TECHNOLOGY EDUCATION IN GENERAL EDUCATION IN FINLAND

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Summary

At the beginning of the new millennium there are plenty of challenges for development of education. One of them is modernization of practical technological education in general education schools. In Finland this area is called handicraft education.

At the moment every variety of teaching methods drawn from the entire 135-year history of handicrafts education can be seen in Finnish comprehensive schools. The best schools and teachers have modernized their teaching, but the majority still teaches mostly according to the old models representing old technology.

Technology education is principally handled by 'handicrafts.' This subject has no national systematic guidance or authorized course of development. The result is that the standard is varied and uneven. In higher comprehensive schools the situation is better than in the lower, due to the subject teacher system. Moreover, the active teachers can easily move back to the old and less demanding teaching models.

At every school stage the subject contents should move toward techniques and new technology. Teaching must be different at different school stages. 'Handicraft technology' can still be defended when it is measured appropriately. Technology education should also be extended to the upper secondary schools.

The main task of practical technological education in general education schools has been education for work. This is indisputable. As is the fact that if the respective disciplines develop and change then the contents of all school subjects need to be reviewed.

Education must be changed according to the development of society and industrial methods. Every production, handicraft, industrial and automatic culture needs to educate people for the world of work. School education must, however, at the different developmental stages of societies, emphasize different aspects. Internationalization increases the need for analyzing the global innovations in education. The aim should be to establish a common terminology as a basis for international communication.

Handicrafts was conceived at a time when the skills taught in those lessons were the basis of production culture. These skills have since been replaced by electronics, computer technology, control technology, communication technology, etc. The term 'handicrafts' has during the last 30 years also proved to be ineffective as a means of breaking down the gender boundaries. Added to this, the methods for 'technical work' in the 1980s and 1990s are no longer applicable in the new education culture.

At the same time, when the contents of practical technological education come under review, the name should be changed to 'technology education'. For the different branches of handicrafts there will still be plenty of room in technology education at lower grades and through differentiated teaching.

For the Reader

The teaching of practical skills and technology in general education occurred in central Europe as early as the seventeenth century as *education for work*, providing skills necessary to society. These techniques were first used in Finnish schools at the end of the nineteenth century as handicraft education. *Handicraft education* consists of using materials and skills to produce objects and artifacts. At the same time the student learns how to 'work according to the rules' and develops various skills needed for working life. Handicraft education combines carefulness and perseverance with the development of the whole personality.

Since its introduction as a compulsory subject in 1866, handicraft subject has always been on the curriculum in Finnish schools. The focus is usually on copying traditional handicraft objects, albeit with some scope for incorporating the pupils' own design. Such repetition can be a problem in families with many children where the same handmade objects tend to be of little use and pile up in the attic, kept only as childhood mementos. However, at the present time some schools offer very good and up to date technology education. Unfortunately, the variation in teaching standards between the schools is increasing. 'The inculcation of the technological readiness needed in modern society is not handled in all schools' (Alamäki - Lehtonen 2000).

Changes in schools as institutions are usually quite slow. If there are no special needs to accelerate development or reform of the school curriculum, the proposed changes may take decades to implement. There are, however, some exceptions. For example, the Finnish 'civic school' was created in the 1950s when the country had to rapidly develop and diversify its industry. In addition to general education, it was thought schools needed to provide vocational training and plenty of practical education in the curriculum, because at that time the network of vocational institutions was far from comprehensive, and there was a need for entrepreneurial skills. The civic schools were able to develop these skills quickly and effectively.

At the moment, in 2000, there are again new, urgent needs for developing certain areas in education. The electrical and electronics industries are lacking manpower. The rapid expansion of information technology could not have been totally anticipated. But a gap has opened up between society's growing need for basic technological literacy and the declining level of practical technological education in schools. The uncoordinated development of schools also leads all too easily to polarization; the better schools and teachers improve by keeping up with developments, while the worse schools become even worse.

Motivating pupils to keep their options open with regard to technology in their further studies is mostly the task of the comprehensive and upper secondary schools. These schools should pay particular attention to developing practical-technological education. Education needs to be versatile and flexible in order to cope with the ever-changing industrial structure of the country. Modern technology is needed in more and more vocational areas as a guarantee of the technological growth of the country. It is also needed at home. If a nation wishes to grow economically, then it must invest in education, plan ahead and support new technology in the general school curriculum.

On the one hand most Finnish citizens use mobile phones and have at least some opportunity to use the Internet. Yet, on the other, few teachers use these in education and it has been estimated that about half of the unemployed people are 'computer-illiterate', lacking even basic computing skills. It has been said, that we are governed by a 'techno-bureaucrazy' which seeks only to generalize the use of new communication gadgets.

(Waris - Viherä - Viteli 13.05.2000, Morning-TV.) This criticism also applies to general education. While medical science is developing minute machines that can crawl through veins and we are in the fourth decade of the space age, the practical-technological education in schools is often still limited to crochet and woodwork.

The effort to help the individual understand new technology and thereby control the existing reality is one of the aims of technological education. Of course, another important aim, which has received a great deal of publicity lately, is the realization of equal opportunities for male vs female.

1 Changing skill demands

School has always responded to the challenge of society to teach technology. Originally introduced as handicraft education, technological education has been developed according to the needs of society. However, the needs change rapidly according to the progress of technology. In Finnish schools the different steps of practical technological education, namely handicraft, 'sloyd' and 'technical work,' have traditionally represented the discipline responsible for education for work, techniques and technology.

All over the world technological education began as <u>handicraft education</u>. Finland was the first country in the world to accept it as a compulsory school subject (Uno Cygnaeus 1866). Central to this was the idea that the school should lead 'through work to work'. Handicraft was connected with the self-supporting agricultural system. As a relic from this, do-it-yourself skills are still a part of the Finnish way of life today. It is possible to introduce handicraft education at various levels in schools. For example, even if the projects are quite vocational and connected with working life, handicrafts should serve as a 'character building' experience in the development of the whole personality - in that they should inculcate accuracy, carefulness and persistence in work. Handicraft education of Cygnaeus has been an early model for numerous countries at the beginning of technological education (e.g. the Nordic Countries, the United Kingdom and the United States, the last one through Otto Salomon, the Swede).

In international educational literature the term 'handicrafts' is used to denote rational reproduction, making objects through imitation. Yet, with the development of technology this model of handicrafts is not sufficient for practical technological education. The increasing mechanization of industrial production has diminished the importance of handicraft skills. Production processes were rationalized and standards regulating production were introduced. Industrial production and patent systems were generalized. The knowledge how to produce the objects and the production skills themselves were separated. The former evolved into engineering skills; whereas the latter became manual labour. The general interpretation of handicrafts as a non-academic discipline geared merely towards satisfying the needs of industry emerged from this process of change. However, the development of technology also led to the need to apply science to handicraft skills: thus handicraft education incorporated the need to teach <u>industrial arts.</u> Finland's civic schools did just this from the 1920s to the 1970s, as both prevocational and vocational education. The civic school also created the basis for national industrial development and entrepreneurial skills.

Finland is the exception in incorporating the education of industrial skills in the teaching of handicrafts in schools.

Technology education is the latest global development stage of practical technological education. It means emphasizing new technology in education. But this is not so new. The term technology education was used for the first time, as far as we know, by Uno Cygnaeus when planning the Finnish teacher training programs in 1861.

The former work skills are just not enough in the changing working life. However, we have no way of knowing exactly what kind of technological skills will be needed in industry in the future. The challenges must be met, therefore, by emphasizing the importance of mental processes and problem solving in the development of technology. Work tasks will be based more and more on knowledge and the theoretical governance of work. The status of creativity will be increased and the acquisition of a broad range of abilities will become more important. New technology demands more effective and more concrete, but less academic, skills than the school now gives. New technology does not necessitate the development of vocational education, but rather the development of general education. It necessitates better skills in logical, analytic and abstract thinking and the ability to use these skills in practical situations: For example, the prototypes of various gadgets are still usually made by hand.

So, technological development in society demands changes in systems of education. These demands are strongest in 'education for work.' This concerns not just general and vocational education, but also the education of teachers themselves in their pre- and in-service training. The increased mobility in working life necessitates a certain change in attitudes: workers must be more flexible.

Mankind has moved towards a situation where, on the one hand, there is an abundance of utensils, but on the other hand, technology itself causes new problems. Better trained professionals, technologists and engineers with a firm grasp of mathematics and science are needed in order to keep pace with the development of production technology. Education has therefore become a more and more important factor in production and investment. The purpose of technological education is to understand the processes: when you learn how to work on materials by hand and by machine, you will also better understand the basics of working with automated machines.

