International Handbook of Technology Education

Reviewing the Past Twenty Years
International Technology Education Studies

Series Editors
Rod Custer, Illinois State University, Normal USA
Marc J. de Vries, Eindhoven University of Technology, The Netherlands

Editorial Board
Piet Ankiewicz, University of Johannesburg, South Africa
Dov Kipperman, ORT Israel, Israel
Steven Lee, Taiwan National Normal University Taipei, Taiwan
Gene Martin, Technical Foundation of America, USA
Howard Middleton, Griffith University, Brisbane, Australia
Chitra Natarajan, Homi Bhabha Centre for Science Education, Mumbai, India
John R. Dakers, University of Glasgow, UK

Scope
Technology Education has gone through a lot of changes in the past decades. It has developed from a craft oriented school subject to a learning area in which the meaning of technology as an important part of our contemporary culture is explored, both by the learning of theoretical concepts and through practical activities. This development has been accompanied by educational research. The output of research studies is published mostly as articles in scholarly Technology Education and Science Education journals. There is a need, however, for more than that. The field still lacks an international book series that is entirely dedicated to Technology Education. The International Technology Education Studies aim at providing the opportunity to publish more extensive texts than in journal articles, or to publish coherent collections of articles/chapters that focus on a certain theme. In this book series monographs and edited volumes will be published. The books will be peer reviewed in order to assure the quality of the texts.
International Handbook of Technology Education

Reviewing the Past Twenty Years

Marc J. de Vries

Eindhoven University of Technology, Eindhoven, The Netherlands

Ilja Mottier

PATT Foundation, Leiden, The Netherlands

SENSE PUBLISHERS
ROTTERDAM / TAIPEI
Contents

Preface xi

Part A General introductions

1 Two decades of technology education in retrospect
   Marc J. de Vries 3

2 A retrospective look at what was essential for technology education during the past 20 years
   Kendall N. Starkweather 11

3 Comparing perspectives: Comparative research in technology education
   Margarita Pavlova 19

4 Is the whole more than the sum of its components? An analysis of technology education in ORT schools around the world
   Alejandro E. Ferrari, Marcos Berlatzky, Mario Cwi and Luis Perez, Dov Kipperman, Sergey Gorinskiy and Osnat Dagan 33

5 Changing practice and changing lenses: The evolution of ways of researching technology education
   Howard Middleton 53

Part B Country studies

6 Twenty years of educational standards for technology education in the United States
   William E. Dugger, Jr. 65
<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
<th>Author(s)</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Changes and progress in elementary technology education</td>
<td>Daniel E. Engstrom</td>
<td>83</td>
</tr>
<tr>
<td>8</td>
<td>The evolution of technology education in the United States: The case of North Carolina</td>
<td>Marie Hoepfl</td>
<td>95</td>
</tr>
<tr>
<td>9</td>
<td>Technology education and the influences of research: A United States perspective, 1985-2005</td>
<td>John Ritz and Philips Reed</td>
<td>113</td>
</tr>
<tr>
<td>10</td>
<td>From ideas to fruition – external funding and its impact on technology education</td>
<td>Gene Martin</td>
<td>125</td>
</tr>
<tr>
<td>11</td>
<td>Reflections on twenty years of wandering through the pathways and forest of technological education in Ontario, Canada</td>
<td>Ann Marie Hill</td>
<td>133</td>
</tr>
<tr>
<td>12</td>
<td>Developments in technology education in Canada</td>
<td>George J. Haché</td>
<td>171</td>
</tr>
<tr>
<td>13</td>
<td>Technological education and environmental sustainability, a critical examination of twenty years of Canadian practices and policies</td>
<td>Leo Elshof</td>
<td>179</td>
</tr>
<tr>
<td>14</td>
<td>Technology education in Australia: Twenty years in retrospect</td>
<td>P. John Williams</td>
<td>183</td>
</tr>
<tr>
<td>15</td>
<td>The developing field of technology education in New Zealand: The last twenty years</td>
<td>Alister Jones</td>
<td>197</td>
</tr>
<tr>
<td>Chapter</td>
<td>Title</td>
<td>Author(s)</td>
<td>Page</td>
</tr>
<tr>
<td>---------</td>
<td>-------------------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>16</td>
<td>The rhetoric and reality of technology education in Hong Kong</td>
<td>Ken Volk</td>
<td>213</td>
</tr>
<tr>
<td>17</td>
<td>The Japanese word “GIJUTSU”: Should it mean “skills” or “technology”?</td>
<td>Toshiki Matsuda</td>
<td>227</td>
</tr>
<tr>
<td>18</td>
<td>A change of industrial technology education curriculum and development of a design learning support system for technology education</td>
<td>Sumiyoshi Mita, Toshiki Matsuda, Jun Iwaki and Takahisa Furuta</td>
<td>241</td>
</tr>
<tr>
<td>19</td>
<td>The centrality of designing – an emerging realisation from three curriculum projects</td>
<td>David Barlex</td>
<td>253</td>
</tr>
<tr>
<td>20</td>
<td>‘I think therefore I design’ (When Descartes met Bronowski)</td>
<td>Tony Lawler</td>
<td>261</td>
</tr>
<tr>
<td>21</td>
<td>The inclusion of food technology as an aspect of technology education in the English school curriculum: A critical review</td>
<td>Marion Rutland</td>
<td>273</td>
</tr>
<tr>
<td>23</td>
<td>Unorthodox methodologies: Approaches to understanding design and technology</td>
<td>Kay Stables and Richard Kimbell</td>
<td>313</td>
</tr>
<tr>
<td>24</td>
<td>Technology education in Scotland: An investigation of the past twenty years</td>
<td>John Dakers</td>
<td>331</td>
</tr>
</tbody>
</table>
25 Mapping reform in Scotland's technology education curriculum: Change and curriculum policy in the compulsory sector
Robert A. Doherty and Brian Canavan 347

26 From dualism towards an emphasis on talent: An overview of curriculum development in Flanders
Didier Van de Velde and Peter Hantsen 377

27 Analysing technology education through curricular evolution and investigation themes
Jacques Ginestié 387

28 Artefacts and cognitive development: How do psychogenetic theories of intelligence help in understanding the influence of technical environments on the development of thought?
Pierre Vérillon and Colette Andreucci 399

29 Stages of 30 years of technology education in Germany
Gerd Höpken 417

30 The last ten years: Change in Malta
David Purchase 429

31 Technology education in Finland
Tapani Kananoja 437

32 Are girls equal in technology education?
Aki Rasinen, Pasi Ikonen, Timo Rissanen 449

33 Innovation of the concept and content of technology education in the Czech Republic in context with their development in the countries of central Europe
Hana Novakova 463

viii
34 Engineering and excellence: An old-new agenda for technology education in Israeli high schools
Moshe Barak

35 Science and technology links in Israeli secondary schools - do we have a reason to celebrate?
Dov Kipperman

36 Technology education in Chile after nine years of implementation: From paper to classroom
Francisca Elton

37 Technology teacher education in South Africa
Andrew Stevens

38 Linking the problem, the project and the design process: A retrospective view on introducing rural teachers to technology education
Calvijn Potgieter

List of authors
PREFACE

This Handbook in a way is the outcome of a jubilee. Its chapters were originally written as papers for the 15th International PATT Conference that was held in Haarlem, the Netherlands, April 18-22, 2005. This conference marked 20 years of PATT conferences. PATT started out as a research into Pupils Attitudes Towards Technology (hence the acronym PATT). A national survey in the Netherlands produced outcomes that were intriguing enough to give rise to interest in other countries. As the original Dutch survey started to be replicated in other countries, a first workshop was held in 1985 to bring together the people that were involved in these efforts to discuss methods and outcomes of PATT-studies. This PATT-workshop was to be the first of a still continuing series. At that time we did not yet envision that PATT conferences were to become a long-standing series, and for that reason there was no ‘1’ added to the name of the workshop: it was just PATT, not PATT-1. But later on it appeared that PATT-1 would have been appropriate after all. In the course of time, the scope of PATT conferences broadened. Not only the PATT-studies were discussed, but also consequences for and relationships with all other aspects of technology education: curriculum development, teacher education, education for entrepreneurship, environment, industry, assessment of technology education, impacts of technology education, etcetera. Most of the PATT conferences were held in the Netherlands, but later on PATT conferences were also held in other countries: Kenya, Poland, South Africa, and Scotland. An agreement with ITEA, moderated by Dr. Kendall Starkweather, led to a series of biannual PATT conferences that were embedded in the ITEA Annual Conferences programs.

