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Professionalisation
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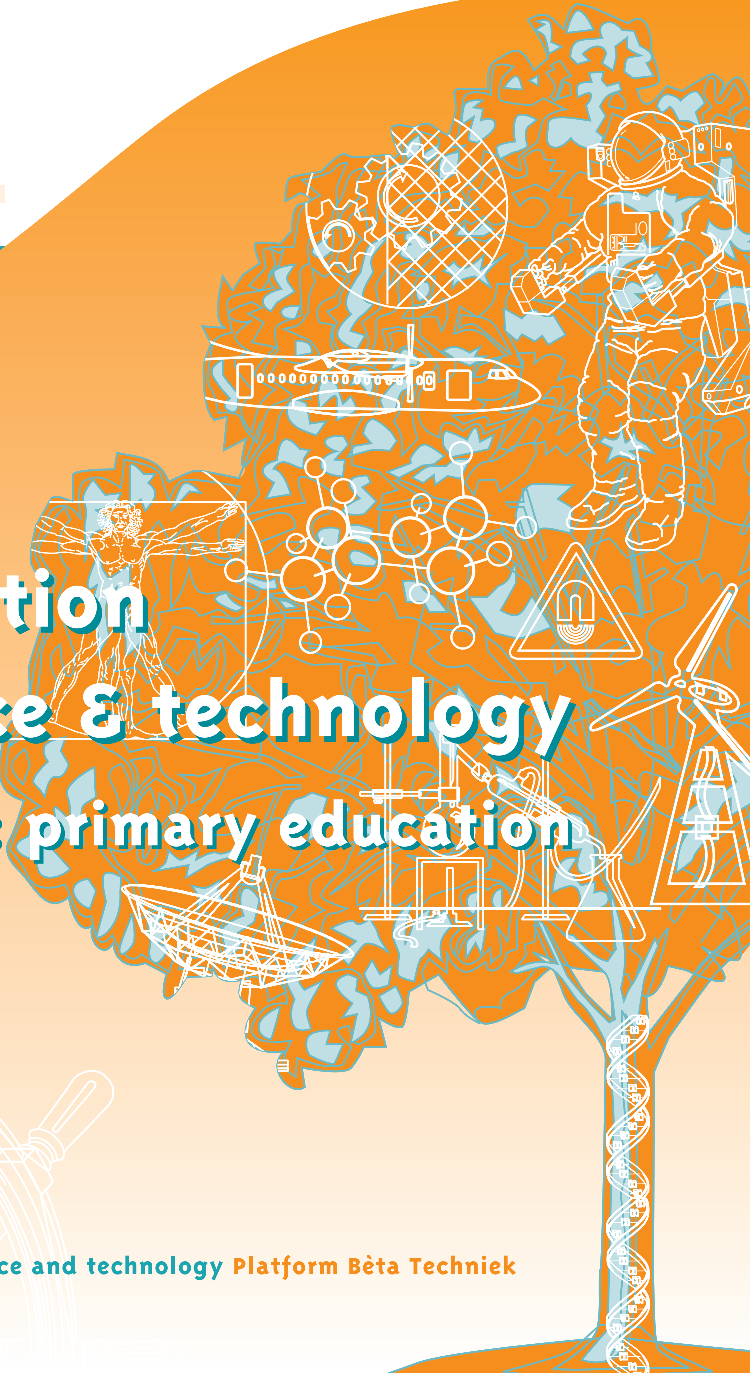
Professionalisation science & technology in the Netherlands: primary education



Theoretical framework

VTB-Pro 2007-2010 Professionalizing in science and technology Platform Bèta Techniek

Content

Professionalisation science & technology in the Netherlands: primary education

Theoretical framework

Authors (members of the scientific board of VTB-Pro Program):

Dr. Juliette Walma van der Molen (University of Amsterdam, The Netherlands)

Prof.dr. Jan de Lange (Scientific Director Curious Minds)

Drs. Jozef Kok (Emeritus Lector)

Part I: Professionalization of Primary School Teachers in the Field of Science and Technology: Some Theoretical Considerations

Introduction

Despite the fact that in society today, we are becoming ncreasingly dependent upon science and technology on a number of fronts, much of the population has little scientific or technological knowledge and the image of a professional career in the natural sciences and technology is not very positive. Although various measures have been undertaken to attract more students in science and technology studies, in the Netherlands, the interest in these disciplines has declined further among young people over the past decade (de Grip & Smits, 2007). While this lack of interest in science and technology often only manifests itself when young people must choose their high school study subjects, most students have already excluded the choice of a science or technology study long before this, during their elementary school period. Students are exposed to very little science and technology in Dutch elementary education, and the result is early rejection of such a potential line of study or profession (Walma van der Molen, 2008).

