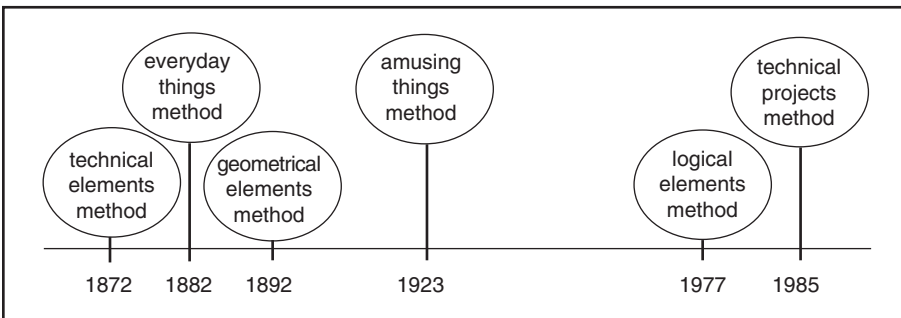
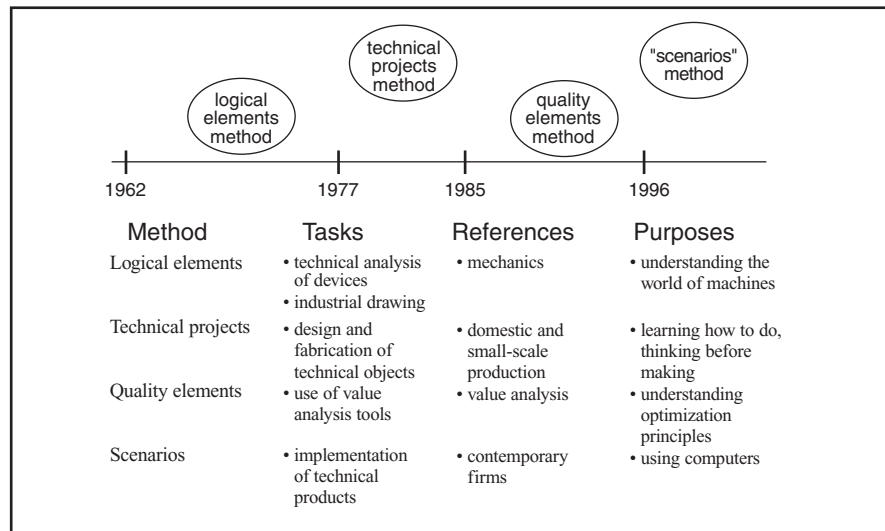


Figure 3. Methods used in the history of technology education for middle schools.



According to these various forms, technology education may be defined as a component of general education without the goal of being or becoming vocational training. Rather, it is intended as a discovery or initiation to technical practices in order to better cope with and act within the technical environment. Technology education has also been constituted as a requisite school discipline for identifying future jobs and professions.

The successive forms of the discipline at both the primary and middle school levels reveal an alternation in the methods adopted. Two types of methods can be distinguished: syllabic methods and global methods. The first are defined merely by elementary efforts or notions along with the pertinent scientific references, whereas the second are defined by the production of basic objects adapted for the students' comprehension. The first are devoid of any technical significance, whereas the second imply a translation for youngsters of real-world practices as a means of proposing technical educational experiences. This alternation is a sign of the instability of technology education in schools, which often tends to become a series of lessons with a pencil and paper but without authenticity or connection to real-world technical practices.

Main Theoretical Issues

The historical analysis of this school discipline raises three main issues with respect to designing technology education within a compulsory general educational context:

1. How to handle the interactions between knowing and doing in order to design an academic discipline based on reasoning and action.
2. How to harmonize the diversity of technical practices in designing a general school discipline.
3. How to maintain relationships with current social and technical practices so as to provide pupils with genuine interpretations of the technical world they will be required to understand.

These three main issues are fundamental to the design of an elementary, progressive, and general approach towards a whole range of situations combined into a single school discipline under the generic label *technology education*.