As PATT-15 had a sort of jubilee character it was decided to use that opportunity to invite people to submit papers in which retrospective views on 20 years of technology education were presented. This appeared to be a good decision, as many colleagues expressed an interest to see what progress had been made in the past two decades. The PATT-15 conference provided a useful platform for discussing these developments and for obtaining a truly worldwide perspective, as countries from all continents were represented. It was our opinion that such a unique opportunity to get an impression of what 20 years of continued efforts in technology education have brought should be opened to those who could not participate as well. It was about that same time that Peter de Liefde came up with the idea to start a new series of books that was to be entirely dedicated to technology education (contrary to series with ‘Science Education and Technology Education’ that in fact deal with science education primarily). It seemed to be a good idea to start this new series for Sense Publishers with what is now the ‘Handbook 20 Years of Technology Education’.

The editors of this book have made a selection of the PATT-15 papers and all of them went through a review process. We want to thank those colleagues who were willing to review papers: Frank Banks (UK), Rod Custer (USA), John Dakers (UK), Jacques Ginestié (France), Chak-Yin Tang (Hong Kong), John Williams (Australia). Thanks to their efforts the quality of this book has been guarded.
carefully. Special thanks to John Dakers and Wendy Dow for the work they did on language editing some papers written by non-native speakers.

Contrary to many other thematic books we have not strived for uniformity in the papers. This does justice to reality. The situation in different countries varies so widely that the stores of two decades of technology education can take quite different shapes. For some countries we have several expensive papers each of which focus on a different aspect of technology education; for other one short paper is the most efficient way to describe what has happened in 20 years. Some papers are based on empirical research findings; for other countries such data for the description do not exist (yet). This may give the Handbook a somewhat unorthodox appearance, but in our view this is the best way to deal with the global reality of technology education.

We want to thank Peter de Liefde for his initiative to publish this Handbook as the first of the new series ‘International Technology Education Studies’. The technology education community already owes a lot to Peter because of his efforts with respect to the International Journal of Technology & Design Education in the time that he still worked for Kluwer Academic Publishers (now Springer). We wish him all the best with his young publishing company, and we are well aware that its success will be of great value to the field of technology education internationally.

Papendrecht/Leiden, Fall 2005

Marc de Vries and Ilja Mottier
Board of the PATT-Foundation
Part A General introductions
1. TWO DECADES OF TECHNOLOGY EDUCATION IN RETROSPECT

WHY LOOK BACK IF YOU NEED TO MOVE FORWARD?

This handbook offers a fairly unique collection of articles, each of which looks back at a 20 year period of technology education. The collection is truly international. But why bother to write all those retrospective texts? One is tempted to answer: because you can learn from the past how to act in the future. That is certainly not an answer that everyone will take for granted. Some sources say that Henri Ford, the famous car manufacturer, once made the following remark: “history is bunk”. Ford was a practical man. His main concern was how to improve the production process of his model-T cars by using the concept of mass production. Studying the past for him did not seem to be a useful way to spend his time. Another quote in the same realm is: “the only thing we learn from history is that we do not learn anything from history” (source unknown). According to this quote it does not matter what the past tells us, because we will not listen anyway. We make the same mistakes over and over. Yet, it may well be that we do unwise by ignoring the past. Here is a third quote: “history teaches nothing, but only punishes for not learning its lessons”. This quote takes a different point of view: it may seem that history is a random collection of facts, but once we have concluded from that there nothing can be learnt from history and acted accordingly, we find out to our misfortune that we could have avoided mistakes by taking into account what history after all did appear to tell.

In the development of a school subject or learning area, a period of 20 years is relatively short. Most school subjects have developed in the course of a process that took perhaps even several ages (depending on what one counts as the true starting point of the development). For technology education, it has been a turbulent period, even though indeed it was ‘just’ 20 years. That makes it even more difficult to draw conclusions from it. Still a retrospective view on the past two decades of technology education may be a useful exercise. In the first place it tells us how we got where we are now. Understanding the current situation can be enriched by insights about how technology education has become what we know it is now. Various questions about why we do the things the way we do them can be answered at least partially by information about the paths that led to the position we take now. In the second place it may help us decide about future steps. ‘May’ because there is no simple one-to-one relationship between what was in the past
and what will be in the future. In that respect the idea that we can simply copy the successful acts from the past into the future does not hold. Too many things change over time and all of those play a part in the failure or success of our acts. Yet it helps to take into account as many as those ‘background variables’ as we can identify when we try to draw some careful conclusions from the past about what is wise and what is unwise to do. Even then we hesitate to be too firm in our answers, but even if our understanding is only partial, it is still better than knowing nothing.

WHAT CAN HAPPEN IN 20 YEARS?

The articles in this Handbook reveal the diversity in ‘histories of technology education’ in various countries in the world. Certainly there a common themes and concerns that reoccur in nearly all countries, but the actual process of technology education evolutions differs from one country to the other. Some patterns can be identified. In some cases it seems that there has not been much movement at all. In some countries, technology education was a craft-oriented school subject 20 years ago and it still is. Some of the Scandinavian countries are in that category, but also Switzerland and Austria. One seldom meets people from those countries in (international) technology education conferences, not do we find publications about those countries in our scholarly journals. In other countries the situation of technology education looks very much the same as the situation of 20 years ago, but rather than stability there was a period of back-and-forth movement, or, if one prefers to phrase it differently, a period of circular movement. Changes have been made and have been made undone in the same short 20-year period. Malta, and in some respects Scotland, are examples of that. It can be a very frustrating experience to be involved in such a movement. Fortunately in a third category of countries real and lasting progress has been made. Country size does not seem be play a vital part in that, because both a large country such as the USA, and a much smaller country such as New Zealand can be counted among the countries in this category. Evidently the secret of success is not in being small or being large, but in other factors that are worth identifying because they might yield important information about what works and what does not (again: we have to be careful here and take into account the many peculiarities and ‘background variables’). Fourthly and finally, there are countries in which developments in the past 20 years have led to a point of decision. In those 20 years fundamental changes have been made in the teaching about technology in schools, and now the politicians want to see results. In many cases it is difficult to anticipate what kind of results they see as valuable. But in any case politicians are not patient people. In spite of what educationalists say, twenty years is a long rather than a short period for them. Money has been invested and they want to harvest now. Educationalists will see that as unfair, but it is social reality and just the way things are. In countries such as France and the Netherlands we see this happening: governments push to decisions: do we want to keep technology education as a distinct entity in the curriculum, do we integrate it with better-established entities such as science education, or do we want to do away with it totally? Of course one can not reasonably expect a new or
drastically reformed school subject to result in concrete evidence of success in just 20 years. Yet, for several countries the fate of technology education depends on that.

The picture sketched above is a simplification for countries that consist of states each of which has a certain degree of autonomy in educational matters. Canada and Germany are examples of that. Different states in those countries have taken different routes in the past 20 years and with different outcomes. In the case of Germany the variety makes it virtually impossible to write an article on ‘20 years of technology education in Germany’. For Canada an effort has been made to write such an article, but here we see at least some movement towards a common approach between states. Such a movement is possible, as the examples of the USA and Australia show us. Those countries started our 20 year period with a very diversified situations, but in that period quite serious efforts have been made to reach agreements among the various states. It is clear that there are advantages of scale in that. Practice also reveals that agreements at a high level of management do not immediately result in changes at the ‘work floor level’. Policy and practice can be quite different things.