How could this be remedied? In the Netherlands, a large scale project called the VTB Program (Broadening Technical Education in Primary Education) is designed to help primary schools integrate science and technology into their teaching. During a three-year period, schools receive financial, organizational and subject-specific support to put this into practice. By 2010, 2,500 primary schools (one third of the total number) will have embedded science and technology in their education with support from the VTB program and regional support desks. The knowledge, expertise and experience developed and acquired by VTB schools will be made available to all primary schools in the Netherlands (see: www.vtbprogramma.nl).

Although initiatives such as the VTB program have been reasonably effective, particularly where children's joy for science and technology projects is concerned, a major problem that cannot be solved simply by allocating more time to science and technology in primary education, is the fact that primary school teachers are not sufficiently trained to teach science and technology. International research (e.g., Palmer, 2004; Trumper, 1998) shows primary teachers' knowledge of science and technology and their attitudes towards science and technology to be generally low. Many elementary school teachers do not feel sufficiently prepared to teach science and technology and find it difficult to deal with the questions of students in this area (Skamp, 1991; Yates & Goodrum, 1990). As a result, they fall back quickly upon standard textbooks and the use of highly structured materials and exercises, rather than stimulating their students to raise difficult questions or leading them through small research or technical design projects (Appleton & Kindt, 1999; Jarvis, 2004). Such practices lead to less than positive attitudes towards science and technology on the part of elementary school children, and to lower science and technology achievement (Harlen & Holroyd, 1997; Jarvis, 2004). There is, nevertheless a glimmer of hope. Research shows, for example, that when teachers are given greater knowledge, skills, confidence, and a more positive attitude via continuing education efforts, they subsequently teach science and technology in a better manner and can greatly improve the knowledge, skills, and attitudes of their students in this area (e.g., Osborne, 2003; Osborne & Dillon, 2008).

The situation sketched above has led the Science and Technology Platform in the Netherlands to launch another large-scale program that is aimed at the professionalization of elementary school teachers in the field of science and technology (*VTB-Professional or VTB-Pro program*). The development of teachers stands central in this program, which offers a minimum of 5000 current and 5000 aspiring elementary school teachers a special training trajectory within the field of science and technology. The training program addresses three pillars of science and technology education:

a) Development of knowledge of key science and technology concepts in addition to key science and technology skills;
b) Development of more favorable attitudes towards science and technology; and
c) Development of the instructional skills needed to stimulate inquiry-based learning and learning by technical design.

The basic assumption within the program is that in order to genuinely and confidently address science and technology topics and projects within their everyday class situation, elementary teachers must first develop *their own* knowledge, attitudes, and inquiry skills within the field of science and technology in an open, exploratory, and reflective manner. For this purpose, it is important that the training offered to teachers be challenging, provides stimulating experiences, and devotes considerable attention to not only substantive knowledge within the field of science and technology but also to the image of science and technology, philosophical issues within the field of science and technology, a more positive attitude towards science and technology, and the promotion of one's own inquiry-based learning. The aim is to have the teacher and aspiring teacher participate in the learning process and learn to think, judge, decide, and act independently within the broad field of science and technology. In addition to this, attention must be paid to the embedding of science and technology in social and practical contexts. The expectation is that when the teacher or aspiring teacher him/herself acquires greater knowledge, research skills, meta-cognitive skills, positive values, and confidence in such a manner, he or she will also be in a position to provide more challenging, stimulating, inquiry-based instruction to his/her students.

In the remainder of this document, a number of theoretical assumptions that are argued to be of critical importance for the aforementioned professionalization of teachers will be sketched. This will be done in terms of recent research in the areas of science education and attitude formation in addition to recent insights regarding inquiry-based learning and learning by design (i.e., constructivist learning). The specific theoretical assumptions will be considered in three separate sections that reflect the three pillars that are fundamental to the VTB-Pro program.

Knowledge and skills with respect to science and technology

In order to identify the knowledge and skills for teachers to acquire, a clear view must first be attained of what can be understood under science or science and technology. In a recent report from the European Commission ("Science Education Now: A Renewed Pedagogy for the Future of Europe," which is better known as the Rocard Report, 2007), both the natural sciences and technology are described as systems of knowledge that attempt to model objective reality. For the current discussion, the preceding has been translated as follows:

Natural science and technology are ways to acquire and apply knowledge okn the basis of not only the methods of natural science and technology but also the structured whole of knowledge and skills resulting from this.

Of fundamental importance for the substantive description of the knowledge and skills that are of specific relevance for science and technology education, is recognition of the fact that a dichotomy characterizes the field: on the one hand, there is the *knowledge of concepts*; on the other hand, there is the *manner* in which such knowledge is acquired. For technology, one can also speak of the additional use of knowledge for design and manufacturing purposes.

The aforementioned dichotomy has also been described in various other publications (e.g., Harlen, 1999; OECD/PISA, 2006). Some publications refer to knowledge *of* science and technology as opposed to knowledge *about* science and technology, while other publications refer to knowledge of scientific and technological concepts as opposed to knowledge of scientific and technological process skills. Of particular importance, however, is that these elements together constitute a system of knowledge and skills within the field of science and technology, and that the elements should be considered in conjunction with each other for the professionalization of teachers and aspiring teachers. In the following, the elements will be considered further.

