

Out with the old, in with the new

Transition to technology education issues in North America

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This research:

- Provides a thumbnail sketch of the development of technology education in North America
- Analyses the nature of change from craft practice (industrial arts) to design and technology (technology education)
- Helps you to see the connection between our struggles in the UK and developments in North America.

Abstract

The change from an industrial arts to a technology education curriculum within Canada and the United States has been under way for several years. An examination of the emerging programmes reveals that, although several diverse approaches are being pursued by the various states and provinces, a number of trends and issues are emerging which highlight factors that need to be considered as curriculum development and change processes occur. Attention to these can help educators in a more successful and acceptable transition to a technology education programme.

Introduction

Technology education tends to be a programme that is set in a context. Historical development, sociological influence, economic imperatives and current educational trends interact and impact on programme form and intended student outcomes. The past several decades have also witnessed a growing influence and sharing of ideas across and within continents with respect to general curriculum constructs and programme content.

As a recent outgrowth and development of industrial arts, technology education in North America is a relative newcomer into the more traditional and well established curriculum areas in the school. Progress towards a technology education programme across Canada and the United States varies both with respect to organisation, content and implementation. Some provinces and

states have barely begun exploring changes from a traditional industry based curriculum ('industrial arts' type of programme), whilst others are well under way with a curriculum framework in place and associated courses developed or under development that reflect a technology emphasis. Resulting curricula in technology education display a diversity of content and emphasis both across and within states and provinces.

Typically, technology education is emerging as an essential part of general education for all students that can be offered at each grade level starting with awareness in the primary and elementary grades to more specialised study in senior high school. In some jurisdictions it may culminate in courses that are vocational in nature, and as such, provide specific work-related skills and competencies for entry into the labour market. Most students, though, would take courses in technology education as part of their general programme.

Definitions of technology education in North America vary, but often refer to student outcomes that address the impact and consequences of technology on individuals, society and culture; human endeavours in using, creating, organising and processing resources; using technical means to solve problems in order to meet human needs and wants; understanding, using and creating technological systems; developing career awareness; and developing technological capability. Overall, it frequently involves the study of technology as both a process and product through a systems approach and as it struggles to establish a firm footing and identity, it is emerging as a complex and dynamic area of study.

The intent of this article is to describe these developments in technology education in North America and then to discuss a number of factors that need to be considered as curriculum changes take place.

Status in the United States

With no federal guidelines, a variety of 'industrial arts' programmes have developed in the United States since the turn of the century. The various states have established

their own interpretations of this practical arts programme which have generally been based on the curriculum constructs of woodworking, metalworking and drafting, or, especially since the 1970s, the constructs of manufacturing, construction and transportation were used in a number of jurisdictions. However, the last several years have witnessed some change from industrial arts toward a technology education emphasis. In some instances, this has been nothing more than a re-labelling of the traditional programme (Clarke, 1989), but in a number of states, changes in the structure of the curriculum are very evident, and as in Canada, a variety of programmes have resulted or are developing. It should be noted, though, that there have been proponents of technology education in the United States extending back over three or four decades.

A number of significant developments have helped to focus this change toward technology education and provide curricula frameworks within which to work. The most recent of these were the *Jackson's Mill Curriculum Theory Project* (Snyder and Hales, 1981), the *Standards for Technology Education Project* (Dugger, 1985), and the development of a *Conceptual Framework for Technology Education* (Savage and Sterry 1990). The Jackson's Mill project recognised the technologies of communications, construction, manufacturing and transportation as basic to human endeavour and suggested them as the content organisers for what was then predominantly industrial arts. Approximately ten years later, with the technology education movement under way in the United States, Savage and Sterry, building on the developments in the field, proposed a technology model comprised of communications technology, physical (production and transportation) technology, and bio-related technology to be taught through an input-process-output model that addresses human needs and wants through the identification of problems and opportunities. Between these developments, the International Technology Education Association, formerly the American Industrial Arts Association, had published several documents to assist educators in the development of technology education programmes.

Recent reports of progress toward technology education programme implementation in the United States indicate a mixed response. Putnam (1990), in a survey of 49 states, concluded that technology education was moving from theory into practice, but in a variety of forms ranging from strongly vocational orientated curricula in some states to technology in others. About three-quarters of the states "reported a human adaptive systems orientation in their curriculum and 34.7% had adopted technology education as the official programme descriptor in their state" (p.8). Communications, manufacturing, construction and transportation were the most common content organisers. However, Dugger et al's (1992) survey of the status of technology education in the United States indicated that, in rank order of courses offered in the curriculum, woodworking, drafting, architectural drafting, general metals, mechanical drawing, technology education (as a course), electricity, graphic arts, communications technology, and lastly manufacturing and electronics were the top ten. Other findings (Rogers, 1992; Rogers and Mahler, 1994; and White, 1990) further illustrate the lack of acceptance of technology education curriculum in some states by the industrial arts teachers.