AREAS OF PROGRESS

In spite of all the frustrations that people go through in several of the countries that are represented in this Handbook, the overall impression is that there are at least some areas where real progress has been made in the past 20 years. In this section the most important ones will be described. For all of those it needs to be emphasized that none of them guarantees the survival of technology education. The examples of France and the Netherlands show that technology education has come under serious threat in spite of the fact that substantial progress has been made in several of the areas that will be described here. In particular the New Zealand case shows that it is only when a combination of areas of progress is in place, the position of technology education in the curriculum flourishes.

A first area of progress is in the philosophical basis for technology education. Two types of progress are visible here. The first one is the evolution of the philosophy of technology as a disciplinary field. In the past 20 years the existing ‘Continental’ philosophy of technology (‘Continental’ thereby referring to the fact that most philosophers of this kind of ‘the big questions’ philosophy lived and worked on the European Continent), became accompanied by a more analytically-oriented kind of philosophy of technology. Analytical philosophy originally was mainly Wittgenstein-oriented and positivist philosophy, but now it is much broader. In general one can say that a stream of philosophers has grown that are interested in analyzing technology ‘from inside’ rather than only making normative statements about the ‘impacts’ or ‘effects’ of technology on humans and on society. Debates about ‘the big questions’ according to those philosophers would benefit greatly from careful analyses about what technology actually is and how themes such as technical artifacts, technological knowledge, design processes can be conceptualized properly. A second progress is that technology educators in the
past two decades have become more and more interested into studying the field of philosophy of technology. Perhaps they had good reasons to do that not until recently. Many of the Continental philosophers wrote fairly critically about technology without showing evidence of a real understanding of what engineers do and think (and perhaps even without showing evidence of a genuine interest to get to know that). That can be a reason for people involved in teaching technology to keep distance from those philosophers in whose eyes technology can only do harm. Many of the analytical philosophers of technology have an engineering background themselves. That makes them more attractive for technology educators as references in the process of establishing a conceptual framework for technology education. The need for having such a framework is becoming more and more evident, in particular in those countries in which the position of technology education in the curriculum is under threat now. If in such a situation neither teachers, nor teacher educators, nor curriculum developers can give a proper and convincing answer to the question "what is your subject about?", then one can expect serious trouble.

A second area of progress is the scope of the content of technology education in the school curriculum. Here a movement has taken place from a position in which technology education has a narrow focus, being mainly about craft skills, towards a situation in which teaching about technology also takes into account the social aspects of technology and the more cognitive, conceptual and epistemic aspects of technology. It is interesting to see that this broadening of scope has led to different changes in the definition of the content of technology education at the policy level. In some countries the widening of scope has resulted in the insight that it is simply impossible and fruitless to try to capture each and every topic in the curriculum by working with a detailed description of the subject content. In such countries, like the UK and South Africa, the content description at policy level has become less detailed, thus leaving ample opportunity for schools to make their own widening of scope according to their local needs. In other countries, such as the USA, the broadening in scope resulted in a more detailed description of standards for technology education. The idea behind doing that is the experience that schools will not broaden the scope of technology education unless that get clear directions about what new aspects to include. It is difficult to say which of these two approaches (becoming less detailed or more detailed) works best and probably this is an example of where one must take into account all the ‘background variables’ of a country when assessing what can be learnt from it.

The broadening in content scope has gone hand in hand with a pedagogical development. In the early phases of technology education there was a strong focus on learning specific skills in a sort of guilds tradition. The master would show how to do it and the pupil would copy the act. Nowadays pupils are expected to develop their own ideas about technology, thereby starting from intuitive ideas towards ideas that have been learnt in authentic situations (as far as educational settings allow for realizing those, of course). In this respect technology education has been in the fortunate position that there were many newly gained insights in science education. Terms as ‘cognitive apprenticeship’, ‘authentic learning’, and
TWO DECADES OF TECHNOLOGY EDUCATION

‘constructivist approach’ could all be borrowed from science education. That, of course, does not mean that technology education could skip all the years of struggle that science education went through to get grips on these issues, but it surely helped technology education mature in a much shorter period. Such struggles can be seen for example in the way design projects have been conducted in the UK in earlier years. Pupils were then guided to fairly prescribed processes that sometimes almost got the character of ‘rituals’. Pupils were forced to come up with more than one possible design solution, merely for the fact that the design process flowchart demanded so. No one seemed to be concerned about the fact that pupils did this only to immediately reject the options in which they had never believed anyway but that they had produced only for the sake of obeying the teacher’s flowchart. So clearly, struggles have been there in finding a good pedagogy for technology education.

A fourth area of progress in the overall development of technology education worldwide is educational research. Twenty years ago for publishing research output there were only science education journals available for people conducting technology education research. Now we have several scholarly journals, one of which is published by a well-respected commercial academic publisher. The existence of such journals is a precious thing. It guarantees that technology education research can be published, also in cases where there is no direct relationship with science education. But those journals need content, and therefore it is important that technology education research is done and will continue to be done. In the past 20 years the research agenda has certainly made progress. In earlier years, most technology education research dealt with desired curriculum content. If at all these studies were of an empirical nature, they were surveys among experts to ask their opinions about what should be taught and learnt in technology education. This was certainly a necessary part of the research agenda, and to some extent it will always remain to be that. But gradually a new type of study emerged: empirical studies into classroom practice. Such studies were extremely useful, for example for revealing the ‘ritual’ character of many design projects. Also an interest emerged in getting to know what pupils, students and teachers think about technology and about technology education. This type of research, though, still today is only a small minority of all research studies, in spite of the fact that it seems to have an evident relevance for teaching about technology.

A fifth area in which undeniable progress has been made is the assessment of technology education. It must be remarked right away, though, that this is at the same time an area in which there is still a tremendous lot of work to be done. As for studies into people’s ideas about technology, for assessment studies too it seems totally needless to defend the relevance of such studies. And yet, for a long time there have been scarcely any developments there. Testing cognitive aspects of technology by means of paper-and-pencil tests was taken for granted as well as testing craft skills by letting pupils make simple (and useless) objects. That creative and problem solving skills also needed to be evaluated, and that this was a very complicated matter, was not recognized until recently. It is only since recent years
that we begin to understand the need for developing more sophisticated and varied instruments for assessing the various cognitive, affective and psychomotor aspects of technology. Much work has been done in portfolio type of assessments, in particular in the UK. Also in terms of research methodology undeniably progress has been made. In earlier years only quantitative research methods were taken seriously. But more recently, qualitative research methods have become real sources of insights, even though some methodological difficulties still linger on. In the meantime, educational research is certainly one of the areas that is under serious threat at the same time. The number of research centers for technology education worldwide seems to decrease rather than to increase. This has an impact, of course, on the flow of articles that go into scholarly journals for technology education. It also has an impact on the number and quality of project proposals that agencies such as the Technical Foundation of America receive. There is certainly no reason to sit back and enjoy the results of success.

The sixth area of progress is the international communication and cooperation in technology education. The past two decades have shown the emergence of a number of series of international conferences and projects. One of the long-term ones is the series of PATT conferences (PATT is the acronym for: Pupils’ Attitudes Towards Technology). Such conferences and projects are no longer temporary exchanges of ideas, but they are more and more influencing the development of technology education in various countries. Finland is a good example of that. Key persons in technology education participated in international activities and implemented ideas from that into their national curriculum. Another example is South Africa, where the original UK influence was increasingly mixed with ideas from other countries. Another indication for the internationalization of technology education is the increasing ambition of the USA’s main teachers’ association ITEA (International Association for Technology Education) to give international support to technology educators in various ways (for instance, by hosting the Technology Education Research Forum, in which major trends in technology education are identified and debated by people from all over the world). It may well be that these international contacts will become of crucial importance for the survival of technology education. In South Africa it had almost been decided to remove technology education as such from the curriculum, but the South African technology educators were able to convince their government that this would put South Africa in an isolated position internationally. Likewise, referring to developments in other countries may help technology educators in countries where technology education is under threat.