Designing the Foundations of Technology Education

The diagram in Figure 1 serves as a base to query the foundations of technology education. Which tasks are appropriate? For which purposes? Which references apply to the set of tasks? The choice regarding references and purposes depends on educational policies aimed at training young people as individuals, citizens, and future members of the workforce. The choice of industrial practices as references is directly linked to the conception of the future from a social and economic standpoint. Is it important to initiate entrepreneurship (Raat, de Vries, & Mottier, 1995), to develop a critical point of view (Deforge, 1993; Petrina, 2000), to promote scien-

Table 1. Comparison of T/M/S Content Standards

Area	# of Stds	Second Level (9-12) Statements	Grade Bands	Date Issued	Web Site
TECH	17 cognitive 3 process	51 cognitive 15 process	K-2 3-5 6-8 9-12	2000	www.iteawww.org
MATH	5 cognitive 5 process	71 cognitive 18 process	PreK-2 3-5 6-8 9-12	1989/2000	www.nctm.org
SCIENCE	7 cognitive 1 process	27 cognitive 2 process	K-4 5-8 9-12	1995	www.nas.org

tific and technical progress, to maintain the technical heritage, to generate new individual or collective skills, etc. Within the French context, history has demonstrated the various choices made over the past 30 years: to enhance the condition of manual workers; to generate enthusiasm for technical jobs; to fulfill the broad-based needs of technicians, marketing professionals, and engineers; to inform customers; etc. The question of why technology education should be included within the compulsory school curriculum is linked to the question regarding references that entails contemporary firms, mass production, workshop activities, etc., as well as to that regarding the choice of fields of technical practice such as mechanics, electronics, economics, and automation (Martinand, 1995).

In relation to the previous choices, the fundamental decision about curriculum would thereby constitute the main type of approach. Would this be a production approach; or an investigation approach of processes and devices; or an analytical approach of quality, objects, and products; or another approach altogether? Depending on the decisions concerning the three method components, a different technology education comes to the fore with a distinct set of contents. The discipline could consist of an experimental technology education, a practical technology education, a design-process technology education, a problem-solving technology education, a creative technology education, and so forth.

In France, the preferred approach has always been to rely upon project-building adapted to the pupils' ages. This decision, however, requires a conceptual framework in order to describe the nature of the school tasks

assigned. In technology education, tasks must integrate material of a technical nature, which has been defined from three components (Combarnous, 1984): objects, technical thinking, and specialized roles. Put otherwise, a technical task arises when pupils are confronted with objects (machines, materials, documents, etc.); when they are asked to design, produce, or, more simply, act or carry out as efficiently as possible; and when they play a technical role such as engineer, technician, or technical agent in a context of teamwork. Nevertheless, this project development approach merely involves a few genuine encounters with the technical world without the intention of training project managers or specialized agents.

These encounters with the technical world via a project development approach then serve as a means for interpreting real technical processes and products. School projects enable not only the generating of vital concepts for examining technical reality, such as quality, value, cost, market, organization, and technical standards, but also learning some machine and computer operating skills.

While concrete technical achievements lie at the core of technology education, the use of computers is very closely related therein. Learning how to use computers thoroughly is essential for future generations. Technology education has the obligation of teaching these multiple computer uses (word processing, spreadsheet applications, database management, computer-assisted drawing and manufacturing, communication applications, etc.). One aspect of these programs is centered directly upon the

acquisition of such knowledge. This aspect does not fall into the realm of information sciences but rather of information technology, as a result of the technological point of view inherent in this systematic learning approach. However, information technology does not span the domain of the unconscious use of computers. To handle these machines better, practical familiarization does not consist solely of hands-on use but includes reflexive practice as well. Learning is organized by virtue of progressive exercises aimed at understanding how to use computers and how to open, enter, select, locate, save, store, and retrieve files. These capacities must be taught so as to remain with the pupil for future activities and to assist in day-to-day life. Pupils need to know about systems and principles of data processing and assimilate these processes in order to identify the advantages and limitations of data-handling programs or choose from among a set of programs. They also have to build an effective model for dealing with computer-related tasks.

Designing the Organization of Technology Education

Designing the organization of technology education within a general educational context raises two major and interrelated issues: how the program is to be defined within the framework of elementary learning and how its progressive evolution is to be organized. Focus then turns to the schedule of technology education courses during the four-year junior high school curriculum.

Given that school disciplines are defined simply by a sequence of knowledge acquisition, it is customary to divide the contents into a number of small chunks and then teach them one after the other. Mathematics or grammar lessons, for example, are typically organized around this principle from the simplest to the most complex. In contrast, for technology education (and for that matter for sports and artistic education as well), specific content components cannot be separated into smaller chunks. In the past, this tendency to define technology education as a cumulative discipline distorted its foundations and the school subject got directed towards applied sciences or geometry.

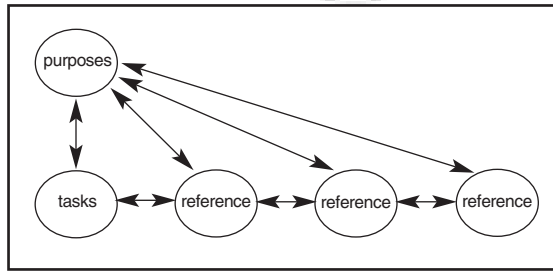
In order to maintain its foundations, technology education must generate prototypical teaching-learning situations from tasks featuring a real technical nature. Defining an elementary school discipline implies choosing technical experiences adapted to the pupils (i.e., enabling them to live a series of adventures shaped by objects, efficiency, and roles). It is also necessary, however, to organize these experiences within a coherent sequence throughout the schooling period.