High standards in examinations are no longer necessarily a presupposition of future success in new technology (see for example Bill Gates and Linus Torvalds). The main idea in general education might be to give clues about new technology.

Changes in work have brought changes throughout society. A technology-centered society, administration, etc. can be called technocratic. In this sort of society there is a danger that some irreplaceable values are sacrificed for technology. There is a danger that technological determinism might come to govern man and society. To safeguard against this decision making about technological options is, however, always based on certain values. The form these values take depends on the knowledge and attitudes of the decision-makers, which should be taken account of at all levels of education. Guiding talented pupils towards studies compatible with their abilities also guarantees a high standard of future engineers and technologists.

Even if the ultimate demands for technology education have come from industry, it is also demanded in other areas of life. For example, it is very important for an individual living in a technological society and in a home with plenty of electrical and electronic gadgets to know how to use technology effectively, safely and properly. So, the needs for modern technology education are both social and individual, just like they were 136 years ago.

Urbanizing societies no longer have so many reasons to keep handicrafts lessons in the program of general education. Utensils are cheap when the modern standard of living is taken into account: it is no longer necessary to teach everybody how to make these utensils and handicraft skills are no longer needed in certain areas of industrial production. Paradoxically, handicrafts education can even support elitism: artifacts are in demand mainly among the wealthy upper classes. Elitism, however, never was the aim when handicrafts education was launched in schools. Yet the original role of handicrafts as basic 'survival skills' for adult life is no longer applicable in the modern world.

In the following text technology education is referred to under various titles, depending on the context: E.g. 'technological education' is used because it can be understood in a broader context: it is not only limited to the specific possibility of a new school subject, and so the term can be used to make better connections between different subjects. The role of the terms 'practical' and 'technical' are historical compromises; in Finland the development is quite slow.

2 Technology education

The early American philosophy of developing technological education could also be applied as a challenge for Finland: "Handicrafts education, wood as material and the skills based on muscular power as methods, belongs to the 'handicrafts era.' If technology education (Industrial Arts) is supposed to reflect the actual technology of the society, the school subject must be continuously developed. The technical basis for the handicrafts era is not the same as the basis for the 'scientific era.' If the criticism that developing Industrial Arts education is not at the level of development of technology and industry means that School should copy whatever industry produces, the argument is true. School can never fully follow the demands of industry. These demands can, however, also be interpreted differently. They must not mean equipment or working methods but 'following the spirit of technology'. " (Olson 1963.)

2.1 Development

After the first initiative by Cygnaeus (1861) technology education has been proposed again and again in Finland from 1973 onwards. It has been motivated on the one hand by the need to internationalize the concepts, and on the other hand by the needs to develop education. So far the proposals have not been fully realized.

Cygnaeus founded 'the Folk schools': primary schools with "boys' handicrafts" and "girls' handicrafts." The aim was general education: Cygnaeus wrote quite often about his fear that vocational education would take over.

In the 1930s there was a need to extend general education in school years 7 – 8 and the 'Civic schools' were created with emphasis on vocational education. About half of the program was taken up by practical subjects.

Comprehensive schools were introduced in 1970. Civic schools and academic junior secondary schools were amalgamated as higher comprehensive schools. The period allocation for education for work was diminished considerably compared to the civic schools. The handicrafts education curriculum in secondary schools was used as a model for the new comprehensive schools. This model already incorporated design into the curriculum and, in contrast to the civic school, was no longer based on materials. The technical work curriculum in comprehensive schools (1970) tried to realize the ideas of folk schools, civic schools and secondary schools. Creativity was emphasized at the lower comprehensive level. At the higher comprehensive level courses, however, were still clearly prevocational. Diminishing periods of time devoted to handicrafts also meant smaller need for teachers.

New developments came, however, to satisfy the needs of the whole age group and to establish a basis for both academic and vocational technological studies. When the comprehensive schools reform was completed the former "boys' crafts" was given the name 'technical work': the task of which was to emphasize a more general education than that offered by the civic schools and to develop 'basic technological skills' (literacy). In 1975 the options offered in higher comprehensive school for technical work were diminished by the Ministry of Education. The curriculum had to be developed and new guides for teachers were published. Aspects of work and technology were emphasized a little bit more than before. A guide for electronics was published in 1979. Computers were introduced in practical subjects from 1981 onwards.

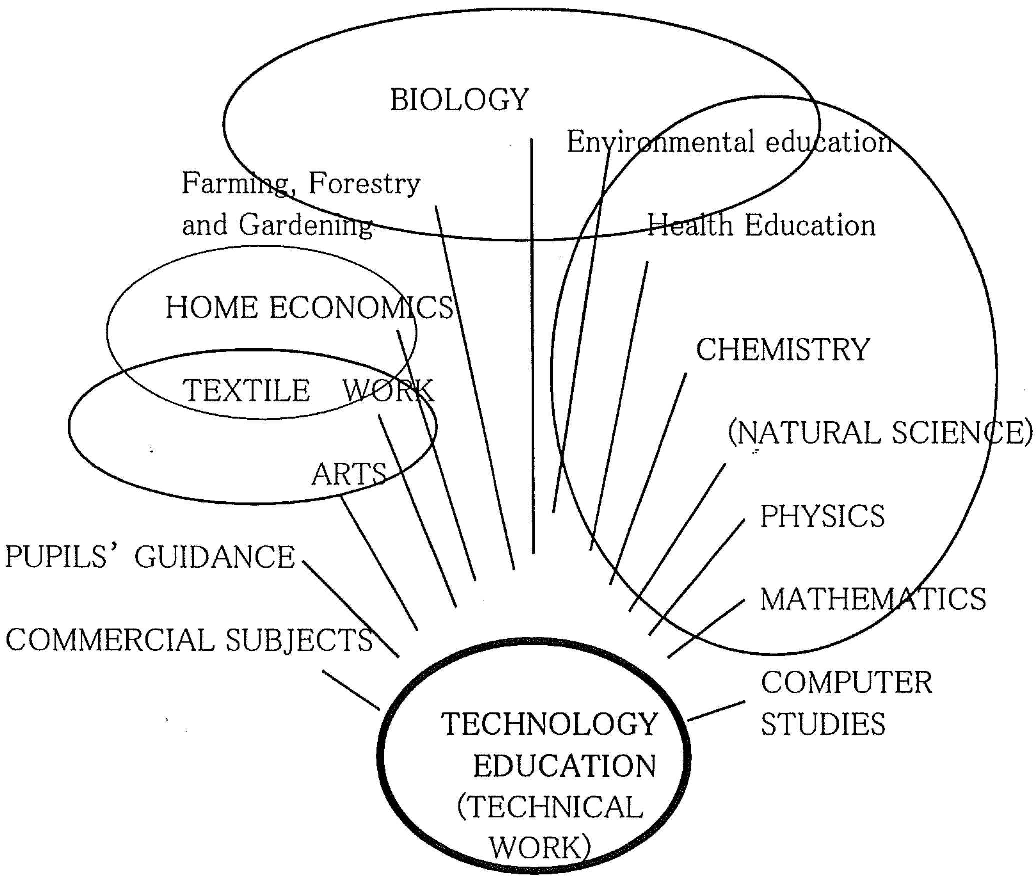

FIG. 1. The relations of Technology Education with other subjects as a subject and as topics (NBGE 1991)

Handicraft as the principal aim was followed in technical work by means of an emphasis on techniques (1985 curriculum and 1988 teachers' guide). Vocational aspects were developed as 'general technology education'. The aim was also to make teachers aware that they themselves could influence the curricula, e.g. through methodology.

In 1991 the education administration system was reformed: the (old) National Board of General Education became a (new) National Board of Education.

In 1991 an expert group for Technology Education was founded in the (old) National Board. Its task was to develop education according to the international guidelines for new technology (Fig. 1). The group was founded because it seemed that some changes in the personnel in the National Board would soon occur. However, 'the Committee for Period Allocation' (new National Board, 1992) stated that changing the subject title from 'handicrafts' to 'technology' would have meant a too cognitive approach, and so the new title was not adopted. Yet, the proposal was a logical enough initiative, and working on it has been proposed a couple of times since then: but so far with not so many results.

The starting points for Fig. 1 are the global models. The ellipses describe deeper collaboration of some subjects. In 1991 textile work representatives had an especially strong interest in collaborating with the Arts. However, in the international models textile work generally should belong in Home Economics.

The basic message of the diagram about the connections and the capacity of technology education as a central subject is still (2001) valid.