Dyrenfurth (1994) in his examination of the status of technology education in the United States also portrays a very mixed reaction to the implementation of such programmes as well as considerable variability both within and across states. He cites several examples of outstanding but different programmes scattered across the country, but also concedes that "not all is exemplary in the United States. One can also see teachers essentially delivering the industrial arts and even manual arts programmes based in the 1930s, 1940s, 1950s and 1960s" and rural and inner city locations are evident "where the state of the art has not advanced significantly over the past twenty years and where the level of equipment and instruction is sadly lacking" (p. 59).

Overall, great diversity exists across the United States with respect to technology education despite recent developments directed at a broad conceptual framework. Examples of programmes can be found that

continue to model industrial based elements of curriculum content and which develop in students pre-vocational, pre-engineering and or vocational skills at the senior high school level. Other programmes reflect the general education technology education approach, especially at the junior high/middle school level, with increasing specialisation within a technology framework towards the end of senior high school. Such diversity should probably be expected given the autonomy of the various states and the lack of an official national curriculum to focus efforts and direction.

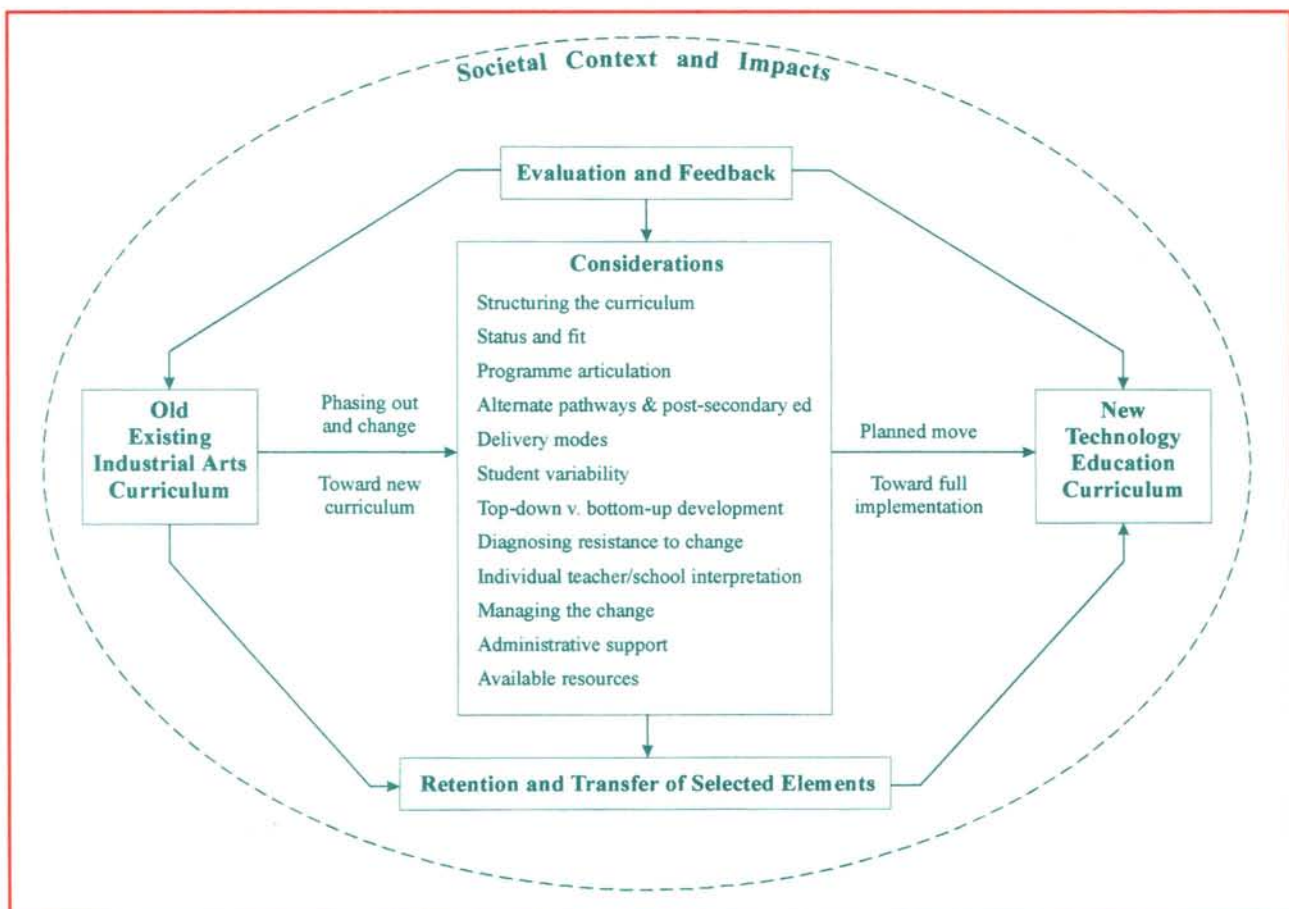
Status in Canada

As in the United States, there are no federal guidelines for school curriculum in Canada, and each province exercises autonomy with respect to educational matters. This has resulted in various interpretations of curriculum and its organisation for each school subject, including more recently, technology education.

Most Canadian provinces have had some form of industrial arts or industrial education programme for several decades that has typically been offered as elective courses to students during their last six years of schooling (age twelve to eighteen years). The majority of students though, would have taken some industrial arts (and or home economics) while in junior/middle school (twelve to fifteen year olds).

Over the past ten years, but more especially the last five, most of the provinces have, to some extent, moved toward a technology education programme (Sharpe and Hache, 1992; Chinien, Oaks and Boutin, 1995). However, traditional industrial arts content and approaches are still evident in at least three of the ten provinces; and across many others, the change toward a technology emphasis is sporadic but on the increase. The new programme names are varied, with the most common being Technology Education (in British Columbia, Quebec and Newfoundland and Labrador). Other provinces have more individualistic technology programme titles that reflect a

Figure 1: Making effective curriculum changes in technology education



somewhat different emphasis in content and direction. For example, Design and Technology along with Technological Studies are both used in Ontario; Industrial Arts Technology Education in Nova Scotia; and Career and Technology Studies in Alberta. The latter programme reflects a curriculum that encompasses a wide range of options from the practical arts (industrial education, home economics and business) areas, each of which enables a student to progress through general technology to very specific vocational content during their high school years (Alberta Education, 1994).