A TIME OF DECISION

As it has been remarked before, in a number of countries it seems the hour of truth has come. Governments question the relevance of technology education in their national curriculum, given the unclear status and results it still has. Several of the articles in this Handbook testify about decreasing numbers of hours for technology education in the schools’ timetables, decreasing numbers of available
teachers and of teachers-in-training, and decreasing budgets for technology teachers and for technology education research. In a number of countries the solution that governments envision is to integrate technology into science education. That is not an unreasonable thought. Technology, or at least modern technology, and science are closely intertwined. But the combination of technology education and science education is a mixed blessing for technology. Certainly there are positive aspects to this: technology will gain from the status of science educations, once linked to it more closely. Also there is gain in terms of content: a good understanding of the nature of technology necessarily entails an understanding of the relationship between science and technology. But there is a reverse side. Teaching the nature of technology as such may easily get lost once it is in the hand of science educators, many of whom still work with the old ‘technology as applied science’ paradigm. In the philosophy of science and of technology this paradigm has been abandoned almost entirely, but in education it still hangs around. In that paradigm technological topics are used in science education to motivate pupils to learn science content, or to show the ‘application’ of science in devices and systems. But the process that leads from science knowledge (and a whole lot of other factors) toward the products that we see around us remains hidden in that approach. And is not that process in the very heart of technology?

Yet, there is hope. The articles in this Handbook that tell us about serious threats to technology education are balanced by other articles that present cases of success. The survival of technology education in South Africa has been mentioned already before, as well as the success of the introduction of technology education in New Zealand. Also we read about enthusiastic teachers and pupils in countries such as Israel and Chile. This enthusiastic atmosphere is sometimes so evident that it can not be ignored by policy makers. That enthusiasm perhaps in the end is the best proof that something has been gained, even though it can not yet be expressed and calculated in terms of increased numbers of students in engineering, improved national economies, better results in industries or whatever ‘objective’ variable one would like to use as an indicated for the success of technology education.

**HOW THEN TO PROCEED?**

There is one thing one can be sure about: enthusiastic teachers and pupils will not be there unless we continue our efforts to build up a sound technology education theory and practice. Both these sides need to be covered. There is a continuous need to get clarity about the nature of technology and of technology education. At the same time we need to work on a technology education practice that convinces governments, school administrators and school boards, teachers, parents, and pupils, that teaching and learning about technology is not only fun but also a necessary component of every (future) citizen’s general education. The fact that these efforts have shown not to be sufficient for guaranteeing the survival of technology education should never hold us back from continuing these efforts. At the same time we need to improve in sophistication in our dealing with the political
process that in the end is decisive for technology education in schools. Often this process is a mystic sort of alchemy to us. We have great difficulties to estimate what is important in the eyes of those who decide about the position of technology education in a country’s educational system. Perhaps it would be worthwhile for technology educators to invest in gaining a better understanding of this process. It may not be the most interesting issue from an academic point of view, but it could well be of crucial importance for the decision about whether or not ultimately there will be any other activity for those involved technology education. Seeking international support has already been mentioned as a possible success factor in the survival of technology education in the coming decades.

THE STRUCTURE OF THE HANDBOOK

Two options for structuring the content of this Handbook have been considered. In the first option the content is present thematically. Such an approach would lead to sections on standards and curriculum content, on teacher education, on the use of media, on assessment, and on educational research, just to mention a couple of possible themes. We have chosen the alternative option of presenting the developments in technology education of the past two decades country-wise. The various themes in the development of technology education are so closely intertwined that describing national developments in terms of separated themes would seriously hurt the validity of that description. Therefore we have asked people to write about 20 years of technology education in their countries in a more comprehensive way. At the same time, for a number of countries articles have been written that do have a certain focus on specific issues, to enrich the more overall description of the country’s technology education evolution. The series of national surveys of 20 years of technology education are preceded by a small number of papers of a more general scope, namely about (the nature of) comparative studies and about trends in research methodologies. These articles are meant to guide us in our appreciation of the nationally oriented part of the Handbook. The order of the countries in this part is not related in any respect to the importance of those countries or to the success or failure of developments. We have only grouped countries in larger regions or continents. Even that is already more than one can really justify. The variety in approaches of technology education in Europe is already so large that the sense of taking Europe as one region is questionable. Yet, for other ‘regions’ (North America, for instance) there is more justification in presenting developments in that way.

This editors’ choice has resulted in the following structure of the Handbook. This introductory chapter is followed by two papers of a more general nature: Starkweather’s article on the relevance of technology education and for studying developments in technology education, Pavlova’s article on comparative studies, Dagan’s article as a concrete example of such a study, and Middleton’s article on international trends in technology education research methodologies. Then follow a number of sections that contain studies on specific countries. We start with a section on North-American developments. The set of articles about the USA have
some different focuses: standards (Dugger), elementary education (Engstrom), state-level developments (Hoepfl), research (Ritz and Reed), and funding (Martin). For Canada we have three accounts: one that describes the overall situation in Canada (Hill), one that focuses on one of the Canadian states (Haché) and one that focuses on sustainability as an issue in Canadian technology education (Elshof).

Next region is the Australasian part of the world. Here we find UK influences, but blended with elements from many other approaches. Countries represented in this section are Australia (Williams), New Zealand (Jones), Hong Kong (Volk) and Japan (Matsuda and Mita). Can we identify differences in this region, the next region, Europe, shows even more variation. The UK is described most extensively here, and for good reasons because it has the longest and richest tradition in teaching about technology. Papers about the England and Wales have different focuses: specific projects (Barlex), design (Lawler), food technology (Rutland), relationships with science (Banks and McCormick), and assessment (Stables and Kimbell). Scotland is part of the UK, but has an educational approach that is distinct from the England and Wales educational system. Two papers describe developments in Scotland (Dakers and Doherty/Canavan; the two papers reveal differences between policy and practice). Other countries in this section are Belgium (Van de Velde and Hantson), France (Ginestié and Verillon; the latter with a specific focus on cognition research), Germany (Höpken), Malta (Purchase), Finland (Kananoja and Rasinen; the latter with a focus on gender) and the Central and Eastern European countries (Novakova). Given the fact that Israel has many connections with Europe, both politically and in its educational orientation, we have included this country in the Europe section (Barak and Kipperman; the latter with a focus on relationships with science). Finally we have Chile and South Africa, two countries in different parts of the southern hemisphere. Chile is a relative newcomer in technology education, but progress is quite impressive (Elton). A general survey of South Africa (Stevens) is accompanied by one that focuses on rural areas (Potgieter), a particular challenge to technology education in all African countries.

Although this selection leaves many countries not represented here, the editors claim that all relevant developments in technology education of the past two decades are described in this Handbook. The collection shows that those two decades have brought both growth and maturing, and also serious threats for the future. What will become of technology education worldwide is by no means evident at this moment. The survey of developments that is presented in this Handbook may serve a role in helping technology educators in different countries strengthen the position and practice of teaching about technology. The fact that technology is so important for our whole world, and is one of the main factors in the globalization of today, justifies that technology should be taught for all citizens. In that respect we agree with a remark, made by Dugger, when he said something like this: “now we work on a project ‘Technology for All Americans’. The next step should be: Technology for All”. 
KENDALL N. STARKWEATHER

2. A RETROSPECTIVE LOOK AT WHAT WAS ESSENTIAL FOR TECHNOLOGY EDUCATION DURING THE PAST 20 YEARS

In our closets back in our homes, our youth hangs in between old winter coats and forlorn ties, waiting for the new, maybe revised, or just different “us” to emerge. For as human beings, we know that we will progress in some fashion, good or bad, and make adjustments to what we wear, do, and how we think about things. What was essential before may not be essential now or in the future. All that we can predict is that change will happen. We do know that we will look different physically, think differently mentally, and change in what is important to us.

Focusing on “what was essential” rather than “what changed” during the past years causes us to ground our speculation in hope. What is essential to us is the same as what gives meaning to our lives, work, and world community.