The (new) National Board published 'The Basics of the Comprehensive School Curriculum' [hereafter *The Basics*] in 1994. This was the state's unifying general guidance plan. Its three-page guide for handicrafts education was written by a group with no expertise in technical work education or research. The guide emphasized equal opportunities, a common gender-free section to the subject and the possibility of emphasis on teaching in different sub areas. The guide could be said to represent 'developed handicrafts education' only with certain reservations. 'Hand skills' were mentioned twice like 'modern technology'. When the teaching contents, however, are not handled, the guide is incomplete and also allows old-fashioned interpretations. Also the long term 'new' aims from 1970, which have not been properly realized in the comprehensive school so far, were not addressed at all in the guide-book: pupil in the center, creativity or problem centered approach, diminishing the influence of gender and integration into broader units.

The National Board's basic aims for handicraft education can be grouped as follows:

1. Nurturing traditional handicrafts and artifact culture
2. Versatile and qualified practical and original action, design and making
3. Governance of materials and working with them
4. Problem centered and intentional activity
5. Survival in technological environments
6. Safety at work
7. Initiatives to complement and continue studies.

The Basics returned to the old term for the subject – 'handicrafts education' – instead of 'technical work' and 'textile work.' In practice this could mean returning to the old basic philosophy of the subject and rejecting the developments made in technical work over the past 25 years.

In *The Basics* 'technology' as a concept is mainly represented as one of the general starting points and aims of education, but also as a specific aspect of various subjects on the curriculum. Technology education consists mostly of laboratory courses in science, the teachers of which do not necessarily have any interest or ability in teaching practical technological skills.

Even if the general part of the text of *The Basics* is very positive toward technology as a basis for all education, yet technology is barely mentioned at all in the section on handicraft education. The same applies to the contradictory use of the term 'technology' both in a memo by the 'Period Allocation Committee' (1992) and in *The Basics*. There are also conceptual contradictions between the representatives of handicrafts education: for example, educators of textiles define 'technology' as tools, methods of work, techniques or machine technology.

The new School Legislation (1996) also used the term 'handicrafts education': the terms technical work and textile work were no longer mentioned. So, the official terminology has lately been supporting old-fashioned approaches. It can be criticized: 'It is wrong to be believe in the enabling power of handicrafts education from the past instead of teaching the skills and knowledge needed in the world today' (Alamäki - Lehtonen 1999).

Many individual teachers and schools have, however, been following the international development of the subject and have eagerly adopted the contents and aims of technology education. Moreover, teacher training in technical work is no longer limited merely to handicraft training alone. Increased research and international contacts brought these changes about. In addition to this, the Journal of the Technology Teachers' Association has in recent issues greatly emphasized the importance of technology education.

Finland is the leader of the Nordic Countries in handicrafts education research. When teacher training was moved to the universities in 1980, a need emerged to construct an academic discipline with professors and associate professors for pedagogy (didactics) for teacher training in technical work and textile work. This resulted in the production of doctoral dissertations. At the moment we have seven doctors in technical work and eight in textile work. However, most of these doctors specialize in Education science. All technical work researchers have adopted the term 'technology education' and they value it as a new subject term: this is usually as a result of the fact that 'technology education' is the new international subject title in general education schools. Textile work research is focused on traditional culture and the Arts; it develops handicrafts education according to those background disciplines. Teacher training in the other Nordic Countries is not academic, and only a few relevant doctorates have been taken on this subject in Sweden.

When defining technology education Parikka (1998) has interpreted technology as, 'innovative processes, as technological systems of the society and as impacts of technology':

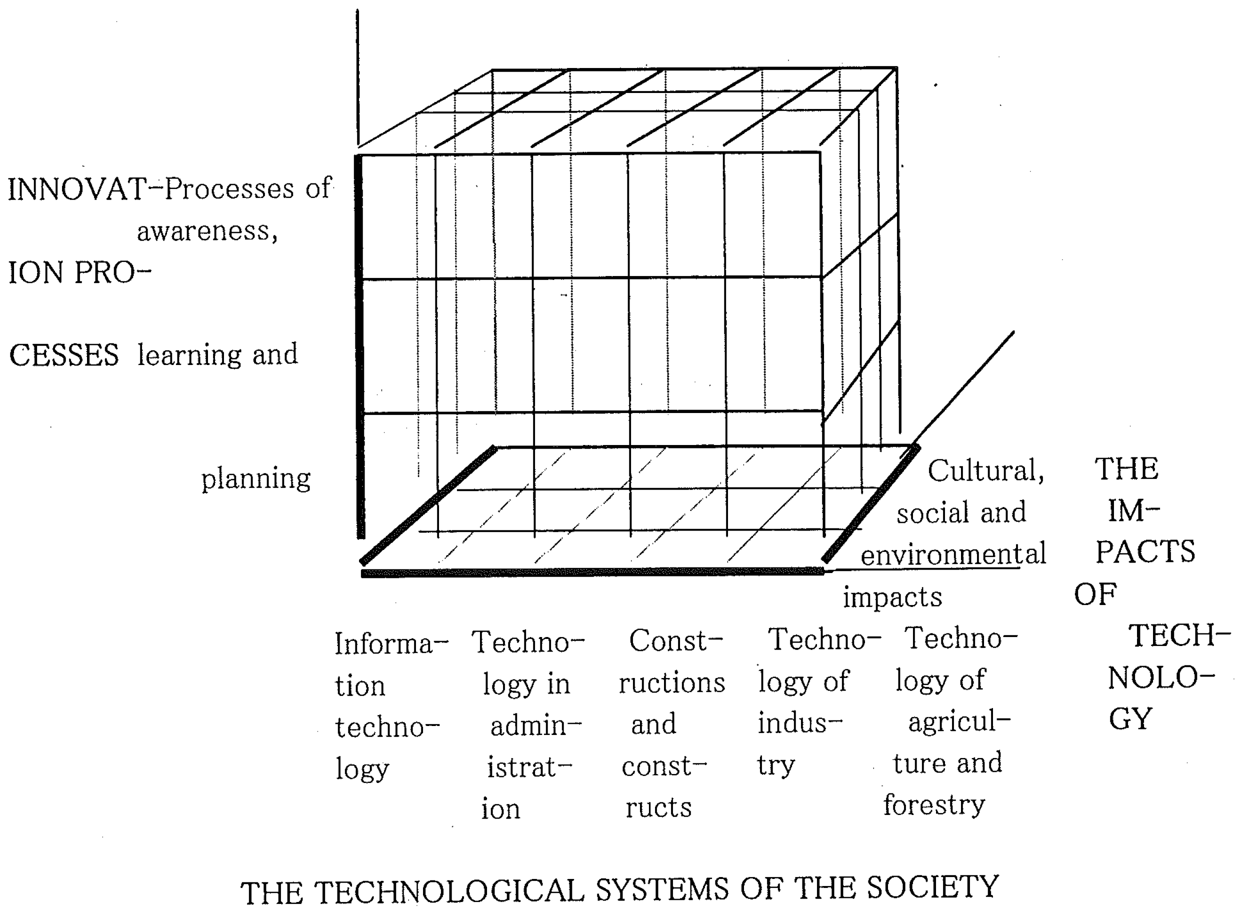

FIG. 2. The cubic model definition of technology (Parikka, 1998)

Modern technology has led to the increasing centralization of the innovation process. Parikka defines innovation as three sub processes, as 'awareness, learning and planning'.

The last developmental stage of technological education – technology education – has also been defined in many pieces of research in Finland. Alamäki (1999) has written one of the latest 'Finnish definitions,' digesting previous research and applying it to Finnish circumstances. According to him the contents of Technology Education are:

'*1 Technological knowledge – "Knowledgeable citizen"*: Citizens in a democratic society should know something about the technological concepts, principles, and connections, as well as the nature and history of technology.
2 Technological skills – "Capable Citizen": Technical and technological skills are part of most human activity and they are essential skills for the survival of mankind.
3 Technological will – "Active and Enterprise Citizen": Technology is determined and guided by human emotions, motivations, values and personal qualities. Thus the development of technology is dependent on citizens' technological will to participate in and impact on the technological decisions.
4 Technological evaluation – "Critical Citizen": Modern technology has significant impact on the economy, culture, working life, society, the nature and everyday interests. Therefore citizens should be able to evaluate the impact and consequences of technology.

5 Technological equality – "Equal Citizen": Equality between men and women in dealing with technology; a large part of technology is traditionally thought to belong to men's tasks.
6 Childhood enrichment – "Balanced Citizen": Children like to design and make products which can be used. However, they do not usually have a chance to engage in technological design and production activities at home. Thus, the design and production activities of technology education create a natural learning environment for children to grow in cognitive, affective and psychomotor domains.' (Alamäki 1999.)