The emerging technology education programmes typically have courses which are organised on the more general constructs of communications/information technology, manufacturing/production technology, construction technology, power and energy technology, transportation technology and integrated/control technology. Combinations of these would form the core curriculum to which common themes such as technological literacy, problem solving, understanding technological systems and processes, and developing an awareness of the impact and consequences of technology would be applied.

Overall in Canada, technology education is developing in various forms and slowly replacing the traditional industrial arts programmes. An examination of current provincial curriculum documents (see for example, Alberta Education, 1994; Ontario Ministry of Education 1994a, 1994b; Province of British Columbia, 1994a, 1994b; and Government of Newfoundland and Labrador, 1994a, 1994b) reveals very different approaches, but also a number of common themes and content organisers. As in the United States, there is also considerable variability both across and within provinces with respect to curriculum change and degrees of implementation.

Emerging issues and considerations

Despite the differences in technology education programme development, content, organisation, interpretation and delivery in North America, it is evident that many generic issues and considerations are emerging. Figure 1 depicts the many factors

involved and the relationship of each within an overall model for changing from a traditional industrial arts programme to one that encompasses technology education. Within such a model, it should be noted that:

- The change operates within shifting socio-economic and political contexts that impact on vital elements within the model.
- Considerations will have to be prioritised within a given context and plan of action for change.
- There is likely to be substantial interaction between each of the consideration elements.
- Evaluation and feedback needs to occur as the change takes place in order to assess progress and take corrective action.
- The overall curriculum change should operate within a planned time frame (short and long term) that allows for each element to be considered.
- The retention and transfer of selected elements of the old programme into the new will impact the new curriculum outcomes.

Structuring a curriculum that offers appropriate technological experiences

Determining the structure and organisation of a technology education programme is a complex task as evidenced by the many different programmes emerging in North America which reveal numerous interpretations, constructs, organisers and content. Within many individual states and provinces a rationalised curriculum structure has emerged based on a variety of processes that have typically engaged technology education and other professionals in 'consensus developing' techniques. Thus 'expert' opinion has often contributed substantially to what are determined to be appropriate parameters (including goals) for detailed curriculum development.