Factors in society cause changes in what we consider essential. Political decisions are made. Natural and technological events happen that shake the world. It has been said that life is 10% what happens to you and 90% what you do about it. The natural human reaction is to make adjustments and move forward to the best of our ability.

A retrospective look at the many events that have occurred either intentionally or as a result of a series of events is a humbling task. Few worldwide efforts in our field have exceeded the amount of research and collaboration that have come from 20 years of technology education.

World leaders in technology, innovation, design, and engineering (TIDE) education have found this effort to be beneficial in advancing thought and practice. Leaders from many countries have been influenced by this effort. The number and names of those leaders are too numerous to count or identify. However, I would be remiss if I did not note the pioneering work of Dr. Jan Raat as a central figure who made a difference to many who followed him. He was a true gentleman, outstanding educator, and leader in our profession.

Historians tell us that it is important to look to our past so that we will not make the same mistakes in the future. We have so much to learn if we properly identify that which was important or essential to take forward in our work and lives. One would think that looking back 20 years would be easy for everything is unchangeable. However, we cannot look back without also looking to the present or future. We need a sense of continuity or perspective about the period in time.

We know that what was essential in the past may be of little importance in the future. In the end, the particulars of what people think about what happened in the last 20 years and what might be essential in the next 20 will matter less than the
exercise of pondering the question. Still, it is comforting from time to time to work backward, from the anxieties and ambiguous portents of daily life to the basics.

The following are questions to ponder when thinking about two decades of constant work.

- What was essential to our field in the last 20 years?
- Just as important, what was done about it?
- Are we proud of what we did?
- What led us to think in the direction(s) that we took?
- How did the events fit into the longer continuum of time relating to before and after the last 20 years?
- Did we make a difference?

We know that even 15 years ago, most of us did not have the use of desktop or portable computers as a part of our daily work routine. Laptops and portable phones were rare and unwieldy luxuries or were considered non-essential. We saw the Cold War come to an end. Four years later, the post war was shattered by acts of terrorism. Today, the language of the future has a dark edge.

The following selected events happened around the world since 1985. Around the World Timeline 1985-2005:

1985 New Zealand is declared a nuclear free zone
1985 Discovery of virus that causes AIDS is announced
1986 Partial meltdown at Soviet nuclear power plant (Chernobyl in Ukraine)
1986 U.S. space shuttle Challenger explodes after launch
1988 Pan American 747 explodes from terrorist bomb over Scotland
1989 Tanker Valdez spills 11 million gallons of crude oil into Alaskan Sound
1989 After 28 years, Berlin Wall opens to the West
1990 Hubble Space Telescope is boosted into orbit
1991 World Wide Web starts
1994 English Channel Tunnel between England & France is formally opened
1995 DVD Digital Video Disc becomes a consumer product
1997 Mars Pathfinder lands
2001 World Trade Center in New York City is leveled by terrorist
2004 Taipei 101, World’s Tallest building opens in Taiwan
2005 Tsunami devastates India Ocean region causing destruction unparalleled in history
(Boorstin, 1977)

It would be easy for each of us to add another 15 events to this list that relate to our home country. During this same time, the number of inventions and discoveries related to science and technology has been enormous. For example, the advent of the Internet and all of the inventions related to its use has considerably changed the financial, educational, political, and religious institutions in our society. Other
advances relate to artificial intelligence, genetics, biotechnologies, nanotechnologies and more. We have been a busy world of creators, inventors, designers, and innovators - reflecting what has become a very highly sophisticated, technological society with no end in sight.

Have we been able to keep up as a profession that professes to have content and methodology reflecting such an innovative society? What have we done during this same time? The following listing outlines what we have accomplished over the last 20 years.

TIDE Progress- 1985-2005; TIDE educators have-

- Adjusted their respective national curriculum thrusts to stay in the mainstream of efforts to advance education.
- Addressed changes relating to narrowing curriculum, enhancing achievement, and increased testing.
- Concentrated on student achievement at all levels (low-to-high ability levels).
- Adjusted definitions (i.e.-technology) as events in society have caused changes in their meaning.
- Created standards or similar criteria to be used in determining what students should know, be able to do, or value.
- Produced assessments in the quest to measure student performance.
- Advanced the technical content of the subject area to reflect the changes evolving from new technological disciplines.
- Advanced research on teaching and learning, professional and curriculum development, and teacher education and training.
- Explored new delivery methods as electronic advances have created new opportunities.

A closer examination of this list reveals that the items are timeless and essential for any subject area or discipline to advance during a given period of time. However, they are even more important to a subject area that changes as technology changes.

TIDE educators have also-

- Continued advocacy with policy makers, decision makers, and stakeholders to better position the field.
- Advanced new ideas on ways of thinking about TIDE.
- Built relationships with new communities, coalitions, and other subject areas to better position themselves within the education community.
- Fought for creditability such as the thrust in selected countries to become one of the basic or core school subjects.
• Shared successes and opportunities with colleagues from around the world.
• Closely examined the place in the school curriculum that the subject should be offered.
• Fought traditional thinking that placed the subject in training or skills curriculum rather than general education curriculum.
• Worked to position technology (TIDE) as a parallel subject in the curriculum with its mathematics and science partners.
• Looked at new borders for the subject area to include science/technology, engineering/technology, or science/technology/engineering/mathematics (STEM) resulting from technological advances and the latest curriculum thrusts.
• Served as the primary advocates from and for the educational community seeking to gain the proper role for this subject in an innovation oriented society.

As educators, we have been very busy. We have not been big in number when compared to our mathematics and science colleagues in our schools. However, we have carved an important position for our subject based on simple logic or reasoning. In short, what we teach is essential for a country to thrive in a world of challenge and change. The needs of a country to be innovative are as follows.

Educate next-generation innovators
Deepen science and engineering skills
Explore knowledge intersections
Equip workers for change
Support collaborative creativity
Energize entrepreneurialism
Reward long-term strategy
Build world-class infrastructure
Invest in frontier research
Attract global talent
Create high-wage jobs
(Council on Competitiveness, 2004)

These characteristics require the expertise of the economic, political, corporate, and educational institutions of a country all working together to achieve success. They require school subjects that allow experiences with technology, design, invention, and engineering.

Educators in our field have made adjustments, as fast as their resources would allow. One goal has been to create societal members who are in tune with technological innovations. We know that innovation improves the quality of lives in countless ways. Therefore, we have been and will continue to strive to:
A RETROSPECTIVE LOOK

- Enable achievement of dramatically higher levels of health.
- Develop product options for the aging population
- Find plentiful, affordable, environmentally friendly sources of energy
- Improve products and services by making them more affordable
- Expand access to knowledge
- Offer new forms of convenience, customization, and entertainment
- Solve the great challenges facing society

With these thoughts, we know that we will have an educational role in the years ahead. The intersection of invention and insight that creates innovation begins with strong and meaningful experiences related to technology, design, and engineering.

Asking the question- What was essential? started this presentation. We have attempted to put meaning into our lives and the lives of our students through activities designed to improve our profession. This work has been accomplished with optimism so fundamental to life that we hardly notice its presence, an optimism of essentials.

It is easy to answer this kind of question, which demands equal parts contemplation and speculation. And, the question itself- What is essential?- is ultimately an elegant rephrasing of the most basic question- What is the meaning of our lives? But, we ask it now because we are at a point in history filled with anxiety and nothing allays fear like getting back to the basics.

We hoard and plan as we muddle on regardless of a world that gives us little reassurance about our future! We have entered a time not just of known unknowns, but also of unknown unknowns! We are mortal beings, which struggle in the world to raise families, stay healthy, satisfy curiosity, amuse ourselves, and leave behind a record of who and what we were doing during our allotted time on the planet.

We did make a difference! You all are to be congratulated on your efforts during the past 20 years for doing your part to further discussion and advance ideas that made a difference. We changed the clothes in our professional closets and continued wearing those that were of importance. We advanced learning during our time to promote the ideals of our profession. In the end, the prime essential for our field will be to raise successful children with just values to be positive contributors to the complex, demanding, and fulfilling future that we anticipate with optimism.