The history of technology education reveals several principles for determining the progression of the curriculum. The first one consists of repeating the same process in different technical experiences throughout the junior high school program. This principle is at odds with the purpose of technology education by virtue of the tendency of such training to produce project managers. The second principle consists of introducing these school experiences gradually with more open-ended tasks: resources are increasingly scarce, technical projects are increasingly complex, and constraints are increasingly present. This principle corresponds with the definition of technology education as both a school discipline that contributes to developing problem-solving skills and a pedagogical means for nurturing the pupils' psychological skills. The third principle consists of defining just one generic technical area and then progressively introducing new and broader tasks. In the past, the areas of woodworking or metalworking and the realm of mechanical practices constituted these generic references, which provided an overview of the entire array of technical practices. This choice, however, does not comply with the purpose of unspecialized education because of its tendency of becoming more of a vocational training. The fourth principle consists of varying the references from more familiar to more unknown domains, for example, from the home to firms or from domestic practices to industrial practices. This principle is typically applied at the nursery school and primary school levels, where discovery of the world initially proceeds from commonplace tools and familiar objects. The fifth principle consists of proposing different technical experiences encompassing a wide diversity of

social and technical references. As an example, the program prescribes technological activities in sewing, cooking, building, electronics, and mechanical assembly. Comparison between these contrasted experiences then enables identifying the consistency of the technical process or tasks along with their technical features. This principle, however, has more to do with planning than with a progressive pace to the instruction. Keep in mind that progressiveness pertains not only to the temporal organization but also to the way in which pupils progress with their learning.

The choice of which principle to employ in setting up a general, elementary, and progressive technology education depends on the purposes inherent in the school discipline. Within the French context, the principle of elementary teaching entails defining project-based accomplishments, whereas the principle of progressiveness implies distinguishing tasks according to the three junior high school degrees. During the first degree, the principle dictates a year of technical initiation in order to acquire basic knowledge of the equipment and techniques, coupled with the implementation of tools in mechanics and electronics and an approach to product marketing. The two years making up the second degree represent a period for gaining technical experience. Each year, pupils are required to experience two contrasted project sequences (to be chosen from among the following: assembly and packaging of a product, mass production after prototype-building, design and building of a prototype, product testing and improvement, diversification of a product range, and service provision). During these project-directed activities, pupils are asked to perform several tasks with references to various types of actual firms or companies (industrial or service). The mass production scenario, for example, proposes different tasks, including the temporal and spatial organization of production, cost calculations, and quality control. During the second year of the middle degree program, the service provision scenario offers new activities: a needs-based study, planning and organization, definition of functional purpose, cost estimation, etc. During the final year of the third degree, pupils are assigned to implement

Figure 4. Differentiation and comparison of different technical experiences.



a technical project comprising four main stages: market study, solution search, production, and dissemination.

Throughout the junior high school curriculum, therefore, the principle of progressiveness takes the form of differentiation-comparison (see Figure 4). The first degree provides the basic background of school-based technical activities. The middle degree is centered on the analysis and comparison of technical experiences in the aim of developing a process model. The final degree enables consolidating this general process model and building upon the knowledge and know-how previously acquired.

This progressiveness has been chosen in order to add greater consistency to the school discipline. Technology education is a discipline of experience and not one of content. If the curriculum is defined first by a list of skills, talents, or capabilities, this discipline could be progressively organized around a series of graded exercises, yet the pupils' activities would be insignificant.

In order to comprehend the technological world and act within it, in order to identify relationships between products and human needs, and in order to know how solutions are chosen at different stages of the design process, production cycle, or sales chain in light of technical, human, and economic constraints, technology education focuses on development activities that provide pupils with practical experience and a conceptual framework for describing and analyzing the technical and economic world around them. Such project-oriented activities are then progressively compared and refined by the pupils themselves (Lebeaume & Martinand, 1999).

Designing the Implementation of Technology Education

Thanks to its various features, technology education only exists in the classroom in the presence of teachers and pupils. This truism, however, implies two critical points:

- A program structure in compliance with a standard and a prescription that incorporate the innovation necessary to develop the school discipline and that allow for different types of implementation, depending on both the context and the heterogeneity of the student body.
- The choice of the contents of teacher training in order to enable teachers to discuss their teaching, according to the features and the principles of the school discipline, and to provide their classroom presentations with responsibility and awareness.