Rasinen (2000), the latest doctor in technology education in Finland, writes about a 'search of curriculum elements.' Rasinen provides a more detailed definition of the concepts connected with technology education through philosophical discussion, with a large questionnaire to the experts in this field and a comparative analysis of curricula in six countries.

All of the seven Finnish technology education doctoral dissertations agree about the opportunity to have technology education as an independent subject in Finland. However, at the moment any blueprint or conception of the subject would be, at best, merely an amalgamation of the various developmental stages of the discipline. The support of public opinion and of teachers' in the field also needs to be cultivated if we are to progress any further.

A Governmental Fund, SITRA, has suggested developing two important fields of technology: 'Top technology' and 'Skill technology' (Prihti 2000). These can be connected to the versatile aims of technological education. These would make it possible for technology education to satisfy the needs of the local environment, and also to bring a common international model of technology education to schools.

Government decision-making about Design Policy (2000) also influences basic education. Emphasizing Design is an important part of, but not a sufficient solution to, the problems of technological education. A clear curricular connection between design policy and technology education should be developed.

In November, 2000, FACTE, Finnish Academies of Technology, organized a seminar to promote technology education throughout the country. The technologists have been worried about the humanistic image of education. This image did not provide sufficient support for industrial development and manpower needs. The idea was that handicrafts and industrial skills should be more or less removed from the general education school curriculum. Learning skills, techniques, and working methods should, during the Information Technology era, be partly replaced by new technology, electronics, control technology, microchips and automation. 'Technological skills' should be discussed, rather than industrial skills and handicrafts. These new skills are still based on the world of work, even if this world is changing. Added to traditional skills they provide an insight into the basic use and applications of machines, equipment, electricity, electronics and automation technology.

On 30 April 2001 a new 'Period Allocation Committee' submitted its Memorandum (Muistio 2001). The memo outlines plans for the organization of teaching in schools over next 10 years or so. It will be followed by 'The Basics for the Curriculum' this year or the next. These reforms will be realized in schools after two to four years. During the writing process numerous social interest groups competed for greater period allocation for their own particular subjects. FACTE campaigned for greater period allocation for technology education: an earlier version of this paper was, in fact, one of those efforts to motivate change. The other aim from the author's point of view was to inform the engineers' and technologists' corps about what has been happening in the development of the subject; a great deal has changed since they were at school. The Memo has incorporated technology into handicrafts education. This is a fairly good starting point for further development.

FACTE Seminar papers and speeches by Bill Dugger, the Prime Minister and the Director General of NOKIA, Mr. Ollila, brought some publicity and had a definite impact on the conclusions of the Committee. Technology was accepted as a new sub area partly in handicrafts and partly in science. For example, now we have a good opportunity to influence the forthcoming 'Basics of Curriculum' and write textbooks in order to show our strength for the future.

The development of handicrafts, 'techniques' and technical work education in Finland can be described roughly as follows:

- In 1866 Uno Cygnaeus defined his aims as moral education and education for work. An emphasis was placed on the civilising influence of skills education.
- From the 1930s to the 1980s the civic school emphasized industrial skills.
- From the 1980s the comprehensive school was geared specifically towards encouraging creativity. Electronics and design became, however, parts of technical work education. Research based development began.
- In the 1990s the emphasis was on techniques and on education for work.
- After 1991 the logical development of the subject came to a halt. The new trend was no longer clearly positive toward technology. Control technology became general, however, next to electronics.
- In 2000 emphasizing technology is back in vogue. One of the aims of this is to mobilize collaboration between subjects.

2.2 Problems

From the beginning of the comprehensive school system (1970) handicraft education got some new aims, which even now (2001) have not really been realized; pupil as a center, creativity, problem solving, equal opportunities and integration.

One of the most important pedagogic reforms of the comprehensive school was to emphasize the 'pupil as a center' in all education. In handicraft education this idea manifested itself mostly through encouraging creativity and the pupil designing for himself or herself. This caused some problems for technological education because creativity was interpreted mostly only as 'artistic work' at the initiation stage of the comprehensive school. Teachers were often unable to teach students to design, because teacher training had not taught the teachers themselves how to teach design.

The long-term integration demanded in the curriculum (1970) emphasized integration of handicrafts with arts according to a Norwegian model. The aim was to support creativity and the expressive abilities of students in particular. This level of integration was never achieved in Finland.

The discussions about the development of the subject have now been going on for the past 30 years. The pedagogical solution has been to place an emphasis on 'problem solving' in the pupils' education. Connecting design with handicrafts education as a part of this has become more general.

Equal opportunities and gender free options have been achieved in many ways from the experiments and research from 1960 – 70 on. Real gender free education has not yet been reached, the girls still make choices mostly for textile work, boys for technical work, and little internal integration of the subjects has taken place. One of the reasons for this might be the strong connections between the traditional subject titles and the gender role attitudes passed down from family and friends.

Technical work teachers have not always agreed with the reforms. Integration with the Arts was an especially strange idea for them. The introduction of design education was inadequately implemented in schools. Electronics was approved because proposals for it came originally from the teachers and it had already been introduced in many schools. Computers had in the beginning many passionate supporters and eager adapters, but also many strong antagonists. Today, about 25 years after the original proposals, there is practically no more resistance to computers, and about half of the higher comprehensive school teachers might use computers in teaching. Short in-service training has generally produced good results.

When teacher training was moved to the universities at the beginning of the 1990s in Finland there was also an opportunity to have a 'more scientific' title for handicraft education. The textile work teacher training department in Helsinki University took the title 'Handicraft science', because it was possible there to get rid of 'Education science' as the only principal grade. Technical work teacher training in Rauma TTI, Turku University, got the title 'Handicraft education', because Education science was the only principal grade for a longer time than in textile work (Helsinki). However, the inner structuring of both of these disciplines has been rather problematic, and so far there has been no development of pedagogy or textbooks in Rauma or Helsinki:

- The representatives of textile education based their discipline on vocational theories and on (mostly British) innovations in technology education. However, general education and technology education should no longer be exclusively devoted to vocational training. Textile work still strongly represents the traditional handicraft culture in both curriculum discussions and implementation. Textiles education has been able to maintain an exclusively vocational content because it concerns only one specific vocational area (viz. textiles).
- Technical work consists of woodwork, metalwork, plastics, machines, electricity, electronics and graphic communications. The use of computers has brought automation to technical work. The representatives of technical work have based their discipline, on the one hand, on technology education; and, on the other, on skills education. Recent developments – such as the new doctorates and the basic work done in Jyväskylä and Oulu Universities – have clearly pointed towards technology education. Also in the English language home page of Rauma TTI the title of the subject has been given as 'technology education,' rather than 'technical work.'

The development of the disciplines above has also been tied to the aims of textile work and technical work in school curricula since the 1980s:

- Textile work confined development to one material. This took into account both the needs of the home and of handicraft culture. The former emphasized vocational skills, the latter emphasized the cultural historic and artistic development of handicrafts. New technology remained merely a tool, if it was used at all.

- In technical work the antiquity of material and skill based development was noticed quite early (in the old National Board), and the result was to favor new technology, understanding, 'technological creativity' and innovations. Collaboration with mathematics and science was found to be very productive.

Modern technology education develops critical thinking about artifact culture: this will promote consumer skills, which, of course, are important for every citizen. This does not mean giving priority to theory at the expense of practical work, but rather making sure practical work involves not only producing artifacts but also designing them and understanding the production process. A new title for the subject might lead to appropriate solutions concerning equal opportunities. Clearly, 'handicrafts,' 'textile work' and 'technical work' are not entirely gender free terms and might need to be re-appraised.

Teacher training programs for technical work have been developed toward technology education in Jyväskylä and Oulu Universities. However, these efforts have yet to receive the necessary governmental support.

2.3 Practical observations about the present situation

The writer has had the opportunity to discuss the subject development with teachers and teacher trainers and to check the curricula in Helsinki schools.

Both at the lower and higher comprehensive schools the standard of teaching varies a great deal. In both of them there are very good and thoroughly thought through study units, projects and topics. There is, however, no real coordination of education at the moment, due to the delegation of the administration of education. This has often resulted in rather weak class work: for example, simple reproduction is still widespread in handicrafts education, especially at the lower comprehensive schools. There is also a lack of appropriate textbooks and an almost complete absence of in-service training.

