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5. A CONCEPT-CONTEXT FRAMEWORK FOR ENGINEERING AND TECHNOLOGY EDUCATION

Reflections on a Delphi Study

INTRODUCTION

In Part A of this book, some important learning theories have been discussed. They are concerned with the 'how' of teaching and learning. In this chapter, we move to the 'what' of teaching and learning. I will describe a framework for developing the content of Engineering and Technology Education (ETE). Thereby I will focus on basic concepts that constitute the discipline of Engineering and Technology Education. But content cannot be separated entirely from the teaching and learning strategies that are needed to turn these concepts into teachable and learnable content. In particular I will build upon the theories of constructivism and situated cognition (see Chapter 1). I will also show how this disciplinary framework is not only useful for developing education that prepares for further study (in engineering), but – even more importantly – for the technological literacy that each and every citizen needs in order to live in a technological world and have control over technology in her or his life.

CONCEPTS FOR ENGINEERING AND TECHNOLOGY EDUCATION

The Need for a Conceptual Framework for ETE

Technology Education has always struggled with its identity as a body of knowledge distinct from other school subjects. One could, of course, claim that this problem is not important for Technology Education, as this element in the school curriculum is not so much concerned with theory, but rather with skills. When Technology Education emerged out of various types of craft education, the scope of these skills broadened from merely making skills (handicraft) into a combination of designing and making skills. Later, when social issues also became a more prominent part of Technology Education, the range of skills was further extended with technology assessment skills. But knowledge seemed not to be a major concern. In light of what was considered to be the nature of technology, this was no surprise. For a long time, technology was thought to be equal to "applied science." As a consequence, the knowledge in technology was considered to be not really new knowledge, different from scientific knowledge, but just the application of that knowledge. It was only later that in the philosophy of technology it was acknowledged that technology

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does have its own knowledge, different from science. It was in particular the work of historian Walther Vincenti that brought about this awareness. In his now classic book What Engineers Know and How They Know It (1990), he presented a taxonomy of technological knowledge types and also showed that science only contributes to a minority of the types in his taxonomy. Knowledge in the other types must be derived from other sources, such as design experience, empirical engineering experiments and direct trial. Since then, philosophers of technology have been active in identifying characteristics of technological knowledge (for instance, the normativity that features in various types of technological knowledge; see Meijers and De Vries, 2009).

The term "Engineering and Technology Education" suggests a broadening of Technology Education by adding the "Engineering" component. This enhances the need to identify the knowledge base for this domain, as knowledge and theories play a vital part in engineering. For such a domain, it is absolutely necessary to have clear ideas of what constitutes its knowledge base. But how can one formulate this without ending up with an endless list of detailed knowledge elements that become easily outdated because of the dynamics of engineering and technology, or that one needs a core of basic concepts that are time-independent and will remain relevant over time. There are several ways that could lead to the identification of such a core. The first is a theoretical one. In the philosophy of technology, studies have been done in technological knowledge, as was mentioned earlier. One could try to derive a core of concepts from those philosophical reflections that could serve as a conceptual framework for Engineering and Technology Education. In doing this, one could also include the work of some technology education specialists who have written about concepts in engineering. In this respect, the work of colleagues from former Eastern European countries are an interesting source (Blandow 1992; Wolfgramm 1994)[1]. In the "polytechnic" education, as it used to be called, a strong focus had been placed on general technological concepts and theories. It was the political changes more than progression in insights that made the work of these colleagues obsolete (at least, in the eyes of the educational policy-makers in those countries). Their work remains valuable for today when we search for concepts and theories that could constitute a basis for Engineering and Technology Education. But there is also a more empirical route towards a conceptual framework for Engineering and Technology Education. One could consult colleagues who have systematically reflected on the theoretical basis of Engineering and/or Technology Education. The insights that these colleagues have gained over the years can become even more useful when confronted with each other and with the insights from the philosophy of technology. One way of accomplishing such a confrontation is by conducting a Delphi study. This is what was done in the summer of 2009 by a small international group of researchers[2].