REFERENCES


3. COMPARING PERSPECTIVES: COMPARATIVE RESEARCH IN TECHNOLOGY EDUCATION

INTRODUCTION

Retrospective analysis of what has been happening in a particular area over a particular period of time can provide a valuable reflection on how a phenomenon is being developed, what issues have been addressed and how it is possible to proceed in the future. This paper reflects on a number of different ways by which comparative research in technology education has been undertaken over the last 20 years. It is possible to identify three major periods in the process of its development. When technology education was established as a learning area a comparison had been made at the level of curriculum documents, syllabi and State Orders. People involved in this process were looking around the world for ideas.

The second stage of development of comparative research in technology education could be characterised by a great number of published or presented papers that described the situation in a particular country (Ajeyalemi, 1990; Putnam, 1992; Middleton, 1996; etc). Even though comparison, as such, was not used in this research, the underlying assumption was that it should inform the research community on different approaches towards the de

te hnology education and that it would be beneficial for the field.

The third stage involved comparison between two or more countries about one or more specific aspects of technology education. These include the meaning of the major concepts, teaching methods, goals, the balance between the global trends and local specificities, etc. (Lewis, 1996; Gradwell, 1996; Pavlova, 1998). This represented a movement from a somewhat superficial to a more systematic comparison, from comparison as a natural way of learning to comparison as a research method.

Histories of any field are collected and reflected on through the histories of individuals who are involved in the development of the field. The development of comparative education research is reflected in the biographical history of the author’s professional development. In 1988-1991 that research aimed at analysing English approaches to technology education and was conducted with the goal of informing and influencing the process of policy development in Russia. In 1997 – 2001 the research was focused on a particular issue – knowledge in technology education, with the aim to analyse it across several countries and to develop a framework for its conceptualisation. Writing about Russian technology education was also being undertaken in parallel with this.
Thus the paper will reflect on these stages and personal history of research and propose a way for the further development of comparative research in technology education, the way that can provide a framework for a better understanding of the role of technology education and its contribution towards students’ development and learning.

STAGE ONE – HELP ME TO ESTABLISH TECHNOLOGY EDUCATION

From the very early days of establishing technology education, comparative research played a significant role in its development. Technology education as a field of study was widely recognised by the end of the 1980s although the debate on including Technology in school curriculum started much earlier. By the end of the 1980s education, coupled with market reforms, became the dominant position in educational policy. Education has been seen as the source of responsiveness to technological change. A close association between education and the economy brought technology education as an important area of discussion in many reports undertaken by educational authorities in different countries. Changes in educational policy and the existence of different practical courses in school curriculum became the background for including technology education in the curriculum of comprehensive schools internationally.

In particular the assumption was made about the goals of technology education - to be relevant to the economic needs of the nation and to prepare students for work and life in society. Technology education was seen as a means for developing knowledge, skills, attitudes and values which allow students to maximize their flexibility and adaptability to their future employment, mainly, and to other aspects of life as well. In the UK, the former Secretary of State for Education, Kenneth Baker, announced that Technology as a subject was considered to be “of great significance for the economic well-being of this country” (cited in Barnett, 1992, p. 85). A Statement on Technology for Australian Schools explained: “Technology programs prepare students for living and working in an increasingly technological world and equip them for innovative and productive activity” (Curriculum Corporation, 1997, p. 4). In the USA it was announced that technology education was “vital to human welfare and economic prosperity” (ITEA, 1996, p.1).

This was the first stage in the development of comparative research in technology education. A comparison had been made at the level of curriculum documents, syllabi and State Orders. People involved in the development of technology education were looking around the world for ideas. During this first stage, approaches to the analysis were not very systematic. Every team that started work on the Syllabus for a particular country looked at the international experience, in many cases by going to other countries as published works were not available.

Similar research had been done at the national level in countries where the educational system was not centralised. For example in Australia this type of research examined developments in Australian schools in the area of technology
education in different states. A report of this study the *K-12 Technology Curriculum Map* was published in 1991. It stated that there was no generally accepted definition of technology education. A variety of roles designated for technology education highlight the absence of a common way of providing it in schools. Understanding of technological courses varied dramatically between applied science, informational technology, industrial technology and trade subjects. Technology education programs were focused on:

- the translation of scientific principles and ideas into tangible outcomes (Technology Studies);
- particular crafts (Practical Studies);
- natural phenomena (Science Studies);

However, the 1991 study identified a shift from an emphasis on physical and practical skills towards the inclusion of the more intellectually demanding processes of identifying needs, designing, problem-solving and appraising.

The results of this study highlighted the need to develop a common rationale for technology education across Australia to provide the different states with a common ground for school education in that area. It was established in 1994, through the National *Statement* and *Profiles*. This comparative research is a typical example of the first stage research. Its main goal was to inform the development of educational policy in the area.

### Table 1. Comparison of the formal parameters.

<table>
<thead>
<tr>
<th></th>
<th>Australia (QLD)</th>
<th>France</th>
<th>Russia</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Level on which the Syllabus is approved</strong></td>
<td>State</td>
<td>National</td>
<td>National</td>
</tr>
<tr>
<td><strong>Subject/learning area</strong></td>
<td>Learning area</td>
<td>Subject</td>
<td>Subject</td>
</tr>
<tr>
<td><strong>Compulsory</strong></td>
<td>Y1-Y10</td>
<td>Y1 – Y8</td>
<td>Y1 – Y 9</td>
</tr>
<tr>
<td><strong>Number of hour, per week</strong></td>
<td>1 - 2</td>
<td>1 - 2</td>
<td>2 (in Y9 – 1hour)</td>
</tr>
<tr>
<td><strong>How is it presented</strong></td>
<td>On 6 levels and beyond via 4 strands</td>
<td>Through the 3 cycles and scenarios</td>
<td>3 levels and 11 content modules</td>
</tr>
</tbody>
</table>

Sometimes the superficial comparisons of this period were not able to provide many insights into what was really happening and why it might be appropriate or not for particular settings. Comparison of formal parameters such as those presented in Table 1 provides some data but its usefulness was limited.

Comparative research at this stage was associated with one feature of the process of globalisation: the international circulation of ideas through social and political networks bringing common elements to curriculum documents of different countries. Compression of the world (Robertson, 1995) provided an opportunity to have a look at the ‘universal’ elements of technology education, and they had been
explored through the supranational connections. The author’s research was searching for the ‘universal’ elements in the English Syllabus that could improve Russian technology education (Pavlova, 1993). One of the elements was a design-based approach to curriculum development.

STAGE TWO – LET ME TELL YOU WHAT’S HAPPENING IN MY COUNTRY

Stage two in comparative research in technology education is related to another feature of globalisation: development of specific, conceptualised characteristics and emphasis on the realisation of policy in specific national settings. By the end of 1990s an issue of universalism versus cultural diversity became the main methodological challenge in comparative education research (Mitter 1997; Masemann, 1997). An argument had been made that the context of the particular country should be extensively analysed so that comparison can happen. Although there was little discussion of comparative methodology in technology education a large number of articles were published in the International Journal of Technology and Design Education (e.g. Potgieter, 2004; Jones, Harlow, Cowie, 2004; Wilson, and Harris, 2004; Compton, Harwood, 2003; Jones, 2003; Ginestié, 2002; Turnbull, 2002; Verner, Betzer, 2001; Given, Barlex, 2001; Volk, Yip, and Lo, 2003; Jones, and Moreland, 2002) as well as papers presented at international conferences (e.g. Huang, 2002; Compton and Harwood, 2002; Molwane, 2001, Lebeaume, 2003) that describe technology education (or particular issues) relevant to a particular country.

This research outlined what was specific for particular countries and how common ideas were being implemented. There were no comparative elements as such in this type of research. However, the underlying idea was that the cross-national comparison should have happened in the minds of academics. A lot of publications had a very descriptive nature that was not really helpful in moving the field forward. Particular contexts were described but it was not framed by the broader context that provides links or shared starting points for further analysis (universal side was not explored).