Choices and eventually consensus enable different jurisdictions to focus curriculum development in various ways and to eventually translate the broader constructs into student outcomes, courses and teaching processes. It is important to rationalise such choices in terms of 'selling' the new curriculum and obtaining necessary resources for curriculum implementation and operation.

These developmental processes can be enhanced in a number of ways that include piloting and trying out new content and approaches; giving careful consideration to adopting or adapting technology education curriculum from other places (including other countries); involving a variety of stakeholders in the developmental processes; and meeting with teachers to gauge reaction and obtain professional opinion on new curriculum. Appropriately timed research efforts can further contribute information for improving or changing various aspects of a new programme.

Another interesting option is to allow local school jurisdictions autonomy and curriculum interpretation within a well defined curriculum structure. For example, in Ontario the onus on detailed programme development and operation resides with individual school boards (local education authorities) in cooperation with all the stakeholders in the system. Technology education guidelines are provided by the local government that include key curriculum constructs, goals and objectives that must be addressed together with suggested processes for developing various courses (Ministry of Education, 1994b). In other places in North America, individual schools can develop 'local' technology education courses that enable educators to offer curriculum content not prescribed by the province or state that fits a particular set of circumstances and is deemed more appropriate for students in that location. Such an option though, is probably best operated through some well established guidelines and approval process that keep these courses within the general bounds of a technology education curriculum.

How and where technology education fits into the school curriculum

An overall analysis reveals the dominant view, both within Canada and the United States that technology is a vital component of the school curriculum. It is also generally recognised that technology forms the core of a discrete area of study as well as an element that cuts across and through the whole school curriculum. In other words, its pervading influence and importance is widespread; and even with a separate technology curriculum, it is necessary to recognise this importance and allow for the inter-connectedness of other curricular areas with technology as a common thread. For example, when we are using or creating a technological process to design and produce something, maths, language, social studies, science and other skills may be employed and societal and or environmental impacts considered as part of the technology education programme.

Although some countries have compulsory elements of a technology education curriculum throughout the regular schooling years, the most notable of which is found in the United Kingdom (Department of Education and Science, 1990), the norm in North America appears to be a recommended compulsory component of technology education at the junior high school level that has a discrete curriculum content, yet is inextricably linked through concepts and processes to other areas of the school curriculum. This core may also continue in many jurisdictions into the first or second year of senior high school through grade ten and/or eleven, but more often as an elective. Generally it is recognised that all students should continue to study technology beyond the middle school years, although it should be noted that such a notion was much less evident in the more traditional industrial arts programmes in North America.

Delivering technology education through other disciplines is an option, but in North America tends not to be the case beyond the primary and elementary years. In a number of instances, curriculum documents use programme descriptors such as 'science and technology', especially in the middle school. Yet, although the links

between these are easily recognised as valuable and complementary, each typically receives separate treatment and is broken down into discrete subject content areas that respect each discipline. In technology education therefore, the emphasis is on developing such things as technological literacy, skills and processes where these are the primary function of the curriculum rather than having parts of these used as a means to deliver the content of other subject areas (such as science). The latter approach, although perhaps beneficial to learning, tends not to do justice to technology education as a core component of schooling, and overall, technology education goals and objectives become very much a secondary, almost incidental outcome under such circumstances. So, although the links between subjects such as science and technology need to be fostered (to the mutual advantage of each), teaching a technology programme through science as a vehicle would simply not do justice to the technological components and essentially treat it as a 'distant cousin'. The exception to this, as described later, would be in the first few years of schooling.

Typically in North America, compulsory schooling ends at age sixteen. However, most educational jurisdictions encourage students not to leave school until they have graduated with a high school diploma which means the completion of grade twelve at age eighteen. Traditionally, the old industrial arts courses have provided elective credits toward such graduation, but were not part of the core requirements such as maths, science and language. With the introduction of technology education, there has been a growing recognition of selected courses in this new discipline as part of the core requirements for graduation (see for example, Government of Newfoundland and Labrador (1995a) and Province of British Columbia (1994b) curriculum guides). This not only helps to raise the status of technology education programmes, but broadens the graduation options for many students, and may directly or indirectly contribute to student retention through to high school graduation.