A DELPHI STUDY INTO THE CONCEPTS AND CONTEXTS OF ENGINEERING AND TECHNOLOGY EDUCATION

About 30 international colleagues in Technology Education, Engineering Education and the Philosophy of Technology were asked to generate concepts of engineering and technology that they considered to be core concepts in these domains. After a first round of responding to concepts that were suggested by the researchers and adding their own concepts, two rounds followed in which the experts were confronted with each others' concepts and given the opportunity to rethink and re-rank the entire set of concepts. Following the (fairly loose) criteria, the researchers were able to establish a consensus after these three rounds. The fact that these criteria are rather loose gives the Delphi method a certain vulnerability, about which it is often criticised. But it is still used in spite of its weaknesses also by researchers of high reputation (for instance, Osborne, Collins, Radcliffe, Millar and Duschl (2003). The outcomes of the Delphi study were discussed by a small panel of experts, some of whom had been part of the Delphi group, and others examined the results with an entirely fresh view. The main aim of this exercise was to structure the list of concepts and contexts that had been generated by the Delphi study. The total list of concepts was divided into the most basic concepts and other concepts that were regarded to be subsumable under those basic concepts. For instance, the concepts 'materials,' 'energy' and 'information' were subsumed under the core concept of 'resources.' The outcome was a concise list of concepts that will now be presented and discussed.

CONCEPTS FOR ENGINEERING AND TECHNOLOGY EDUCATION

The outcome of the Delphi study was a list of concepts presented in Table 1[3].

Without giving meaning to the terms in this table, they remain empty words. Therefore, I will now discuss this meaning, thereby drawing on both the remarks made by experts during the Delphi study and the insights from the philosophy of technology.

Table 1. Concepts list

Main concept	*Sub-concepts*
Designing ('design as a verb')	Optimising Trade-offs Specifications Technology Assessment Inventing
Modelling	(no sub-concepts mentioned in the Delphi study; one can think of abstraction and idealization)
Systems	Artefacts ('design as a noun') Structure Function
Resources	Materials Energy Information
Values	Sustainability Innovation Risk/failure Social interaction

The term ‘design’ (as a verb, or ‘designing’) has been the object of considerable reflection and research[4]. Designing is the type of problem-solving in which a design problem is solved. This differentiates it from other types of problem-solving, such as fixing a malfunctioning device or solving a cryptogram puzzle. Designing is a human activity that leads from a practical problem to a solution that usually takes the shape of an artefact. In designing, people seek a material realisation for a practical function that is to be fulfilled. Apart from the requirement of fulfilling the function, there are usually a variety of other requirements related to other aspects of the problem (price, legislation, aesthetic considerations, the psychology of the user, etc.). A design problem would not be a problem if there no conflicts would exist between requirements. Designers somehow have to solve these conflicts, either by trade-offs or by creatively redefining the requirements. Creativity is what sparks the moment of invention, the moment of finding a possible solution for a problem ‘out of the blue.’ By assessing a possible solution against the requirements, redesigning it, and repeating this in a number of cycles, an optimised solution that fits best with all requirements is gradually reached. The problem is seldom approached immediately in its full complexity. Rather, designers make a simplified version of the problem. That is what modelling, the second basic concept, is about: reducing complexity by first leaving out the less essential aspects (abstraction) and replacing irregular features of the problem with more regular ones (idealisation). An example of abstraction is: leaving out the aspect of colour when designing a new chair and focusing only on shape; an example of idealisation is to replace the complex form of the chair by a simpler one when calculating forces on the chair.

In this short description, I have shown the role of the various sub-concepts of designing and of the concept of modelling. In this description, I have also used terms that have not made their way into the table, but still can be seen as useful sub-concepts for designing (for instance, problem-solving and creativity). These did get mentioned in the Delphi study but were considered to be of less importance than the concepts appearing in the table. Some concepts did not make it in spite of the fact that they do get attention in the philosophy of technology. An example of this is the concept of heuristics, which is sometimes even considered to be the very basis of engineering methods (Koen, 2006). Heuristics differ from algorithms in that they are rather loose search rules that do not necessarily lead to success. An example of a heuristic is: trying the inversion of certain parts of the design (e.g., changing up into down or left into right). Clearly, the Delphi study need not be seen to be conclusive or exclusive here. But the Delphi study did identify a number of important concepts related to designing.

The third basic concept in the table is ‘systems.’ Already in early efforts to identify the core concepts of technology, such as the book The Man-Made World, the concept of ‘systems’ was in this core (Truxall and Piel, 1971). It also features prominently in the Standards for Technological Literacy document developed in the USA[5]. The content of this concept varies in different literature references and could take two directions: (1) the input-process-output approach; and (2) the approach of systems as a combination of parts (‘sub-systems’) that work together. Both are useful approaches and are in fact complementary. The fourth concept is that of resources.