Materials, wood, metal, textile, machines and electricity are still generally the basis of handicraft curricula. Some schools have systematically started to use the revitalized term 'handicrafts,' even if there is still division with regard to the traditional materials. Added to this, the curriculum has commonly described the students' or teachers' work as 'familiarizing themselves with materials, constructing objects and teaching this process.' However, the criterion of teaching towards these defined aims should be what is learnt by the pupils whilst reaching those aims. Only then can an appropriate evaluation be planned.

The contents of the optional subject is in many schools based on students' choices, 'what they want to produce for themselves.' This will naturally secure motivation and raise the number of options, which will also guarantee reasonable number pupils choosing to do the subject. However, this is not an accurate or reliable way of to define contents of the course beforehand. A description of the contents should therefore be attached to the original aims.

'Teaching how to produce artifacts' is still the main aim of handicrafts education. This refers either to handicraft-like or industrial-style production techniques. However, there is no longer such a need for these skills in Finland. Internationally, technological education should principally inculcate an understanding of artifact culture and technology: it should teach consumer skills rather industrial production skills as such.

Integration is aspired to, on the one hand, inside the subject, and, on the other hand, as a means of cultivating collaboration between school subjects. Inner integration in this context means cultivating collaboration between technical work and textile work.

Inner integration has already begun in schools. The arts and crafts spring exhibition in Helsinki in 2000 showed that co-operation between technical and textile work is developing. According to the Finnish 'Basics for the Curriculum' and the development of international technology education it seems that further integration is a goal for the future. There are, however, still some problems which need to be solved. The definition of the contents of textile work is, in most curricula, still more detailed than that of technical work. Textile work education has only one material area to take care of; whereas the traditional scope of technical work is about five times bigger. So it is quite clear that if textile work - handling one material - is going to be taught in the same number of periods as technical work - handling five material areas - then the aims and practice of teaching/learning will be formed quite differently in these two subjects. Clearly therefore, technology education's curriculum will not be tailored in exactly the same pattern as that of textiles.

The collaboration between technical work and textile work in some cases aspires towards an integration of disciplines; in some schools collaboration between technical work and home economics has also been mentioned. Electronics and computers have already been used in technical education for a long time: the use electronics began over 30 years ago and computers 20 years ago. However, the use of computers in lower comprehensive technical work is still quite rare.

The teaching of entrepreneurial skills has recently enjoyed a great deal of publicity in Finland. In technical work guidance entrepreneurship was mentioned as early as 1977. Yet, surprisingly enough, it is rarely mention in the curricula on technical work education today. In lower comprehensive schools it should also be interpreted more as 'enterprising activity.' In higher comprehensive schools some productive projects could be possible.

After higher comprehensive school students have a choice to go to either vocational institutions or upper secondary (academic) schools. The organization and curricula of comprehensive schools should take into account the need to motivate these pupils. The vocational aspect of technical education has diminished due to the lack of periods devoted to the subject. Some kind of information for pupils wishing to continue their studies of metals, wood, machines, electricity and electronics should of course still be given.

Some of the latest developments in the subject have given cause for optimism. Quite innovative construction kits and textbook materials have been developed in technology education in collaboration with British colleagues in Wolverhampton (e.g. 'Easy', Tiusanen, Step Systems).

2.4 Mathematics - Science -connections

Integration of education for work with mathematics and science education has strong traditions in Finland. Uno Cygnaeus wrote about 'technical handicrafts' and brought the concept of technology to education. He had to fight against, on the one hand, the supremacy of academic education and, on the other, the representatives of vocational education.

However, Cygnaeus has been known as the initiator of 'educative sloyd.' Cygnaeus' innovations were a compromise and made it possible to introduce handicrafts as a new subject in school. Later on, integration occurred naturally in the Finnish civic school; whereas, still later on in the comprehensive school, it did not.

Paradoxically, physics and mathematics in the matriculation examination at the end of the upper secondary school has always used technology. Yet, technology has never been an independent subject in lower or upper secondary schools.

The (old) National Board discussed collaboration of technical work with mathematics and science as early as the beginning of the 1980s. This was consistent with the international trend in industrialized countries at the time, such as the US, the UK, West and East Germany. The diminishing options for physics was largely behind this activity this trend. The effort was to make physics more appealing through technology education. Also in the (old) National Board there was a large project for integration of scientific studies. This led to an improvement in relations of physics and chemistry with industrial and environmental studies (for example, Unesco based activities, FINISTE and the Baltic Sea project).

The integration of technical work in Finland was realized in practice in the curriculum through the developing study of machines and electricity, electronics, LEGO kits, basics of control technology and automation, technology competitions for students and as entrepreneurship education.

At the moment (in 2001) science education takes into consideration the needs of industry, society and the environment (LUMA is the title of a Government project) more than ever before. In the actual wording of the curriculum the emphasis is on technology and the environment.

Environmental studies

Environmental studies was principally a science subject in the early days of the comprehensive school (1970–). This tendency was underpinned by the recommendations of the International Council on Scientific Unions (I.C.S.U.) in Druûba (1968) and the British Nuffield project. Basic concepts of the new subject included supporting learning to learn, utilizing children's questions, building on concrete experiences in teaching and developing the pupils' communication skills.

Finland made efforts to try to familiarize teachers with methods of teaching based on practical work. The results have been rather varied due to problems in both in-service training and textbooks. Also, science has been completely removed from the pre-service training of primary school teachers. The same problem has been written of in Britain. Moreover, Nuffield and other similar kinds of projects, such as Oxford Primary Science, were also criticized in Britain. The hoped for results never appeared. Critics pointed out, for example, that teachers were given only rather vague guidance on how to conduct the 'student-centered' approach. The new textbooks offered no assurance to teachers about the superiority of the new methods over the old ones. Some critics preferred science integrated with technology, rather than using artifacts and mechanics. The Inspectorate, HMI, proposed that the latter two aspects be increased. Later on the curricula and the textbooks connected with the project were frequently re-edited in Britain and Finland.

Professor Frey, director of IPN, a Unesco based Science education institute in Kiel, has suggested (1987) that integrated science should emerge once more. He also proposed that integrated science should be taught especially for those 15 – 19 years old students who are not planning a career in science.

In Finland the (old) National Board removed the 'technology items' from environmental studies in context of handicrafts (1985). The aim was to encourage innovation in technical work. However, like in the British Science education, this did not occur immediately.

Science

The development of science in general education in Finland can be described as follows:

- From 1866 on the subject was connected with developing industry; trainee farmers were taught to improve productivity with modern, science-based methods.
- In the twentieth century the science curricula of secondary schools were strictly scientific and applications of science were done mostly in civic school technical work. In the civic schools technical work and physics were generally taught by the same teacher. This created a good basis for integration.
- In 1970, even though modern education science was adopted, the science curriculum remained purely scientific in comprehensive schools. Biology was stabilized as a subject title, contents were expanded and became more theoretical both in the comprehensive and upper secondary schools. The basics of microbiology came to schools.
- In about 1980 there was a new interest in applications that conformed with the international trends. This can be called 'inquiry teaching'. 'Science – Technology – Society' ideas were introduced. Laboratory courses of physics came to upper secondary schools in order to increase the inquisitive approach.
- In about 1990 – 2000 'creativity' was promoted as one of the aims of science. Constructive approach and inquiry learning were developed.
- After the year 2000 the developments of the previous years will hopefully lead to better collaboration between subjects than before.

The professor of physics at Helsinki University, Kaarle Kurki-Suonio, has discussed the relations between science education and technology: 'When it was discovered that education starting from theory only leads to hostile attitudes towards physics, the starting point was shifted to the technological environment, from practical problems and needs.' This shift led to an emphasis on project learning and problem solving, and helped to cultivate 'the experimental empiricism of the inventor.' Yet, according to Kurki-Suonio, it also led to 'authoritarian belief.' He proposed that: 'The natural world and its observation could also be the starting point for teaching and formation of the scientific process. Thus, the empiricism of teaching will follow the constructive experimental approach of the researcher.' This would mean a 'growth in independent thinking.' Kurki-Suonio emphasizes that 'this does not mean commitment to only one process,' because 'interpretation, application and problem solving have a place in teaching as well as in research. These represent the importance of preparation, but their share will grow in education only with the advancement of understanding based on conceptual governance'.

Professor Kurki-Suonio and his wife, the researcher Riitta Kurki-Suonio (1991), separate science and technology from each other: "Science answers the question 'why?'; technology the question 'what use?'" Science is the concern of researchers and students;

technology is the concern of funding agencies and administrative bureaucrats. So the Kurki-Suonios' make comparisons between science education and technology, not science education and technology education. On relations between science and technology they write: 'Science and technology are inseparably intertwined in physics'. However, if we are to refer to school education, then this should be written: '...inseparably intertwined in science education and technology education...' Doctor Lavonen has commented, with regard to the work of Kurki-Suonio, that 'physics and other natural sciences are often understood as synonymous with techniques, even if the former are more sociological and humanistic than the latter.'