Articulated technology education experiences

The issue of where technology is best situated in the curriculum and to what extent it should be emphasised is a pertinent one. An examination of current and proposed technology education programmes, both in the United States and Canada, suggests that it should be a core part of the curriculum for all students. If we accept this premise, then the key questions to address are at what grade levels should it form part of the core and what should be the outcomes (student competencies) at each stage? The most popular approach is a gradual, but mandatory, introduction of technology in the primary and elementary grades within or as an integrated part of other subject areas ('introduction to' and 'awareness of') followed by a more specific core technology education curriculum during the middle school years that has distinct organisers and content. The latter makes sense and is a logical time to expose all students to technology as a discipline, given the typical shift in curriculum emphasis during this period of schooling (after grade six) to subject/discipline based content. Technology education as a core area can then be continued at least through the first or second year of senior high school (grade ten and/or eleven) with elective offerings thereafter which allow for a continued general programme and or more specialisation based on student interest and need. Some technology education curriculum allows for optional broad-based or specific vocational content through the senior years (*see Figure 2*).

A further implication of a continuum of technology education curriculum components through kindergarten to grade 12 is that of articulation and progression in terms of courses and content. It should be noted, for example, that the processes of problem solving and design are universally recognised as critical elements of delivery in a technology education programme at all levels and often touted as generic skills for all students. To introduce them at an earlier level would be a logical move to make and also enhance the concept of articulation and connected experiences. Along the same vein, keyboarding and other basic skills related to computers and computer technology within information and

communication technology strands are rapidly becoming vital competencies for students to learn early in their school career. It is therefore important to establish a continuum of technology education experiences and adjust the curriculum accordingly for prerequisite experiences and progression. Attention to such details considerably enhances the overall strength of a technology education curriculum.

Articulation also includes a logical progression and flow in how technology education is taught at various levels in the school system. This is especially important to consider between key transition points in the kindergarten to grade twelve educational system. Many students, for example, move to a different school after elementary, and at that point the curriculum becomes much more compartmentalised and taught by 'subject' teachers. In the case of technology education, approaches would change from integration and thematic to a structured technology curriculum of specific courses offered within specialised facilities.

Making allowances for students of varying aptitudes and ability levels

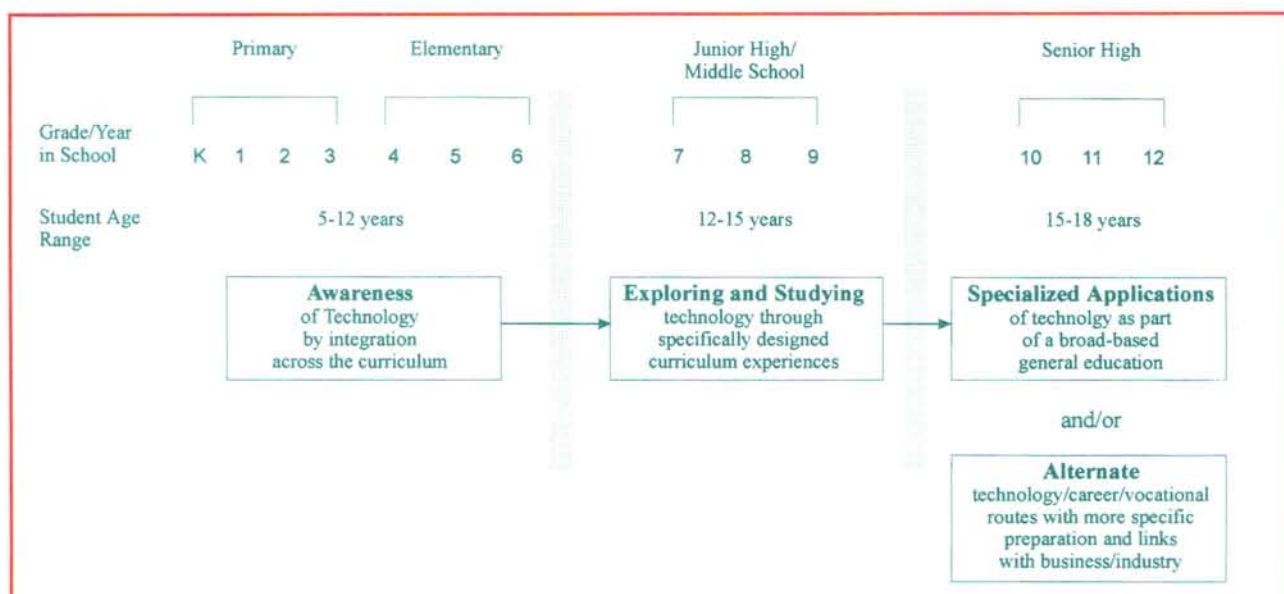
Students with special needs have continually been a specific concern and challenge for teachers regardless of subject area, and with the emergence of technology education and change from industrial arts, some concern has already been expressed by the field that increasing academic requirements are becoming one of the

problems with respect to acceptance and implementation (Dugger, et al., 1992). It is therefore important that curriculum developers in technology education be aware of this and not make the subject an exclusive domain for some students and not others. Choices and options need to be considered that address the needs of a diverse range of students.