The author’s personal history of this stage relates to the analysis and description of technology education in Russia. The issues addressed included general description, analysis of the process of change, approaches towards teaching, design as a new concept, etc. For example, a number of limitations had been identified in interpretation and use of a design-based approach towards teaching technology. These were mainly caused by traditional perceptions of the educational process as a systematic approach to teaching based on theory (Pavlova and Pitt, 2000; Pavlova, 2002a).

STAGE THREE – THIS IS AN ISSUE, LET’S COMPARE

The dominant approach in comparative education by the end of 1990s was a cross-national comparison. It had been challenged by a number of researchers in comparative education (Welch, 1993; Cowen, 1996). As a result, an important
methodological problem was raised: what are the appropriate units for comparative analysis. This challenge was addressed in technology education research by choosing a particular issue (unit of analysis) such as problem solving, students’ attitudes, activities and comparing it across a number of countries (e.g. Banks, Barlex, Jarvinen, O'Sullivan, Owen-Jackson, Rutland, 2004; Graube, Dyrenfurth, and Theuerkauf (Eds.), 2004; Rasinen, 2003; Hill, Anning, 2001). Although, the global-local problematic has not been particularly explored, this type of analysis was useful for a number of reasons. Firstly it demonstrated an attempt to focus on a particular issue and to find better solutions that would be appropriate for particular contexts. Secondly, it represented a systematic approach towards comparison using comparison as a method of research. All three stages in the history of comparative education are closely interrelated, each provides knowledge and understanding required for the next stage.

Reflection on research done by the author, on knowledge in technology education provides an example of the study relevant to Stage three. A comparative analysis of educational documents that were directly connected to the policy in technology education was a part of that research. Consistency in choosing documents and their position (the statutory status or the consultative nature of the document) were considered as important issues in achieving a systematic approach towards comparison (Pavlova, 1998, Pavlova, 2001). For example, the date of publication of the documents analysed (before April 1999) was among the factors employed to provide a measure of consistency in the analysis. Multi-level analysis framed by the global –local considerations provided an appropriate methodology for this comparison. Results of the analysis that related to knowledge in technology education documents is summarised in Table 2.

This summary highlights that only declarative/conceptual knowledge was stated in the curriculum documents of Russia, the UK and the USA. In those countries procedural knowledge could be implicitly seen through the description of what students should be able to do or skills required. In the latest version of the Australian Statement declarative knowledge was not separately specified. The assumption was made that through the specified activities students develop the ‘required’ knowledge. Thus, the emphasis was on procedural knowledge. Required knowledge was explicitly described in the UK and the USA documents. In the UK document a list of knowledge was specified from the very first document and then gradually developed throughout the analysed period. In the USA the nature of knowledge in technology had been explored and then used as content for the Standards. Through the analysed period a shift had been made from considering technology as a body of knowledge to limiting its place as a part of the structure of technology. Nevertheless, knowledge per se remained in a very important place in the USA document.
Table 2. Understanding knowledge in curriculum documents - comparison between four countries

<table>
<thead>
<tr>
<th></th>
<th>Australia</th>
<th>UK</th>
<th>USA</th>
<th>Russia</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Definition of knowledge</strong></td>
<td>Non-explicit: Information is knowledge generated and used in everyday life</td>
<td>Not stated</td>
<td>Knowledge is interpreted information that can be put to use</td>
<td>Not stated</td>
</tr>
<tr>
<td><strong>Source of knowledge for technology education</strong></td>
<td>Not clear, Knowledge is not explicitly stated, the required activities are specified</td>
<td>Terms of Reference stated knowledge which students need to have to achieve technological capability</td>
<td>Place and nature of knowledge in technology</td>
<td>Non-justified selection of knowledge – what students have to learn to achieve the aims of the subject</td>
</tr>
<tr>
<td><strong>What knowledge is stated?</strong></td>
<td>Technical knowledge about information, systems, materials and process of designing, making, appraising + value judgments connected to those issues</td>
<td>Technical knowledge about materials, systems, structures, products, etc.</td>
<td>Technological knowledge; emphasise on the relationship between technology and society and vice versa</td>
<td>Technical knowledge or particular knowledge (legislation, for example)</td>
</tr>
<tr>
<td><strong>Relationship knowledge/understanding</strong></td>
<td>Not stated</td>
<td>Not stated</td>
<td>Understanding is knowledge synthesised into new insights</td>
<td>Not stated</td>
</tr>
<tr>
<td><strong>Structure</strong></td>
<td>Boundaries are not clear</td>
<td>Boundaries are not clear</td>
<td>It is possible to set up boundaries</td>
<td>Boundaries are clear</td>
</tr>
<tr>
<td><strong>Is the selected approach justified?</strong></td>
<td>No</td>
<td>Several assumptions have been made, no theoretical justification</td>
<td>Yes</td>
<td>No theoretical justification</td>
</tr>
</tbody>
</table>
Technological knowledge is seen as having clear boundaries in the USA and Russia, and without clear boundaries in the UK and Australia. At the end of the analysed period, in the UK the emphasis was on technical knowledge, although values were considered as playing an important role in technology. In Russian documents technical knowledge was seen as important to achieve the aims of technology education and was described in the content modules. In the USA, the philosophical/sociological aspects of the relationship between technology and society were stated as important.

The forms of knowledge and levels of its generalisation (using Mitcham’s approach) were used to some extent in the USA documents. In Australia, Russia, and the UK documents they were not discussed. In Australia and the UK the main emphasis was on lower levels of generalisation (artisan skills and technical maxims). In Russia and the USA the higher levels of knowledge were also involved (technological theories and descriptive laws). Knowledge about technology (as a general phenomenon) was included in the USA Standards and to a very limited extent in the Australian Statement.

These results together with analysis done on the other levels (academic discourse, academic perceptions) provided a basis for the development of a conceptual model of knowledge in technology education that incorporated universal-context-dependant elements.

This research also demonstrates that a different approach towards comparison is required to understand better the nature of technology education in different contexts. There is a need to have a framework that would allow an understanding of technology education not only on the level of educational policy, curriculum theories, and academics’ perceptions but also on the level of school practice.

Comparison on the basis of two ideological beliefs about the purposes of general education is proposed as a way forward in developing comparative research in technology education. These beliefs are: whether education is designed to broaden minds and develop all students in the creation of a better society or is it really about training students to live and work in a market-oriented state, to be ‘productive’ in seizing the opportunities of the market. These two approaches summarize an important issue that divides different social theories in their views on the role of education in society.

STAGE FOUR – COMPARE TO ESTABLISH A BETTER SOCIETY

The comparative research presented in stages 1-3 above was focused mainly on providing information and increasing awareness of what is happening around the globe. Here it is argued that comparative research in technology education can serve another purpose – it can help to establish a better society. In the proposed approach a comparison is made between two different rationales, thus cross-national comparison is overwritten by comparison that crosses country borders. In all societies it is possible to identify two major groups of technology educators who have different answers for the question: what is the nature of technology education? Is it instrumental or developmental? Two issues will be used to
demonstrate the utility of the proposed approach to comparative research. They are: values in technology education and education for sustainable development.

VALUES IN TECHNOLOGY EDUCATION

The necessity of exploring values in technology education has been argued by a number of authors (Layton, 1991; Barlex, 1993; Prime, 1993; McLaren, 1997; Breckon, 1998; Holdsworth and Conway, 1999) to be a vital aspect of a comprehensive technology curriculum. These researchers highlight the potential of a technology curriculum in enriching students' awareness and appreciation of their responsibility as members of a technological society. Further development of research in this area (Pavlova, 2002b) proposed a framework for addressing values in technology education based on the ideas drawn from philosophy (e.g. Habermas, 1974/1963) and psychology (e.g. Oser, 1994) and related to the notion of the hierarchical order of values (Schwartz, 1992 cited in Prime, 1993; Rokeach, 1973).