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means. In a similar way, one can break down the concept of 'risk' by noting that this concept deals with the consequences of an action and the chance of some of these forming a threat to safety, health, privacy or other goods. Thus, at least four notions can be related to the concept of 'risk.' One more example is 'functions.' This concept is often described as a transition from a given state of affairs to a different state of affairs that has certain desired characteristics. This transition is not an accidental one but an intended one. Again, we have analysed the sub-concept in terms of certain underlying notions.

CONTEXTS FOR ENGINEERING AND TECHNOLOGY EDUCATION

The Need for Contexts in Engineering and Technology Education

We have now seen which concepts can be used for teaching about engineering and technology. But what is the nature of these concepts? Can they be observed directly in the practice of engineering and technology? This is not the case. What one sees in reality is, for instance, not systems, but cars, houses, mobile phones, fast-food stores, bridges, etc. The concept of 'systems' has a model character. It captures some aspects that these cars, houses, etc. have in common and leaves out all sorts of peculiarities. It is an abstraction. As soon as we turn from the abstract concept of 'systems' to a concrete object, like a car or a house, we will notice that this concept of 'systems' takes a different shape in each concrete manifestation[7]. This is why nowadays we use the term 'situated cognition': knowledge of these concepts cannot exist without the 'texture' that is created by the concrete situation in which the learner finds the concept (Hennessey, 1993). A car is a system, but not in the same way that a house is. Both are parts that work together, but in the case of the car, this results in motion and in the case of the house, not. That is why designers need knowledge not only of systems in general, but also more specific knowledge that applies to cars (for a car designer) or houses (for an architect). This poses a challenge to education. How do we deal with abstractions knowing that they take different shapes in different manifestations and that learners may have problems with recognition of the general features that define the concept? There was a time in which we believed that it was possible to teach the concept at an abstract level right away, and that the learners were able to 'apply' the general notions to specific situations. But that appeared to be too optimistic. Later, we believed that it would suffice to teach the general concept in a concrete situation, help the learner to make the step of generalisation to the understanding of the general concept, and then leave it to the learner to 'transfer' that knowledge to other situations. That, too, appeared to be problematic for many learners. More recently, education specialists proposed a more complicated approach. In the concept-context approach, the learner is taken through a variety of situations, or contexts, in which different manifestations of the same general concepts are present. Gradually the learner begins to understand the communalities between the manifestations and acquires the general concept. By then the understanding has become so versatile that it is no longer a problem to apply the concept to a new situation in which process the concept again takes a different concrete shape, but is still identified as a manifestation of the same abstract concept.

Here is still a debate as to what proper contexts are. Some experts believe that it suffices if the contexts are concrete situations that can be recognized or imagined by the learner. Other people put more demands on contexts and want them to be practices in which the learner herself or himself is involved (Pilot and Bulte, 2006; Bulte, Westbroek, De Jong and Pilot, 2006). Practices are coherent sets of activities aimed at a certain goal. Such practices can be travelling from home to school, living in a house, communicating with peers through the Internet, playing amateur football, etc. In the different practices, the concepts take different shapes. The systems in the context of 'home to school' travelling are mostly related to creating or enabling motion, whereas the system in the 'living in a house' can be directed towards entirely other goals. This means that a car is not easily recognised as having certain features that make it fall under the same concept ('systems') as the house in which one lives. This barrier must be overcome by having the learner grasp the concept in a variety of practices. As we will see, the experts in the Delphi study took the notion of contexts in a wider sense. In my discussion of the outcomes of the Delphi study in terms of the contexts for Engineering and Technology Education, I will elaborate a bit in the direction of the practices approach.

Outcomes of the Delphi Study: Contexts

In Table 2, the outcomes of the context part of the Delphi study are presented.