The more complex, yet apparently functional forms of technology education programmes tend to have common themes that are applicable across all courses as well as levels of achievement (outcomes) that allow for varying degrees of student progress in each course. The former provides a common thread through the whole technology education programme, whilst the latter (levels of achievement) would allow any particular course (or parts of courses) to be offered at a level of complexity commensurate with student need and prior achievement and thus challenge them appropriately.

Within specific technology education courses therefore, each of the various components would best have stated outcomes which range from the simple to the complex as well as alternate activities. This would provide flexibility within the programme courses to enable learners of differing ability levels, or varying degrees of previous experience with selected aspects of the courses, to work at an appropriate level.

Figure 2: Technology Education Curriculum Delivery Continuum



In the latest British Columbia technology education framework documents specific reference is made regarding students with diverse needs with suggestions that adaptations should be considered to the learning environment, presentations, materials used, methods of assistance, delivery approaches and ways in which progress is assessed. (Province of British Columbia, 1995a, 1995b). Another province has started to address the issue by stating low, medium and high order outcomes for each curriculum objective in a technology education course (Government of Newfoundland and Labrador, 1995b).

There may, however, be limits to what can be achieved, but curriculum approaches can be devised that will enable most students with diverse needs who are accepted (or integrated) into regular school situations to experience meaningful activities and development through technology education activities. The key is to challenge students appropriately, provide teachers with alternate strategies (and training), and also ensure that assessment procedures take into account individual student progress.

Providing alternate pathways for students within the senior high school including articulation with post-secondary education

Although a general technology education programme route through school can benefit most students, alternative pathways for those in senior high are often most appropriate for specific groups of students and thus should be considered. Such pathways could lead directly into employment (vocational preparation), a university or college programme (as pre-requisite or preparatory courses), or foster partnership linkages with business or industry. Also, as indicated earlier, several of the practical arts areas could collectively constitute a programme that would provide students with an array of choices and options to pursue.

The vocational pathway has the potential to provide some students with employability skills and thus enable them to start work after high school and/or continue with training in the chosen career field. An extension to this route would be an

articulated apprenticeship programme that would enable students to obtain credit while in high school toward a three or four year apprenticeable trade qualification (journeyman). This obviously has implications for school facilities and teacher qualifications that would have to be carefully assessed.

Another possible application of senior high school technology education courses in North American schools could be toward admission into specific post-secondary institutions, that is, recognition of technology education courses as legitimate components for entrance into university or college programmes, and/or the granting of advanced credit toward, for example, a degree or diploma programme. Options and developments in this regard might include the collaboration of post-secondary educators in the formation of high school technology education courses, especially with respect to content and processes that could enhance the educational progress of students upon completion of schooling.

Some schools cannot afford pre-employment or vocational programmes at the senior high school level. Therefore, the vocational extension of technology education evident in selected states and provinces can be achieved to some extent, not through specific vocational facilities in high school, but with additional high school curriculum options in partnership with the post-secondary system which can, for some students, link their experiences in technology education with more specific career orientation in the latter year(s) of schooling. A further extension of this notion would be to extend some of the senior high school technology education courses (or parts of them) into local business and industry through partnership arrangements, and thus expose students to aspects of technology not available in schools in a more cost effective and meaningful way. Such an approach could also build upon already established trade and industry, co-op, youth apprenticeship or work experience programmes currently in place in many schools.

Appropriate delivery modes

One of the most vital features of the traditional industrial arts programme was that it allowed students to learn through hands-on manipulative skills. It was evident from an analysis of North American programmes that curriculum delivery was heavily oriented to hands-on, kinaesthetic experiences both in Canada and the United States. This was apparent at all grade levels to some extent, but very pronounced at the junior and senior high school levels.

