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The following introduction by Marc de Vries has been taken directly from the International Handbook of Research and Development in Technology Education, Eds Alister Jones and Marc de Vries. Sense Publishers Rotterdam.

Marc considers the terminology that describes technology education. He also looks at the development of technology education in a global sense. Marc does refer to specific examples in various countries and New Zealand is referred to. Consideration of stakeholders and long term aims of technology education feature in this introduction presented by Marc. He also acknowledges the contributions that other people bring to the book referred to above.

Introduction

The fact that this International Handbook of Research in Technology Education is now available indicates that technology education has grown out into a well established field. Although it is still very much in development, there is a certain maturity that justifies presenting a survey of what has been accomplished in the past. That is why the editors and the publisher considered it to be timely to bring out this Handbook.

In this Handbook all main topics one would expect for an educational field are present: the underlying philosophy, curriculum development, teacher education, relations with other subject areas, assessment, and educational research. The (relative) maturity of technology education is illustrated by the fact that for each of those topics a sufficient number of high quality contributions could be commissioned. This introductory chapter offers an overall survey of those topics and the way they have developed in the (relatively short) history of technology education. Let us first consider what is meant by 'technology education' and related terms.

1. Defining the field

In this Handbook we will use the term 'technology education' to indicate the learning area that deals with the way in which human beings change their environment to make it fit better with their needs and wants, thereby using various types of knowledge. This description fits well with the current state of the philosophy of technology (see Section 2). Technology is all around us in our contemporary society. For that reason it makes sense to educate future citizens about this important aspect of our lives. It is another matter, though, how this should be done. Does it mean a separate school subject is necessary for that? Or can one deal with technology entirely in the context of another school subject, be it science or whatever other subject? Does it require interdisciplinary projects as intervals in the normal curriculum? Different answers to these questions are given in different countries, and for different school levels. This is what makes technology education still a fairly fuzzy concept, in spite of its current state of development. That makes it necessary to discuss a number of possible confusions.

The editor-in-chief of the International Journal of Technology and Design Education receives quite some submitted articles that can only be rejected even before they are reviewed because they are not within the scope of the journal. These are articles that describe studies into the way technology can be used to support the teaching and learning of various school subjects, such as science, mathematics, and languages. Apparently the term 'technology education' in the title of the journal has triggered scholars to submit articles in which technology is not the content of what is taught and learnt, but a means for teaching and learning about other issues. For that, however, the term 'educational technology' is more appropriate and more commonly used. This is a first confusion regarding the nature of technology education. Of course technology education and educational technology are not entirely unrelated. In the first place educational technologies can be applied in technology education, no less than in other educational fields. Perhaps technology education is even one of the most evident fields where new technologies can serve an excellent role in enhancing the teaching of learning. In the second place a good understanding of the possible, and the appropriate role of technologies in the teaching of science, mathematics, languages or whatever other subject area, assumes a good understanding of technology itself, and that is exactly what technology education aims at in the end. Still, one can distinguish clearly between those questions that are solely concerned with the effects of new technologies (new media in particular) on teaching and learning, whereby the technology itself is taken as a black box, and those questions that concern the nature of technology itself, whereby the black box is opened. The former is 'educational technology', and the latter is 'technology education'.

Another term related to technology education is 'technological literacy'. This term is used to indicate an important aim of technology, namely to provide people with a type of literacy that is important particularly for the technological society in which we live today. Not only do people need to be able to read and write (the original meaning of the term 'literacy') and to use numbers (numerical literacy), they also need to be able to use and control technological devices and systems. The term 'technological literacy' is not identical to 'technology education' because the aim of helping people to acquire technological literacy can partially be done in the teaching and learning of other domains in which technology is not the main focus. The term 'technology education' is used to that teaching and learning in which technology is the main focus.