This table has a certain history. Originally, the terminology in the Delphi study suggested a dichotomy in contexts. The list of contexts as generated by the experts contained all of the domains that have become 'classic' in the USA curricula: production/manufacturing, construction, transportation, communication, and more recently, also biomedical technologies. In addition to these, the experts identified other contexts that all seemed to be related to basic human and social concerns: assuring basic needs like water, food, energy and safety for ourselves and future generations, locally and globally. In the panel discussion following the Delphi study, these additional contexts caused us to take a fresh look at the 'classic' domains and made us realise that these, too, in fact refer to basic human and social concerns. But in order to recognise this, it was seen as useful to rephrase them: 'shelter' instead

Table 2. Context

Context
Shelter ('construction')
Artefacts for practical purposes ('production'/'manufacturing')
Mobility ('transportation')
Communication
Health ('biomedical technologies')
Food
Water
Energy
Safety

of 'construction,' 'artefacts for practical use' rather than 'production,' 'mobility' rather than 'transportation' and 'health' rather than biomedical technologies. This change, in fact, replaces ends for means, and thus reveals better the basic needs underlying these domains.

The table now contains contexts at a rather abstract level. In order to make them useful for education, they must be 'translated' into more concrete situations. To this end, the approach in terms of practices can be valuable. As stated before, practices are coherent sets of activities in which the learners themselves usually participate. Let us now re-examine the contexts in Table 2 and see how these can be transposed to a more practical level. The context of 'shelter' contains practices like 'living in a house' or 'participating in a church project aimed at going to a village in Africa and building a school for the community.' The context of 'artefacts for practical use' can be made more concrete in a practice like 'do-it-yourself' or 'making toys for deprived children in developing countries.' 'Mobility' becomes recognisable for learners when it is made concrete in such practices as 'travelling from home to school and vice versa,' or 'going on vacation.' The context of 'communication' can be transposed into practices such as 'using your mobile phone to stay in touch with friends,' or 'communicating with a friend in South America.' For 'food' one can think of practices like 'helping to cook a meal at home,' or 'eating in the school cafeteria.' 'Water' can mean such practices as 'using water in the household,' or 'purifying water when camping.' The context of 'energy' can be turned into a practical context like 'saving energy at home.' 'Health' can become 'going to the hospital for a test,' or 'doing voluntary work in a house for elderly people.' 'Safety', finally, can be operationalised in practices like 'making the school a safe place,' or 'taking measures to protect your privacy when using the Internet.' Note that I have chosen the examples in such a way that they are all activities that pupils and students can be involved in already and thus are easily recognisable for them. This sets certain limits to possible contexts. We will not find activities like those developed by NASA to make children aware of space technologies (see http://www.nasa.gov/offices/education/about/index.html). It is possible, however, to relate those to practices in which children do participate already. For instance, one could make them design food for use in situations where there is no gravity. This will not be part of their own normal life, but by referring to eating, which is an activity they do know, they can be challenged to extending these experiences by using their imagination. These 'exotic' contexts are particularly suitable to enhance creativity and innovation as they challenge the learner to reflect on unfamiliar situations with often very complex problems. In a similar way, one can deal with global concerns. In the Delphi study, the non-traditional contexts were brought forward by the experts based on the consideration that learners need to develop an awareness and understanding of the broader, global issues that we should be concerned with even though they may not be a direct threat to us, here and now. Using the contexts only in the sense of practices that learners themselves are involved in would exclude almost all possibilities of including these global concerns in the curriculum, which would be undesirable. But here, too, we can stimulate references to situations that learners are familiar with. Reflecting on the issue of global energy consumption (a macro-level problem) can begin with reflection on energy consumption in the micro-situation of the learner herself or himself.

DEVELOPING A CURRICULAR STRUCTURE FOR ETE

Two Approaches for Using the Concept-Context Combination

We have now seen the concepts and contexts that can form the conceptual framework for Engineering and Technology Education. We now turn to the question of how to develop this into a curriculum structure. I will discuss two alternative approaches for this: a concept-based one and a context- based one.

In a concept-based approach, the concepts are taken as the structuring element for a curriculum framework. This means that the curriculum will have the concepts as main headings for the various parts of the curriculum. Or, in the case one elaborates this further into a textbook for Engineering and Technology Education, the concepts will be the basis for the chapter titles. This is the approach that was taken in the Man-Made World book. The concept-based approach then leads to teaching each of the concepts individually in a variety of contexts. For instance, the textbook would have a chapter on Systems, and introduce this concept by having the students go first meet this concept in the context of 'shelter.' In this part of the chapter, the student will be faced with this concept in a particular form that is determined by the specific context ('shelter'). Then the learner moves on to the next section in the book in which the same concept of systems is presented in a different context, e.g., health,' thereby again taking a particular form. By moving through the different contexts one by one, the student will gradually get an understanding of the more abstract concept of 'systems.' Then he/she moves on to the next chapter where another concept is dealt with in a similar variety of contexts. Of course, it is not necessary to have each possible context from Table 2 represented in each chapter. One can look for 'natural' connections between concepts and contexts to seek out what works out best for the learning of the concepts. Of course the learner also gradually develops an understanding of the complexity of the contexts by going through the whole sequence of chapters.