Plans for science education outlined in a recent Committee Memo (1990) have yet to be implemented. According to this Memo science education should focus on more clearly defined objectives. The Committee also proposed introducing science into lower comprehensive schools (viz. at the Primary level), with an emphasis on environmental and biological studies. The committee said nothing about technology education.

Mathematics

- From 1866 on the main aim of Mathematics in schools was 'practicality.' Geometrical measuring and calculations in the folk school and later on in the civic school were equivalent to geometry in the secondary school.
- In comprehensive schools from 1970 lessons on measuring and geometry were removed from the curricula. Set theory and algebra were introduced into lessons. 'Differentiation' was promoted, with homogenous courses in the higher comprehensive schools; but at the end of the decade these were removed.
- In about 1980 a new international trend was adopted, 'Back to Basics'. Geometry and the basic calculation methods were back in vogue, and the share of Set theory was minimized.
- Since the year 2000 the prospects for better collaboration between subjects are brighter than even before.

Integration or collaboration between education for work, mathematics and science is under discussion once more. The need for new technology, the increased experimental learning in physics and mathematics and the introduction of a new subject – 'environmental studies and science' – have all given rise to new opportunities for collaboration. The "School's Club Center" and Association of Mathematics Teachers have recently published 'inquiry learning' materials. These materials have, however, not yet been used very much. Dr. Lavonen has created 'Empirica' – a collection of computer programs and equipment for learning various scientific technological processes (the 'LUONTI' -project).

Since 1991 teacher training institutes have launched various projects to develop technology education in collaboration with science and mathematics (Parikka 2000). For example:

- The 'LUONTI' project at Helsinki University, where technology is part of science and mathematics.
- 'TOTY' at Joensuu University for RD of computers in education; for example, using LEGO kits and developing technological thinking.
- Jyväskylä University has a large project for RD in technology education.

- Jyväskylä has several ongoing projects in educational technology with connections with technology education, and separate technology education projects. Several licentiate and doctoral studies will be pursued in these projects.
- In 1996 Jyväskylä University has emphasized that teaching technology will be a large part of their future educational plans.
- In 1998 Jyväskylä started the 'LUOTEK' project to coordinate the local RD.
- In 1999 Jyväskylä funded the LUOTEK coordinator for three years.
- Since 1995 Oulu University has been developing technology education as a 35 cr. course as collaboration of faculties of education and technology and other interest groups. In Oulu technology education is defined as broadly consisting of opportunities for emphasis not just on educational technology, but also on science, mathematics and the teaching entrepreneurial skills. A proposal for a 'Technology Education Center' was made in 1995, and the plans were put into action in 2000. European Community is supporting the regional project.
- Rauma TTI has for a long time had a project for technological literacy with emphasis on information technology.
- In Savonlinna the TTI has been developing studies in collaboration with the regional opera company and local industry for a project on technology and technical work.
- Kajaani TTI started an EU project 'KYTKE' in 1997 for developing entrepreneurial skills and technology education. The project is the continuation of an older project for developing technology education (1989). The idea has been to create a pilot network of teachers from every municipality in the region for versatile industrial and economic development.
- In 1996 'FATE', Finnish Association for research in Technology Education' was founded by persons working in Oulu and Rauma TTIs. Its aim is to help to develop technology education and the professional skills of the teachers in field and in the TTIs. Members of this association are comprehensive school teachers, teacher trainers and researchers. A few international meetings have already been organized
- There are several ongoing international projects.

The specific areas that should be developed in the Finnish curricula need to be discussed from an international perspective. The recent efforts to make mathematics compulsory in the matriculation examination and to develop science education are very similar to the process of changing handicraft education to technology education. These contrasting efforts for reform could be mutually beneficial. For example, the efforts to increase the number of girls participating in mathematics and science has a great deal in common with attempts to broaden the appeal of technological education, to harness some of the country's untapped potential, to train new innovators, and to develop modern general education. While, on the one hand, schemes to develop mathematics and science education, for example 'LUMA', are concerned with the inner development of the subjects; on the other hand, the revised guide of LUMA (1999) also emphasizes the role of technological education.

There are needs for new technology in Finland. This applies to both practical professionals and innovators. The needs to develop simpler and more inspiring lessons for science and mathematics and the need to motivate through practical technological education applies to pupils of all ages in high schools. A strong theoretical education is necessary mostly for the future innovators.

With regard to mathematics and science education it can be noted that experimental inquiry learning is not as widespread as was wished, especially not in the upper secondary schools.

3 Development needs

Technology should be seen as a cultural factor. Added to writing, reading and calculation skills, computer skills have also been increasingly regarded as part of 'culture'. Technology should also be seen as a factor influencing human culture in general. Everybody should have the opportunity to take a 'basic course in technology' at school. The course should inculcate a basic understanding of the methods and products of technology and of the impact of technology in general. Teaching should focus on appealing to the students: taking their interests and their needs into account. Technology education should especially be organized for those who do not study technology but who will have to make decisions connected with technological choices later on in life.

Children's perceptions of technology are based on artifacts that they see and sometimes play with in everyday life. Teaching should also analyze and handle these artifacts, including toys. It is also important that teaching does not purely aim at reproduction. 'We can reflect the spirit of technology, the attitude and application of search and research, the inventiveness, the creativity, experiment, development and problem solving, all of which are a part of, and fundamental to, advancing technology' (Olson 1963, 89). For teaching new technology it is no longer enough for the teacher to have the skills of a master craftsman, like in the handicrafts era. At that time teacher training aimed at mechanical activity, which only has a limited utility in education.

Ongoing developments in science and technology will have a growing influence on vocational qualifications. Technological education should belong to everybody. Science and technology are penetrating to more and more areas of human life. This means that people should learn to think in an increasingly abstract and rational manner. The connection between practice and theory is becoming more and more complex. The connections between practical applications and problem solving, for example, will be essential in education in the future.

A new area in technological education is 'technological literacy'. It is needed in order to survive in the modern world, to understand and use technology. It can be called 'a survival skill.' Valuing computers more than technology and 'computer literacy' more than technological literacy has been criticized in the past (Dyrenfurth 1984; Otala 1986). Technological literacy *includes* computer skills. If technology means the ability to make or create something, then technological literacy is 'the skill to use technology appropriately at work and at home'.

The structural changes in industry have mobilized the need to advance technological education throughout the world. Pioneering work has been carried out since the 1960s in France, the US and the UK. The new title, technology education, spread rapidly during the 1980s – 1990s. It has been adopted in Italy, the Netherlands, Belgium, Australia and New Zealand. In Sweden the subject is called 'teknik,' in Germany 'Technik' as a part of 'Arbeitslehre,' education for work. In the different countries the common basic motivation has been to teach survival skills in a world which has become more complex as a result of technology. The innovations that it has brought to technological education in schools include:

- A transfer of ideas and methods from material or skill based education to a more general type of technology education in order to guide students towards understanding technology;
- new technology applied to old material based approaches (wood, metal, machines, electricity, textile);
- creative design transferred into the hands of students instead of merely using or modifying the ready made drawings;
- closer relations to mathematics and science than before.

Some of the current and future challenges for practical technological education development at schools in Finland include:

1. Individual needs

1.1. Children must have the opportunity to become acquainted with the cultural history of work in practice.

1.2. Children must have the opportunity to learn through concrete experiences; work by hand has a great pedagogic significance.

1.3. Children must experience some of the satisfaction and pleasure to be gained from concrete and productive work.

1.4. Child must be motivated in technological experimentation and creativity, instead of merely teaching them skills.

1.5. A child has to learn how to work individually and in groups.

2. Domestic needs

2.1. The maintenance of artifacts at home, like small repairs, presupposes basic skills.

2.2. Living is more 'technical,' electrified and automated than before. General education must teach skills necessary for making small repairs at home and develop the knowledge to recognise if and when a professional is needed.

2.3. The number of motor vehicles has increased. In order to understand the basics of their operation some education is needed.

2.4. Artifacts at home, such as furniture, etc., are sold more and more as kits. Skills are needed for assembling.

3. Vocational needs

3.1. One must have the opportunity to become acquainted with different kinds of work in school. The different developmental stages of work, the basics of handicrafts, industrial arts and new technology, must become familiar.

3.2. Technological development presupposes trained manpower. Schools must guide students towards options for new technology more than ever before.