A third related term is 'engineering education'. This term, too, must be distinguished from the term 'technology education'. Engineering is the domain of professions that is concerned with the development and maintenance of technological devices and systems. Although engineers use technology, like citizens also do, this is not their primary role. The work of engineers is to design new technological solutions to practical problems or to improve existing ones. To be able to do that, engineers need knowledge about the physical and chemical phenomena that underlie the functioning of artifacts and systems. They also need knowledge of mathematics for modeling and making calculations. Technology education is broader than engineering education, because it also entails what users need to know and be able to do. Sometimes it is mentioned as a difference that

technology education also covers the human and social aspects of technology, whereas engineering education only deals with the 'hard' aspects of technology. This, however, is in conflict with many developments in engineering education today. It has become clear that engineers can not do a good job without taking into account the human and social aspects. We have learnt that every technological problem in fact is a socio-technological problem, and therefore needs to be approached as such. This has caused important changes in the education of engineers. It has certainly brought engineering education closer to technology education as engineers are now often taught how to imagine themselves in the position of users. Nevertheless, there is still a difference. In engineering education students are still primarily prepared to become an engineer, and in technology education students are prepared to become citizens, irrespective of their future career.

The term 'engineering education' is closely related to another term than can easily cause confusion about the nature of technology education, namely the term 'vocational education'. Vocational education prepares for a specific profession. Technology education offers an introduction to technology as a component of both our professional life and our life as a consumer and citizen. As a consequence, vocational education, like engineering education, deals with technology in a much more detailed and in-depth way. This is only possible due to the limited scope of vocational education. Technology education is a form of generic education, and vocational education is a form of specialized education. Sometimes vocational education is seen as part of technology education. In this Handbook, however, we will use the term 'technology education' as the type of education that primarily contributes to the general education of all future citizens.

2. The development of technology education

Although mature enough to have its own Handbook now, technology education is still a latecomer in education. It was only in the past two or three decades that it has been developed on a worldwide scale (see De Vries 2000 and De Vries 2006). In that respect it is relatively new. But 'new' is not to be taken in an absolute sense. In many cases technology education emerged from an already existing subject. In most countries that subject was craft. The history of technology education to a large extent can be characterized as the effort to move away from this past, both in content and in reputation. Still today, technology education struggles with inappropriate popular images of what it is. Policy makers, school board, parents and industry still tend to think about technology education as a school subject in which pupils learn to make simple devices by processing materials with a variety of hand tools and simple machines. These prejudices are extremely hard to correct. But even if technology educators would be able to convince the 'outsiders' of the true nature of technology education, there will be another barrier for the reputation of this learning area.

The development of technology education is also hampered by the competition with science education. In principle, science education and technology education need not be competitors at all, but in practice this is often the case. There is a simple reason for this. It is again related to terminology, as in the previous section. It is common language to say that television, mobile phones, computers and whatever other device is the outcome of

science, not of technology. In newspapers one will read that “scientists have invented a new type of device for . . .”, while actually invention is not what scientists do, but technologists. This has to do with an old and deeply embedded preference for the cognitive over the practical. We admire the new high tech devices that we see around us, and because of their sophistication we think that they must be the work of scientists. Technology is associated with technicians and they only do the simple things, like repairing the toilet or screwing a plug onto a wire. It will take a long time before such prejudices will be taken away, and meanwhile technology education will continue to struggle with the strong position of science education in the school curriculum.

In the course of time, technology educators have taken different routes to overcome this barrier. One obvious way to go is the following: if you can not beat them, join them. This, however, still assumes that science and technology are competitors and this is not a very fruitful way to think. There are good reasons in the nature of both science and technology why these two learning areas can be related. Science does play an important role in technology, because it offers insights into the sort of variables designers can consider for optimizing their designs. Vice versa, technology offers instruments to scientists for experimenting, measuring and processing data. If one then also realizes that this interaction between science and technology does not take place in a vacuum, but is embedded in a social context, one ends up with a type of education that is often called ‘Science, Technology and Society’, or shortly STS. In theory this could be an appropriate way to teach about both science and technology (see Section 8). In practice, however, the central T is crushed between the two surrounding S’s. The practice of STS has often been that technology merely functions as a motivating context for teaching science. It is the social relevance of technology that features in STS teaching, not the nature of technology itself. This is why STS has been a problematic issue in the development of technology education more than a stimulus.