The hands-on approach is obviously not new, but a valued retention of the strategy that was popular in the former industrial arts programmes. It is also a strategy or learning style that recent surveys of large numbers of senior high school youth indicated a strong preference for (Sharpe and Spain, 1991). It is therefore apparent that specialised facilities are needed for technology education programme delivery, especially at the junior and senior high school levels. Such facilities need to be designed to reflect the nature of the curriculum and the various content organisers used as well as promote the hands-on nature of curriculum delivery vital to this area. However, such specialised facilities would not necessarily be needed at the primary and elementary levels where only selected resources and equipment would suffice rather than having a specific facility for the technology education components (which would almost certainly be taught within the existing framework of other curriculum areas).

It is important though, to consider the nature and sophistication of the tools and equipment used in the delivery of a technology education programme and utilise what is appropriate, given the curriculum and intended student outcomes. Installing expensive 'high-tech' equipment, although attractive, does not necessarily achieve this. Many of the fundamental underlying generic concepts, principles and processes can be taught with modest investment in basic tools and equipment.

Almost without exception, some form of student oriented design and problem solving processes are common elements in the delivery of technology education programmes, a sharp contrast from the

traditional industrial arts related project approach that was often teacher chosen and directed. Such processes are considered fundamental to a technology education programme and provide a flexibility that enables students of almost any ability level to participate. They are the central focus of the technology programme in the United Kingdom, and key components of those developing in North America. In some technology education programmes, design and problem solving are considered a prerequisite to all other technology courses. However, there is a danger that teachers may emphasise such processes as research, exploring, documenting and portfolio building and then allocate relatively little time for the production and fabrication aspects of design and problem solving approaches.

There is little evidence of states and provinces substituting courses in computer science or computer literacy for technology education. However, the value of computer technology and what it can offer as an indispensable 'tool' within a technology education programme is well accepted. In fact, some basic computer related skills and processes are vital in terms of accessing and processing information, performing routine tasks, learning from simulation, etc. for all students regardless of the curriculum area or subject. However, simply having computers in a school, or courses in computer applications does not constitute, or substitute for, a technology education programme.

Individual teacher/school interpretation

Even with a well established technology education curriculum framework, various interpretations are likely to occur at the school level. Administrators are in a position to influence which aspects and parts of the curriculum are implemented and emphasised along with the timetabling of students into classes. Teachers, probably the greatest strength or weakness in terms of curriculum implementation, will bring to the delivery process their own attitudes, preferences, competencies, strengths and shortcomings. All will impact (positively or negatively) on the technology education programme students receive, as visits to a random selection of schools will verify.

Some mechanism (department head structure, subject coordinator, district manager, etc.) may therefore have to be established, if not already in place, to address such issues and help identify strategies to assist individual schools and teachers as well as facilitate professional development activities where applicable.

Managing the change

Various states and provinces are managing the move to technology education through a number of strategies that typically involve, for example, the development of a structured curriculum, dissemination of information to stakeholder groups (including parents, students, school administrators, teachers and school board members), phasing in curriculum change, teacher in-service, and developing resources. Ideally, actions should be carefully organised and coordinated as the new curriculum changes are implemented. Unfortunately, this is seldom the case.

Additionally, teachers need more than information and copies of new curriculum outlines when major changes take place, and as a result, a number of states and provinces have responded by providing detailed teaching guides and varying amounts of in-service activity. The latter, often conducted through local school boards, provincial or state coordinators, or through subject (technology) specialist teacher organisations helps to address the feelings of teachers (and others) about programme changes, helps provide new skill and competencies required, orientates people to new curriculum, and can be used to address new (different) teaching approaches. It can also help alleviate fear and apprehension about change that typically increases with age. The actual quality of such in-service is of critical importance: organisation, timing, content, etc. all play a vital role. Such experiences also need to provide alternate pathways for individual teachers to develop. Most of all, teachers need continued support over a period of time in order to adjust to new curriculum content and delivery processes.

As with any change, new ideas need to be introduced appropriately, in a timely fashion and in a way that clearly communicates

intent and direction. Especially the 'why' or rationale for change has to be tackled. Convincing others to accept new ideas is not always easy, but it helps when those most directly affected (teachers) are involved at the ground floor level. Ways and means to communicate to all the other stakeholders is a vital component in the overall scheme. The state of New Jersey, for example, conducted a deliberate, planned public awareness campaign as part of the introduction of technology education (Commission on Technology Education, 1987). Such procedures are enhanced when programme goals and objectives are written in terms understandable to both educators in other fields and people outside of education.

It is also apparent that adjustments may have to be made over time as the programme evolves and evaluation and feedback are obtained. Full implementation of a new curriculum area is often a lengthy process, and unless firm, long term commitments are in place, local government policies, securing resources and other influencing variables could change and disrupt an otherwise carefully developed plan of action.