3.3. Work increasingly involves the use of computers. These skills are central in all practical education.

4. Social needs

4.1. The citizen must learn to become a critical consumer.

4.2. The citizen must get information and skills of new technology in order to be able to participate in social decision making in this regard: for example, with regard to matters concerning environmental and nature conservation.

One of the most important aspects of modern technology education is considering the changes in 'work': that which was appropriate in the time of Cygnaeus' or the civic school time, is not often relevant today. Psychomotor skills and the use of professional machines have been partly replaced by new technology. This should be emphasized in the curricula.

The duty of practical technological education is to guide children in technology. General education should provide experiences and insights in technology, not skills or facts as such. Problem solving and a student centered approach help to motivate learning, and it is only through this approach that other aims can be achieved during learning.

Also creativity should in the future deepen the emphasis on a problem centered approach and design in technology education. Liberation from gender roles means inner integration for handicrafts or at least options beyond the traditional gender roles. Added to this, teaching should be integrated to provide a broader general educational experience in schools.

In the 'Basics of the Curriculum' by the (new) National Board (1994), there is a description of 'the starting points for aims and contents in handicraft education.' The philosophy of the development of basic technological education can also be summarized as follows:

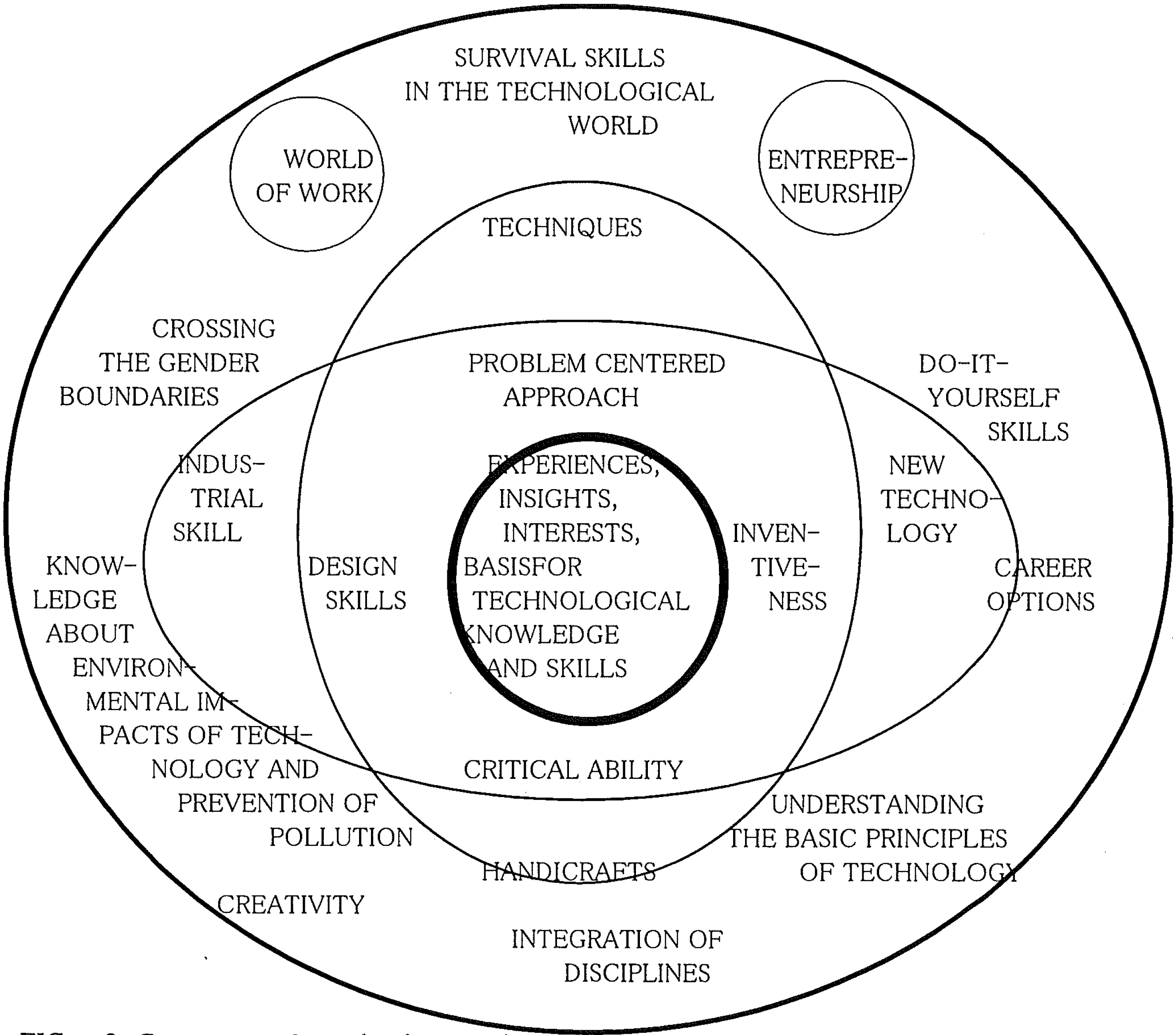

FIG. 3. Contents of technology education

The core of the figure describes the teaching / learning activity, the elements of which should appear in every lesson. The transfer of knowledge and skills, which can be found in the professional literature and programs on vocational training, should not be the aims. The most important important thing is that the pupil should gain positive experiences in technology. These bring motivation, joy and enthusiasm for learning and so, good results. The sharing of knowledge and skills will naturally become more central as the years of studies progress.

At the outermost circle there are 'general background factors for technological education,' which influence teaching but are not operational at school in every lesson. When writing the curriculum and planning education one has to think what the impact of these factors will be. Naturally the basic principles of technological education also include, for example, acquainting the pupil with the basic concepts, processes and systems of technology.

The middle circle describes the different development stages of technical work education, handicrafts, industrial skills, techniques and new technology, which all, affect education at present. The emphasis should be moved from the beginning of the list towards the end.

The inner middle circle describes teaching / learning aims such as they are usually written in the curriculum language.

Detailed development needs

The following measures are necessary to promote technological education in Finland:

Administrative proposals

The contents of technological education must be developed with the emphasis on new technology.

The subject title of practical technological education in comprehensive schools has been 'handicrafts' for a long time. This title could not change the gender roles of handicrafts education. Changing the title to a new one - for example, the internationally used 'technology education' - could bring new attitudes to the subject.

Technology education must be introduced also in the upper secondary schools.

If future plans for the curriculum are to include integration of subjects at one of the school stages, then every individual subject curriculum concerned should be clearly defined first of all. Only then can the disciplines be modified. Integration should mostly concern the pedagogic aspect and measures.

Teacher training courses for technology education must be introduced. Regional needs must be taken into account when deciding which institutions should handle these courses. In other Nordic Countries - Sweden, Norway and Denmark - there are several TTIs for technological education. There is a vibrant competition between these TTIs. In Finland there is only one institution for technical work subject teacher training.

National in-service and further training of teachers are important development measures.

The 'task force' requested by Unesco must be established to follow up the national development of science and technology education and to create preconditions for internationalization.

The situation in technological education in Finland is about the same as it is in countries where technology education has already been launched. The difficulties have been much the same. An unbiased international group of experts should be invited to analyze the Finnish situation and to make suggestions for future development.

Functional proposals

The lack of textbooks is one severe defect hampering development. It is vital that teachers are supported in their work with actual textbook material. Financial support should be given educational publishers to encourage innovation.

One way of experimenting with different curricular solutions and innovations would be to assign individual development tasks to various individual schools and teachers. Teachers would then have access to fresh data on expert guidance about the global development of the subject area, and they could then apply a broad variety of innovations and write curricula and textbooks if needed.

Measures aimed at diminishing the separate gender roles and promoting inner integration of subjects still have a long way to go. A variety of solutions have already been attempted in schools. Systematic data should be collected about these attempts, their benefits and possible defects.

With regard to the contents of the subject, the work done in kindergarten so far has been highly versatile: children are introduced to technology, there are kits to be constructed, etc. In preschools and in schools the same kind of activities should be continued in a broad fashion: kits and textbook materials on technology should be made widely available.

The contents of early technology education should be broad because teaching needs to motivate the entire age group. The teaching should not be restricted merely to skill training or the cognitive approach. Instead it must be balanced and develop the different abilities of students at different grades so that everybody can find his or her own methods. Differentiation of teaching must also be developed.

Design is an essential part of technological education. In teachers' pre-service training there is never enough time devoted to it. Moreover, the traditional background of handicrafts teachers, home or cottage craft, may lead them astray when it comes to modern general education. In-service programs for design should be developed.