The French educational context, which features a national curriculum determined by the Education Ministry, acts to influence the structure of teaching standards. As opposed to the UK, for example, the French system does not include a national assessment based on standards for each year and for each program component. According to pedagogical tradition, technology teachers implement their discipline with a wide degree of freedom. They are allowed to draw up their lesson plans and orient their teaching in a way they feel to be the most effective. It is thereby essential for learning assessment to be integrated into the foundations of the discipline. Technology education, defined as a discipline structured by technical experiences and practical tasks, requires an assessment in accordance with this set of principles (Lebeaume & Martinand, 1998, 2002). New programs identify three components in assessing pupils: participation and involvement within a teamwork setting associated with a project assignment; skill development associated with these particular tasks; and mastery of a few basic skills required for all pupils upon completion of each degree, in order to pursue the next higher degree program. At the end of the middle degree, they must be able to use measurement tools (e.g., electrical regulator, sliding gauge), operate equipment (e.g., soldering iron, drilling machine), and be comfortable with presentation tools such as scheduling or matrices. In addition to the know-how acquired, a certain amount of knowledge, not defined in words but in ideas,

proves necessary to querying, understanding, organizing space and time, and making choices. From this perspective, examples include syllabus notes, production plans, design proposals, market studies, cost estimations, and product life cycles. Upon graduation from junior high school, the student assessment calls for the presentation of a technical project as a means of explaining decisions and choices and of using computer-assisted tools. Students are asked to establish a relationship with their work and the corresponding technical reality and then to produce an explanation that includes notions such as value, flux, (needs defining) constraints, standards, functions, and market. The complementarity of these three components of the assessment serves to maintain consistency in the discipline. Since project tasks lie at the heart of school activities, the experiences turn out to be more educational than merely skill-building or knowledge-building. Assessment is to be fundamentally included within the school discipline.

Implementation of the discipline also requires compatibility with the highly distinct set of school parameters: facilities, environment, organization, timetable, teachers, and pupils. The “technology” structure needs a certain degree of built-in flexibility. This characteristic is apparent by virtue of the decisions required by the teacher in the choices available as regards technical project components. Teachers have to choose two scenarios from among the three, with this choice depending on the local context. They must also decide on the technical product, the resources allocated, the conditions or constraints, and the stated goals and references (small vs. big firms, familiar or not to the pupils, overlapping or not with school practices). These multifaceted choices thereby generate diverse combinations of the organized tasks and different approaches to technology education. Among the range of technology education formulae, the organizational framework facilitates the maintenance of consistency within the discipline.

However, the existence of this discipline also presupposes new perspectives opened by means of controlled innovation. A school discipline cannot simply reproduce the same activities anytime and anyplace. Hence, innovation within the predominant framework offers significant potential for updating and shaping the future of technology education.

The contents of technology teacher training display the consequences of the fundamental principles adopted by new technology education programs in France. These contents can be organized around three main themes:

- Knowledge of the programs and of the discipline, for the purpose of identifying the broadest decision-making spaces.
- The skills involved in the pedagogical implementation of tasks and activities in conjunction with pupils, facilities, etc., to enable teachers to provide technology education, regularize teaching situations, adapt situations by taking account of pupils' reactions, institutional requirements, etc.
- The skills necessary for critiquing the relevance of academic situations in order to control the technical nature of pupils' tasks, discuss their significance with respect to external references, and defend their orientation in light of the purposes. This aspect relies upon negotiating with the method, its three components, and their relationships.

The contents of this didactic teacher training are not organized into syllabi of vocational techniques, but rather as the ability to deliberate about technology education in its current configuration and perspectives. Technology educators, defined as the specialists in this branch of

teaching, are required to possess expertise in all aspects of the school discipline for which they have been assigned responsibility.

Method Employed at the Core of Technology Education

To conceive of technology education today as a disciplinary curriculum requires certain conceptual tools in order to identify key issues and make pertinent design and implementation decisions. Method provides a means for representing the objectives of the discipline in light of all its features, specific characteristics, nature, and conditions of existence. The authenticity of this discipline is fundamentally necessary because of its educational purpose in the compulsory general school system.

This analysis of the context specific to France also serves as a proposal to other school disciplines and to other countries. It clarifies the fact that technology education exhibits fundamental characteristics and the infeasibility of designing a technology education program with a model imported from another discipline. Its historical evolution and the alternation of methods have revealed the major effects resulting from its marked structural approach.

Lebeaume Joël is a professor at the École Normale Supérieure of Cachan, Paris, France.

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