Implications of a top-down versus a bottom-up model of curriculum development and implementation

Key ingredients of effective curriculum change are involvement and ownership. Recent surveys of the technology education movement in North America continue to affirm this and that the processes must involve those most directly affected. For example, Oaks (1991) survey of technology supervisors across the United States indicated that state department of education personnel should take a lead role. He concluded that this group "did not generally see university personnel or local education administrators as strong proponents or leaders in the transition to technology education" (p. 71), but they did acknowledge their own vital role, along with that of teachers, in technology education curriculum development. Volk (1993) also indicated from his survey work that curriculum changes mandated through a top-down model were less likely to be seen as relevant by classroom teachers.

Curriculum development and implementation strategies should therefore, where at all feasible, include teachers and those working most directly with them. Use of empowerment, a process "where leadership is pushed down to the level where action is most appropriately applied" (Wennig, 1995, p. 533) would be applicable under such circumstances. Teachers could, as some currently are in a number of states and provinces, continue to be effectively involved in such activities as developing the philosophical base, writing curriculum content, pilot testing courses, developing teaching materials, and evaluating initial delivery efforts. Such collaboration, endorsed by those with the overall responsibility for a new curriculum, provides an example of the more effective bottom-up model of development.

Diagnosing resistance to change

If technology education is to become widely accepted in North America, then identifying obstacles and overcoming resistance to change is a critical programme implementation issue. As indicated earlier, some recent research revealed a lack of acceptance of technology education by large numbers of former industrial arts teachers in some states. Specific reasons for this were not identified, although according to Rogers and Mahler (1994), in-service training programmes had helped with acceptance levels. Further improvement may therefore be, in part, a function of time and continued involvement in similar professional activities.

It is also apparent that well established older teachers may take more time and need more help to change their attitudes and accept a technology education programme. For example, the research of Dyrenfurth, et al. (1993) in an examination of part of the transition process to a technology education program in Illinois found, amongst other factors, that age of teacher respondents differed significantly in terms of the degree of change being made: younger teachers were not only more readily accepting of the change, but also, forming the core of the exemplary teacher sample within the study. However, it was also noted that such teachers were generally in a less powerful position in the school system.

An implication of this is that teachers with many years of exposure to the delivery of industrial arts programmes will likely find the change to technology education a more difficult and lengthy process. In fact, Rogers (1992) found that a number of such teachers had alternative ideas about proposed new technology education curriculum and were refocusing the programme prior to accepting it. Curriculum implementers will need to take such factors into consideration along with any teacher insecurity that is likely to result from the introduction of a new programme.

Resources available

One of the biggest and most obvious factors in terms of available resources to implement and continue to deliver technology education programmes is essentially funding. It continues to be cited in much of the research in North America as an issue in implementation (see for example, Dugger, 1992; and Oakes, 1991). Without a solid commitment to funding at different levels (government to individual school) then the pace of change can be virtually non-existent. It is also evident that resources, including funding, are not equally available, even within a particular state or province; and rural (and inner city) areas in particular tend to have more problems in this regard (Hache and Sharpe, 1993).

One other resource should also be mentioned here, that of qualified technology education teachers. Even with the best available physical facilities and curriculum, this is obviously one of the most vital components in the change and implementation equation. The situation is further exacerbated by the large numbers of industrial arts teachers in the system who have had little or no experience with most facets of a technology education programme. It is particularly a looming problem for technology education implementation at the primary and elementary levels in North America where traditionally few states and provinces have had a kindergarten through grade twelve programme. Few primary or elementary grade teachers are trained in this discipline. Also, in a number of school districts, it is not unusual for teachers from outside the traditional practical arts areas to be involved

in teaching technology education, especially those that are in the science or computer technology areas. Overall, the lack of a properly prepared teacher resource has particular ramifications for pre-service and in-service teacher development in technology education which, in turn, is tied directly to the development and acceptance of the discipline by the larger education community.

Summary

The transition from industrial arts to technology education in North America is well under way, although the various states and provinces are responding with a diverse array of curriculum structures and programmes that differ with respect to organisation, content and delivery. The overall change process from one programme to another is complex and involves many interacting factors and issues that need to be considered as each new programme moves toward full implementation. Examining, understanding and addressing such issues can provide educators with some insight into the many options and processes available and enable them to take appropriate action. This can facilitate a smoother and more successful transition and thus help in the development of a technology education programme that is more acceptable to all those involved, including the student.

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