The alternative route for solving the problem of competition with science is to develop technology education into a separate subject in which the specific characteristics of technology are strongly emphasized and used to differentiate it from science. There are certainly many opportunities for that, and in fact a lot of recent insights in the philosophy of technology deal with such specifics. For instance, the normative dimension in technological knowledge, that is absent in scientific knowledge, is such a distinguishing element, as well as the ‘designerly’ ways of thinking that were identified by design methodologists (“means-ends” reasoning as opposed to “cause-effect” reasoning). In general, design as a distinguishing activity in technology has been put forward to promote technology education as a distinct area in the curriculum (as opposed to investigating in the case of science). Also the manipulation of tools and materials, inherited from the craft past of technology education, still today often features as a distinct characteristic of technology education.

The outcome of all of this is that in many countries technology education has become a separate school subject (see Section 1). In some countries it has survived serious threats of being removed from the curriculum (e.g., in South Africa and Sweden). When this text was written (November 2008), technology education in Australia faced a similar threat.

In many countries it still struggles to maintain its position in the curriculum. Even in the United Kingdom where 'Design and Technology' (D&T) has a longstanding status as a subject that was even compulsory for pupils of ages 6-18, now it has been made elective for upper secondary education (ages 16-18) and its status is probably already under negotiations when this Handbook will come out. In some countries a decision has been made to integrate an existing subject 'technology' (or whatever the name may be) with science education. In those cases there is a chance of getting a positive combination in which the nature of both is done justice, but also the chance that technology will simply be absorbed by science (this scenario threatens technology education in, for example, the Netherlands). In some countries technology education is making significant progress (in particular New Zealand should be mentioned in that respect). Finally, there are countries in which technology education is still in its craft phase (e.g., Switzerland, Denmark). In a large country such as the United States of America, we find different practices in different states, and the main activity of the International Technology Education Association in that country is to create some unification in this palette to strengthen the overall position of technology education in the curriculum. The Standards for Technological Literacy have been a major accomplishment in that context.

3. Motives and stakeholders in technology education

The development of technology education in the school curriculum has been driven by several motives. The most obvious motive, of course, is the fact that technology plays such an important role in society, and that citizens must be technologically literate in order to be able to live in that society. A similar, but probably more vulnerable motive is that technology education is the subject 'par excellence' to stimulate general abilities such as creativity, problem solving skills, and communication skills (to mention a few). This ambition, however, is not unproblematic. Research studies have shown that these skills are much more context-dependent than it was assumed in the past. Therefore one can question if learning how to solve a technological problem will 'automatically' also improve pupils' abilities in solving other problems. It seems that one can indeed transfer from one context to another, but even then one is still way removed from 'general' skills. A third motive is that pupils need to know the nature of technology as a possible field of studies and careers. In many countries the number of engineers is a continuous concern and technology education is seen as a means for promoting technological studies and professions. The risk of using this motive is that it will move technology education in the direction of vocational education, with negative effects on its status and maybe also negative (narrowing) effects on its scope and content.

What motive is put forward depends, of course, on the stakeholder that promotes it. Although no data are available on which stakeholder prefers which motive, the following suggestion seems plausible. Technology educators themselves tend to put most emphasis on the cultural and social importance of learning about technology. Governments and industries often have primary interest in assuring a sufficient future workforce. Parents and school board tend to focus on the general educative merits of technology education, such as its contribution to stimulating creativity and problem solving skills. For pupils a new motive appears in case they have become acquainted with real good technology

education: it is fun! Pupils can experience it as a welcome change in a curriculum that otherwise is filled with more abstract subjects.

We have already seen that developments in technology education suffer from a negative image. Another problem appears when we study the way stakeholders assess technology education against the motives they subscribe. All stakeholders tend to be impatient when it comes to the realization of the motives for technology education. Although no school subject has ever been removed from the curriculum because it did not result in measurable social effects within a time span as short as one or two decades, or even only one government period, technology education is expected to meet such unrealistic expectations. When, for example, enrollment numbers for engineering studies do not go up within a couple of years, it is assumed that technology education fails to do its work.