Technology education's connections to other important subjects through new technology must be clarified. This can be focused in particular on the priorities of the social interest groups representing industrial development in Finland: TEKES (Fund for developing technology), TES (Fund for promoting technology), SITRA (Finnish fund for independence), etc. Biology would be one of the new centers of attention, because of the current rapid development of biotechnology.

Connections between practical technological and entrepreneurial education and local municipal interests should also be investigated.

Computer based methods should become more general in all education. The Internet will hopefully act as a tool for collaboration between schools and as a channel for information enabling teachers to acquaint themselves with the programs of teacher training departments. Problem solving should receive more attention. Varying methods of teaching - for example, using constructional kits or machines - should be encouraged.

The representatives of the 'great public,' especially the parents working on the school boards, need access to relevant information in order to make decisions and to guide their children towards appropriate choices.

4 Discussion

Technology education satisfies a variety of needs. Handicrafts and industrial arts still have a place in the Finnish interpretation of technological education. Their emphasis must naturally be varied in different parts of the country. In the industrial environments new technology should be given priority; in remote areas there remains a greater need to teach traditional technologies. The Finnish government has, however, emphasized the need to increase distance working and distance learning and to generalize computers in order to support regional industrial development.

The meaning of handicrafts has changed throughout its history. It was important learning the basics of constructing everyday objects of necessity, when techniques, machines and new sources of energy were not yet in the service of man. Handicrafts is the earliest stage of technology, and teaching it in the schools today is no longer relevant for industrial needs.

'Education for work through work' was a reference by Uno Cygnaeus from the German Diesterweg at the end of the 1900s. The aim of handicrafts education was to educate citizens to be able to participate and work in society. There was no vocational training at that time, and general universal education was a recent innovation with a long way to go. The task of the new schools was to influence the attitudes of pupils and to teach them skills relevant to the new social and individual challenges of the time. Moral education was central to this process: both Diesterweg and Cygnaeus were religious.

Handicraft skills were new technology in the agrarian society at the end of the 1800s. These skills gave pupils the opportunity to work in industry or to establish their own enterprises. There was full employment. Handicraft was a traditional central discipline in Finnish teacher training (from about 1863 – 1970), with a generous amount of time devoted to it.

The role of handicrafts has remained in the sophisticated industrial world as:

- experimental design of the inventor,
- prototype production of the designer,
- producing souvenir kitsch for tourists,
- technical service and maintenance.

Handicrafts also serve the purpose in an industrially developed country as:

- a method of education; 'Learning-by-doing'; 'Hands-on',
- therapeutic hobby work,
- nostalgic work in primitive conditions on holidays and leisure time, construction and maintenance,
- 'elite hobby crafts,' for example painting Chinaware and constructing model airplanes, railways etc.

Handicrafts education has a got 'recreational emphasis' in the school due to its practical nature. Yet it is becoming more and more theoretical. This is naturally a positive development for the image of the subject. However, handicrafts should be compatible among the other school subjects with cognitive, affective and psychomotor aims, objectives and contents.

The new Finnish education law of 1996 uses the title 'handicrafts' instead of technical work or textile work. It might imply that the infrastructure of technical work in general education is in danger of being dismantled in the long run. Fortunately the titles of technical work and textile work still are in the curricula so far (2001). This might well be an appropriate solution at the moment; but increasing internationalization creates a pressure to adopt the new subject title: technology education. The situation is also problematic because of the close friendship between textile work and art, which is embedded in the curriculum. A clear alternative would be to write the curricula separately for handicrafts (technical work and textile work) and technology (technical work and science).

Today the situation is slightly different than before. There is no more need to give vocational training in general education schools. Education for work has been organized by founding the vocational training institutions. Vocations and 'work' have become more technological. Getting work is not as clear for every citizen as it was before, at least not in its former meaning. An unemployment rate of 5 – 15 % is general in the industrialized countries. However, every citizen has both at home and at work plenty of technical gadgets and new technology, the control of which makes quality of life better and helps people to survive in a technological society. There is increasing support in schools for teaching entrepreneurial skills. It must also be emphasized, that entrepreneurship is close to the Finnish practical technological education and do-it-yourself traditions: 'shoulder bank,' as we call it. Lately the Finnish vocational training system has been given two important demands: Skill standards must be raised according to the new needs of work; and career options of students must be guided reasonably according to the needs of industry. The new polytechnics partly satisfy both of these demands.

There has certainly been a slight move toward cognitive emphasis in handicrafts education. There is no return to the old material or skill based education. Computers are used as tools in schools and it has been accepted that technology is an essential part in practical technological education. A central aim still is to guide certain pupils towards vocational training for work and industry. The importance of this has sometimes been neglected due to the interest in computers, but the situation has recently begun to improve. The basic idea of education for work, 'education through work for work' should be changed for example to 'education for work and technology'.

Comprehensive schools have already had some experience in motivating girls studying technology. This has revealed a few problems. In particular, girls seem to fear the possibility of dangerous working situations. For example, there have been problems with the participation of girls in the higher comprehensive schools' traditional teaching with machining wood and metal. Part of the reason is that girls haven't been given any practice in handling hard materials in the lower comprehensive schools. In order to motivate them better it would be important to emphasize in teaching / studying solving daily technological problems, instead of the traditional practice of merely producing artifacts. For example, environmental questions are increasingly connected with technology. Tackling these question in a practical fashion is one possibility. These topics have especially appealed to girls.

In comprehensive school the students and their parents still think that the title 'handicraft' consists of two areas, one to boys and the other to girls. The efforts of the (old) National Board in the 1980s for integration did not bear fruit partly just because the terminology had an age-old cultural gender bias. A new subject title – technology or technology education or technology teaching, etc. – might promote breaking gender borders, added also to the influence of the new subject contents. Another recommendable alternative would be to write the curricula separately for handicrafts and for technology. They have their common area in 'Hands-on' or 'Learning-by-doing,' but they are not synonymous.

It was stated above that commitment to materials should be diminished in the curricula. This does not mean removing materials completely as topics. Activity based on materials is a natural starting point for most technological practical learning. However, teaching should be based from the very beginning on projects, topics, themes and problem solving instead of working on materials and learning skills. The former represent a motivating, integrating, holistic approach; the latter represent a disciplinary and vocational vision.

Handicrafts education has a diminished status at the lower comprehensive schools. The majority of primary school teachers are women and consequently there is an emphasis on textile work; whereas, the significance of technical work is played down. When the two principal aspects of handicrafts- technical work and textiles- are not integrated in teacher training and when schools still tend to have posts for textile work subject teachers even if the subject posting for technical work is diminishing, then there are no real preconditions for integration of handicrafts. The fact that in some cases technical work education has become more or less hobby crafts, recreational activity, 'easily run extra periods', etc. is also a major problem. This stems mostly from problems in teacher training. Added to this, primary teachers have about 13 other subjects to run, which, unlike handicrafts, have appropriate textbooks.

Teachers of technical work have been divided between defenders and antagonists of the new ideas for technology education. Discussions have continued for years. Young teachers generally support new teaching without reservations. The older teachers mostly try to stick to their tried and tested old methods. The apprentice method still is strong. 'Technology education' as a term was opposed mostly because it sounded too new and fresh. Objections on these lines appear to be rather misguided. In Rauma TTI, which has the monopoly for technical work subject teacher training, technology has been in the curricula for about 30 years as 'wood, metal, machines and electricity technologies.' Problems are exacerbated by the fact that there are no general textbooks on the subject. A set of generally accepted textbooks might have acted as a unifying factor. In some school subjects the new foreign language based terms have been adopted without pain, e.g. 'the history of nature' became biology, and 'the study of the soul' became psychology.

The marriage of technology and equal opportunities seems to be a complex issue. In spring 2000 there were about 32000 matriculation examinations made upon completion at (academic) upper secondary schools; of these about 19000 were girls, and 13000 boys. Concerning girls the closer relations between science and technology could increase the expected number of girls choosing mathematics and science: i.e. furthering the development of equal opportunities. Concerning boys the question is about equal opportunities in participating in upper (academic) secondary school in general. Integration with technology education on a practical level could increase the number of good results and male students. So, equal opportunities in technology education demands some similar and some different strategies for girls and boys.

Automation in production, a high unemployment rate and environmental pollution need not work against technology education. The emphasis should be consciously moved away from passive acceptance of technological determinism towards human beings understanding and taking control of technology. Technology needs to be a part of general education in order to do this; and there needs to be higher level of collaboration between technological and scientific education.

However, in addition to this, teaching needs to concentrate on motivating pupils, emphasizing the practical aspects and modernizing the theoretical basis of basic education in physics, mathematics and technical work. Finland's information technology culture was built on these subjects.

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