Among technology teachers, values related to competence (technical, economic) have a priority compared to moral values (Holdsworth and Conway, 1999). However, as stated by Habermas (1974/1963) rationality (defined as efficiency and economy) "cannot itself be placed on the same level with all the other values"(p.259) or prevail above them. He cited Hans Albert who made the suggestion:

to place in the foreground … in the establishment of a criterion for the validity of ethical systems, the satisfaction of human needs, the fulfillment of human desires, the avoidance of unnecessary human suffering. Such a criterion would have to be discovered and established, just as this is true for the criteria of scientific thought. (Habermas,1974/1963, p.280)

Thus, rationality and effectiveness must be framed by moral considerations. Moral values constitute a part of the person's value system. According to Rokeach (1973) moral values refer to those "that have an interpersonal focus which, when violated, arouse pangs of conscience or feeling of guilt for wrongdoing" (p.8). They refer mainly to modes of behaviour and "do not necessarily include values that concern end-states of existence"(p.8). The moral (morality) is considered as an aspect of the ethical, “namely that which particularly concentrates on obligation, the ought and ought-not, on duty and conscience and human virtues, where the ethical will also include consideration of the good life, happiness, well-being, admirable conduct over and above the call of duty"(Jarrett, 1991, p.14).

Moral values of both students and teachers should be addressed in technology education. In relation to the professional morality of the teacher a concern similar to that expressed by Habermas provides a basis for the theory that starts from the assumption that no professional action should be guided only by "functional criteria of means and end relations under the perspective of functional success" (Oser, 1994, p.60). As argued by Oser (1994)

A responsible professional action must be informed by a structure of moral values that enables the actor to estimate positive and negative consequences that
concern human beings immediately or indirectly. The relationship between success and care in regard to consequences is the core criterion of this theory. (p.60)

Thus, moral values should be at the top of the teachers’ hierarchy of values. It was suggested (Pavlova, 2002b) that in order to provide adequate learning experiences to students, technology teachers need to consider the relationship between effectiveness and responsibility as a starting point for approaching value analysis. The regulative model of professional morality, which 'limiting the aspects of effectiveness by the aspect of responsibility', was proposed as a framework for the development of an appropriate classroom environment in technology education. Teachers should view the classroom environment and the process of designing and making primarily as "a moral enterprise but as serving functional purposes"(Oser, 1994, p.103). It is important that teachers’ attention is being focused on moral values and on the inclusion of students as real discourse partners in discussion of ethically problematic situations.

Classroom environments that cultivate responsibility will stimulate students to put moral values first that would not be considered as one category of values among the others but as a reference point for all design decisions. The nature of technology education provides a rich context that can be easily moved beyond the concept of effectiveness. To deal with values effectively the teacher has to develop an appropriate classroom environment that will
- help students to recognise a situation as being ethically problematic,
- enable students to have a voice and express their feelings and thoughts, and
- find a solution that serves the best interests of all parties involved.

Thus, it was suggested that discussion of values presented in technology education literature at the moment, should be replaced by discussion of moral values. Also three components of values have to be taken into account:
- Cognitive component provides the awareness of different values and demonstrates reasons to put moral values first.
- Affective component establishes links between the technological task and students feeling by putting technology into a meaningful context.
- Behaviour component gives students an opportunity to act in accordance with their moral values.

The third component of values, a behavioral one, is not explicitly presented in technology education literature. However, it is analyzed in the psychological research as an important component of values that may lead to action (Rokeach, 1973).

Thus an argument about moral values that provides a frame for all technological activities strongly supports the importance of ‘developmental’ rationale for technology education.
The notion of developing students so they are capable of being involved in the creation of a better society, by developing their responsibility is closely related to the concept of sustainability that is concerned about the future of humanity and the quality of life for the further generations. “Education not only provides the scientific and technical skills required, it also provides the motivation, justification, and social support for pursuing and applying them. Education increases the capacities of people to transform their visions of society into operational realities” (UNESCO, 2001a, p.1)

Education for sustainable development (ESD) has gradually become an important issue for many educators internationally. UNESCO, for example, specifies that since Rio, there has been increasing recognition of the critical role of education in promoting sustainable life patterns in order to “change attitudes and behaviour of people as individuals, including as producers and consumers, and as citizens carrying out their collective activities” (UNESCO, 2001b, p.3).

Technology education as a part of general education can play an important role in promoting sustainable production and consumption. When the concept of sustainability is discussed within technology education it is focused mainly on the ethical aspects of the decisions that students make during design processes and on the sustainable design of products, with a major emphasis on the environmental impacts of these products (Elshof, 2003; Martin, 2003). These impacts can be assessed using such methodologies as Life Cycle Analysis (LCA) (http://www.pre.nl/life_cycle_assessment/default.htm) and Design for Environment (DfE) (http://www.pre.nl/ecodesign/default.htm).

A number of documents were developed to address the issue of education for sustainable development (ESD) at the national/state levels. For example, in the UK, in 2002 the Qualifications and Curriculum Authority produced a curriculum guidance document for schools, identifying the main concepts relating to ESD which provide opportunities to students to learn about ESD (referred to in Office for Standards in Education, 2003). In Australia, different states are developing their vision on ESD (Wooltorton, 2002). However the role of technology education in ESD has not been fully elaborated.

For example, a reference to appropriateness is made in the Queensland Syllabus. Appropriate technologies can be interpreted as ‘technologies with a human face’ aimed to enable people to earn a sustainable living. Although the ‘right’ statements are made in the content of technology education for Queensland schools, they are not included in the description of outcomes. Thus no assessment mechanism is proposed to measure to what extent teachers include these concepts in their practice and to what extent students will consider these issues when they are making judgments. In addition, a number of in-service materials have been printed to facilitate the implementation of technology education. However, examples (case studies) that are included in the Source book demonstrate that the meaning of appropriateness is very limited. Appropriateness is considered in terms of the particular local context and only within the current situation (not oriented towards...
The ‘right’ examples of design projects do not include the description of how appropriateness/sustainability can be taught.

Thus there are a number of problems in the representation of ESD in technology education. Not all aspects of sustainability (environmental, social, economic, ethical) have been conceptualised within technology education and as a result, guidance for technology education teachers concerning what to teach, how to teach and how to assess student learning is not coherent and comprehensive. Recent research on these issues (Pavlova, 2004) proposed a systematic representation of ESD for technology education and a framework for planning learning activities that can be a useful tool in facilitating discussion.

Although further research is required in developing ESD via technology education, its importance has been clearly stated. Together with an emphasis on moral values these highlight the importance of developing responsibility in technology education students that, in turn, relates to an identifiable rationale for technology education and teaching practice. Understanding of what rationale for technology education is used, instrumental or developmental, can provide a clear understanding of what technology education is about in a particular setting. Thus this framework for comparative research will help to gain a deeper understanding of technology education on both theoretical and practical levels and to see universal and contextualised elements in approaching the area.

CONCLUSION

This paper reflects on the history of comparative education research in technology education. Three stages of its development has been identified and analysed using some samples of research done in this area as well as some sample from personal professional history. Two important methodological issues: global trends – local specificities, and appropriate units of analysis were discussed to highlight different approaches adapted at different stages. A move towards the next stage in the development of comparative research in technology education has been argued as essential in moving research forward. Comparison on the basis of two ideological beliefs about the purposes of general education: whether education is designed to broaden minds and develop all students in the creation of a better society or is it really about training students to live and work in a market oriented state, to be ‘productive’ in seizing the opportunities of the market, was argued as an effective way of gaining an understanding of technology education in a particular setting. The importance of this new framework has been justified through discussion of two research issues – values in technology education and education for sustainable development.

REFERENCES

PAVLOVA


Lebeaume, J. (2003). The place of technology education in the curriculum: The French example of main issues for the middle school. In J. Dakers and M.J. de Vries (Eds) *PATT-13 International conference on design and technology educational research* (pp. 41-44). Glasgow, UK: Faculty of Education University of Glasgow.


PAVLOVA