In the second context-based approach, the contexts are used as the structuring principle. In a textbook based on this approach, one will find chapter titles like 'Water,' 'Health,' 'Shelter,' etc. Each of the chapters contains activities in which the learner is confronted with a variety of concepts. In each chapter, the learner acquires an understanding of the context that is central in that chapter, and by moving through the whole set of chapters will gradually develop an understanding of the various concepts.

Both approaches have pros and cons. The evident example of the context-based approach is that it gives rise to recognition with the learners immediately. It is also a commonly practiced approach. The main reason for this is the opportunity to stay close to the pupils' and students' daily life experiences[8]. It is, however, by no means evident if indeed the concepts are recognised by going through the various contexts because learners have to develop an understanding of many concepts simultaneously. Towards the end of the curriculum or book, there will be a stronger need to make explicit what each of the individual concepts means once learners have come across them in a variety of contexts throughout the whole curriculum or book. For the concept-based approach, these pros and cons are inverted. It will be easier to develop an understanding of each of the individual concepts, but getting an understanding of the individual contexts is divided over a lengthy time period. Besides this, the chapters in the book or the parts of the curriculum will make a more coherent impression in the context-based approach because the contexts have a coherence that the learners are already acquainted with, whereas the concepts to them have no coherent meaning yet. Another advantage of the context-based approach is that it is easier to conceive broad and rich activities for each of the chapters in the book or parts of the curriculum (based on the richness of the contexts), whereas in the concept-based approach, one will probably end up with a set of smaller activities that relate to different contexts. This, however, does not mean that a narrower set of skills is developed.

It is difficult to 'prove' that either one or the other option is the best. In fact, one would want to have the best of both somehow combined. One could, for instance, start with a series of broad contexts in which a preliminary understanding of a number of concepts is developed and afterwards shift to a series of concepts that are then dealt with in a variety of narrower contexts (more like the practices as coherent sets of activities in which learners are involved themselves). The reverse order is also imaginable: starting with a series of concepts and then moving to a series of contexts[9].

ENGINEERING AND TECHNOLOGY EDUCATION FOR TECHNOLOGICAL LITERACY

Technological Literacy and the Concept-Context Approach

To develop technological literacy, one needs an understanding of both concepts and contexts, as I will argue now. It is the combination of both that enables someone to live in a world in which technology is everywhere and also to have control over that technology rather than being controlled by it. The relevance of understanding contexts is probably the most obvious one. In particular when contexts are seen as practices in which learners participate themselves, it is clear that an understanding of the nature of those practices and the role in technology in those practices contributes to technological literacy. But how can an understanding of the basic concepts we have seen contribute to technological literacy? That is because this understanding enables us to act in a more sophisticated way. Once we realise that many technological objects around us have a systems character, we understand that manipulating them means that we have to bring in the appropriate input, if necessary monitor a series of actions (the process) that the object executes, watch for certain desired outcomes, and reckon with the possibility of unexpected and perhaps even undesired outcomes. The notion of a system hierarchy helps us understand why all lamps in a chain of lamps for a Christmas tree may fail when only one of the lamps malfunctions (depending, of course, on how the lamps are connected, in parallel or in series). We then understand that this is caused by the interaction of the various subsystem lamps in the total system (the chain). This understanding helps to act in an appropriate way when being confronted with the malfunction. The notion of a socio-technical system helps us understand why certain technologies are not successful in society, and this insight can help us respond to new, emerging technologies in a more sophisticated way. What these concepts do is provide thinking tools that exceed individual situations and serve us in a broad range of decisions we have to make, in different times and different practices.