4. The long-term aim of technology education and what it requires

This naïve thinking as sketched above does not do justice to the fact that the most important aims of technology can only be realized in the long run. For the realization of all the motives that have been mentioned in the previous section it is necessary for technology education to result in helping pupils and students develop a proper concept of technology, an understanding of the basic concepts in technology, and a positive-critical attitude towards technology (see Section 4). Many technology educators are of the opinion that in order to reach those goals it is best to give pupils and students the experience of going through the process of technology. Going through a process of designing is probably the best way to learn that technology is a human endeavor in which decision making, based on normative judgments, and the use of a variety of knowledge domains, plays a vital role. This approach has the additional advantage that it connects the various types of literacies that are aimed at in general education. Designing entails the use of language, symbols and numbers. By doing design technological literacy is connected with linguistic and numerical literacy. Sometimes this multi-literacy is even mentioned as an additional motive for having technology education in the school curriculum. A factor that can further enhance this multi-literacy is the increased role of new media and other technologies in technology education.

This learning can only take place when a number of conditions are fulfilled. In the first place it assumes the availability of teachers that have the right attitude and the necessary knowledge and skills to be able to design teaching and learning situations and environments in which such learning takes place. Teacher education programs need to be targeted towards educating such teachers (see Sections 4 and 5). Secondly, teachers, teacher educators and curriculum developers have to develop curricula and teaching materials that such teachers can use. Thirdly, the assessment of technology education, both formative and summative, must be rich and multifaceted in order to assure that multi-literacy teaching and learning will take place (see Section 6). Fourthly, industry support is needed to ensure the 'empirical validity' of technology education. Sometimes it is feared that industry involvement in technology education will narrow the scope of technology education, but this overlooks the fact that industries in the past decades have learnt a great deal about the importance of human and social aspects of technology. In

some countries, like Germany, it is even industry in particular that challenges technology education to emphasize this multi-literacy (for which the term “Schlüsselqualifikationen” or “key competencies” is used. A fifth crucial factor in the development of such learning is that the development of technology is supported by sound educational research (see Section ?). A true “R&D culture” is needed for technology education. It is particularly this conditions that still leaves much to be desired. This Handbook has a special focus on research for technology education. It is here that it becomes perhaps most clear that the Handbook should be seen as a torch rather than as a milestone. Much of what is written in this Handbook needs further development in order to reach its full value and thus is forward-looking rather than backward-looking. In the final chapter we will resume this point.

A final condition for reaching the long-term aims of technology education is the development of a continuous learning line through the various levels of education. Many countries are still far removed from that situation. Ideally, pupils would get a first orientation and awareness raising in primary education, a learning of basic concepts and processes in lower secondary, a more precise and differentiated image of (the various types of) technology in upper secondary and specialization in tertiary education (higher vocational or academic). This condition more and more appears to be even a condition for the survival of technology education in the school curriculum. In the countries where technology education is or has been under threat, the fact that technology education was only present in some levels of education contributed significantly to its vulnerability. Subjects that are only taught in lower secondary education and are not part of the exam syllabus are almost inevitably doomed to get a low status. This holds for technology education in many situations. Even if technology education is part of lower secondary education but is absent in primary education (which is the case in many countries), the position of technology education is easily attacked. Apart from the educational value, a continuous learning line therefore is a prerequisite for the success of technology education.

5. International developments

One of the driving forces behind the development of technology education, apart from the ones that have already been mentioned, is the increasing international cooperation. One of the most obvious effects of this is the blending of elements from different national traditions in technology education. As stated in Section 2, in many countries technology education emerged from a form of craft education. But the direction in which it emerged differed between countries. In some countries, design was brought in as a new element (as was the case in the United Kingdom). In other countries, such as the countries that were part of the former East Block in Europe, industrial production became the new focus. Again in other countries, learning concepts (that is, an enhancement of the cognitive element) became the new trend. Also, there were countries that brought in ‘high tech’ elements (such as robotics) in the technology education curriculum. Finally there were countries that particularly added the social aspect as a new ingredient. Thus a spectrum of approaches in technology education developed worldwide. Due to international conferences where people representing different approaches met and exchanged ideas,

elements from these approaches were transferred and curricula with richer combinations of elements developed.