Limitations of the Concept-Context Approach; the Need for Future Research

It should be added here that the understanding of concepts is only one contribution to technological literacy, not the whole of this literacy. Apart from understanding concepts, we need skills that enable us to use this understanding in decision-making and other actions. Such skills can be practical, such as operating all sorts of devices and machines, but also cognitive skills such as cause-effect and means-ends reasoning (Garmire and Pearson, 2006)[10]. Besides that, technological literacy also comprises opinions about and attitudes towards technology. Here, too, one can ask the question if it is possible to identify a core of skills and attitudes that could be used as the basis for curriculum development. Another Delphi study might be helpful to answer this question. The reason the concept-context Delphi study was conducted was the fact that not much effort had yet been made to identify the core of concepts and contexts for Engineering and Technology Education. More had been written about skills because they have been traditionally an important part of technology education. But perhaps the dramatic changes that technology education has gone through and the engineering element as a new component in technology education may well justify new efforts to determine the core of skills in Engineering and Technology Education. Clearly, there is a challenge ahead of us here, for which again a combination of the insights of the philosophy of technology and the opinions of an international group of experts could well be a good route towards finding an answer to this question.

In this chapter, I discussed the concept-context approach as one of the strategies that could be used to turn concepts into teachable and learnable content. In the concept-context approach, theoretical notions are confronted with practical situations, and thus the dichotomy between what one can call ‘school image’ (the often rather abstract way reality is presented in school) and ‘street image’ (pupils’ and students’ intuitive ideas about reality), often found in constructivist educational research, can be broken. Cognition is always situated, and the concept-context approach does justice to this. The outcomes of the Delphi study regarding concepts and contexts for Engineering and Technology Education have given us important clues as to what constitutes a curriculum that represents the true nature of technology and engineering. The challenge now is to elaborate this into a curricular structure.

NOTES

1 In this approach, often very elaborate and complex schemes features that often did not appeal to Western European educators who were more in favour of simplicity. Nevertheless, these schemes contained a lot of sound conceptualisation.

2 The research was done by Ammeret Rossouw, B.Sc. (Delft University of Technology, the Netherlands), Dr. Michael Hacker (Hofstra University, USA) and Dr. Marc J. de Vries (Delft University of

Technology, the Netherlands). The full text of their report can be found at: https://www.hofstra.edu/pdf/Academics/Colleges/SOEAHS/ctl/ctl_Finalreport_%20CCETE.pdf.

3 Both Table 1 and Table 2 contain the results in a slightly reformulated manner (my terms now, based on later considerations).

4 The amount of literature about this is vast and it makes no sense listing just a few references. The journal *Design Studies* is a useful resource for recent research in this domain.

5 ITEA 2000. It is useful to note that a difference exists in the way the term 'systems' is used in technology education in the USA. Traditional textbooks have chapters titled 'Transportation systems' or 'Communication systems,' but reading these chapters quickly shows that the term 'system' is then used to indicate a domain of applications of technology rather than an engineering concept. This use of the term matches better with what I will call 'contexts' in this chapter. In the ITEA Standards, we can see a shift in terminology compared to the traditional USA textbooks: the term 'systems' is not used in the same way as I use it here, and not in the sense of contexts.

6 Risk is the focus of the research efforts made by a group of philosophers of technology at the Royal Institute of Technology in Stockholm, Sweden, led by Dr. Sven Ove Hansson.

7 It is good to make explicit here that this is not obvious. Other people deny that abstract concepts have any existence at all, but are merely names for things borne in our minds. In my opinion, the abstract concepts are real and more than names. So take a realistic rather than a nominalistic stance in this chapter.

8 It is, however, not necessarily the case that this option is more attractive from this perspective. It is well imaginable that the other option (the concept-based approach) can be elaborated on in such a way that it is full of situations that pupils and students can refer to, and that it allows for the development of a broad range of skills.

9 This was done in *Technologisch*, a Dutch series of textbooks, for which I served as one of the authors. The same approach was used by John Williams in the textbooks *Introducing Design and Technology* and *Design and Technology in Context* (both MacMillan Education, Australia, 1994). The *Kids & Technology Mission 21* series, produced by NASA and published by Delmar in 1992, was an American example of the combination of a concept-based and a context-based approach. There were modules with titles like Design, Energy & Matter, Connections, Machines, which had a concept-based character, but also modules based on contexts, such as Community, Space, Transportation and Communication.

10 This is one of the few references where this type of skills is discussed explicitly as part of technological literacy.

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