One of the first organizations that initiated international exchange of information was the American Industrial Arts Association that changed its name into International Technology Education Association (ITEA) to indicate firstly a shift away from craft-based education and secondly an interest in internationalization. At around the same period, the series of international PATT conferences started. PATT is the acronym for Pupils' Attitude Toward Technology. This name referred to attitude research among pupils, which was the original interest of the PATT conferences. Later, the scope of the conferences widened and specific themes were defined for each conference. Cooperation with ITEA was established and since then international sessions are a reoccurring phenomenon at the ITEA Annual Conferences in the USA. Another organization that initialized international cooperation and meetings was the World Council of Associations for Technology Education (WOCATE). The early death of its founder, Dietrich Blandow, however, meant a substantial reduction in activities and today its existence is not much beyond a formality only. In the UK, the International Design And Technology Education Research (IDATER) conferences for some years functioned as a platform for exchange of research output, but they no longer exist today. To some extent the conferences organized by the UK teachers association DATA (Design And Technology Association) have taken over this role.

Apart from these conferences and their organizing bodies, there are the international journals as a vehicle for the internationalization of technology education. Of these, the International Journal for Technology and Design Education is the only one that is published by an academic (commercial) publisher, namely Springer (formerly Kluwer Academic Publishers). The Journal of Technology Education is published under the auspices of ITEA. Then there is the Journal of Technology Studies, published by Epsilon Pi Tau, a USA-based fraternity for technology education. The Journal for Design and Technology Education, published by DATA increasingly has an international character, visible in both its editorial board and in its contributing authors. Apart from the journals there are a couple of book series for technology education. Sense Publishers, a fairly recently founded academic publisher, has the International Technology Education Series, of which this Handbook is one of the volumes. Springer has the International Science and Technology Library, in which some titles came out with a strong technology focus.

The result of these efforts to bring together knowledge and experience from different countries was not only that elements from different approaches to technology education merged, but also that international research projects were established. The DEPTH project, for instance, was initiated at a PATT conference and later the results were published in the International Journal of Technology and Design Education. Efforts have been made to produce an international agenda for technology education research, but this has never led to a substantial effort to coordinate international research for technology education. Also the idea of an international technology education curriculum has been brought forward at several conferences, but never led to anything practical. The differences in (national) contexts apparently are a barrier for more drastic

internationalization of technology education. The more modest efforts, though, clearly have had an impact on technology education practice. Also international contacts have been instrumental in the success of technology educators in, e.g., South-Africa and Sweden in their efforts to save the position of technology education in their national curricula.

6. Readers and authors

The purpose of its publication is to provide a general introduction to the field of technology education for (relatively) outsiders and as a source of information for those who are involved in it. We believe it can also serve as a reference text for teacher education programs to introduce future technology teachers to the main topics and issues that are relevant for their (future) field of teaching.

In the course of this chapter all Sections have been introduced. For each of the Sections, the section editor has written an introduction that provides more detailed information about the chapters in that Section, as well as a more in-depth introduction of the topic with which that Section is concerned. In the closing chapter the various lines will be brought together in a final consideration of the future of technology education that focuses particularly on the quest for sustainability of technology education as an often threatened learning area.

Readers will notice that the various chapters in this Handbook differ in nature. These differences are often related to the various backgrounds from which the contributors have written their texts. Several of the authors in Section 2 (in particular the philosophers of technology) are not directly involved in technology education but have developed insights that can serve as a resource for those that are. Some authors are involved in technology education, but only as researchers and not in technology education practice. This may sometimes give a certain color of distance to their texts, although mostly it is not difficult to imagine consequences for technology education classroom practice. Other authors, mainly those in Section 7) wrote from a science or STS education background. Sometimes this is mirrored in their use of the word 'science' (which is at times used to indicate both science and technology). Finally there are authors that are directly involved in technology education practice, either as teacher educators or as technology teachers. Their chapters, of course, reveal a great degree of practical experience. Many of the teacher educators combine educational research and teacher training. In their situation, a direct translation of research output into educational practice is possible and often realized. Perhaps the gap between research output and the use of that output for improving practice is one of the most difficult ones to fill. Hopefully this Handbook, that brings together issues in technology education research and in technology education practice can help in passing the boundaries between these two.

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