Knowledge of concepts

It is not easy to describe the key knowledge components within the field of science and technology unambiguously. In the OECD/PISA study, "knowledge of science" was divided into four categories: knowledge of natural science systems, knowledge of living systems, knowledge of the earth and space systems, and knowledge of technical systems. The descriptions presented in the study itself come mostly, however, from a natural science perspective and encompass very few contexts of relevance for young children and their teachers.
Nonetheless, the PISA classification - which goes back to the "Science Standards" from the USA in 1996 - allows us to formulate some critical concepts more precisely. The four initial systems can also be expanded to include a fifth category, namely mathematical systems. And the different categories (i.e., systems) can next be characterized in terms of the concepts indicated below.

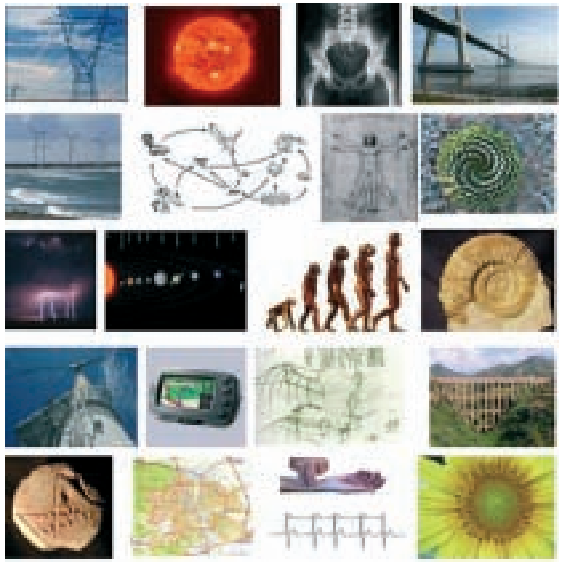
Physical systems. Where attention is devoted to concepts such as: 1) features of objects (whether natural or constructed); 2) position and movement of an object in space and time; 3) force and motion; 4) energy or the capacity to cause change; 5) transformation of energy; 6) radiation, such as light, warmth, radio frequencies, x-rays; or 7) electricity and magnetism.

Living systems. Where attention is devoted to concepts such as: 1) the cell, organ, and organism; 2) man, plant, and animal; 3) respiration, circulation of blood, and digestion; 4) life cycle and reproduction.

Earth and space systems. Where attention is devoted to concepts such as: 1) the structure of the lithosphere, hydrosphere, and atmosphere; 2) the soil, mountains, stratification, change (erosion), and tectonics; 3) water, including the ocean, sea, lakes, rivers, canals, tide; 4) air, including the atmosphere and stratosphere; 5) climate and weather; 6) history in the form of fossils; 7) the earth in space including the structure of space with respect to earth, moon, sun, and stars in particular; and 8) gravity.

Technical systems. Where attention is devoted to concepts such as: 1) construction, facilitation, and progress; 2) design, including criteria, limitations, innovation, invention, problem solving; 3) transformation of energy, function, materials; 4) facilitation of a better life and scientific progress including information and communication technologies, games, medical systems, traffic safety systems, and navigation tools and instruments among other things.

Mathematical systems. Where attention is devoted to concepts such as: 1) quantities, including numerical phenomena, quantitative relations and patterns, "number sense", and logical operations; 2) form and space including spatial orientation, navigation, representation, forms, and figures; 3) changes and relations including correlations, diagrams, tables, types of change (e.g., linear or constant); and 4) uncertainty, data, and chance.



When considering these knowledge concepts, it is important that considerable attention be paid to the cross-connections between these systems in the composition of the training program. Structural knowledge of concepts from different domains only emerges when individuals learn how two or more concepts relate to each other and how different systems occur within certain themes. In addition, special attention should be paid to how the mathematical system appears in all of the other systems.
In the application of the mathematical concept of quantity, it is important - for example - to see that important aspects of this concept such as an understanding of relative size and the recognition of patterns in data occur in virtually every branch of science and technology. *Patterns* occur and can thus be detected in language, music, video, traffic, buildings, art, and nature. The concept of "form and space" can be seen in the *forms* that are visible all around us: houses, bridges, snowflakes, maps, crystals, shells, plants, and the universe. The mathematical concept of "changes

and relations" points to the fact that every natural phenomenon is, in fact, the manifestation of a change and that innumerable examples of relations between phenomena can be perceived in the world around us. Organisms grow; change can be continuously perceived in the seasons, the tide, and the weather; there is development in the quickness of computers and air pollution; and much, much more. To close, it is important to emphasize that the mathematical concept of "uncertainty" also appears, in fact, in all of the scientific and technological disciplines. Scientific and technical knowledge is always the product of a process in which uncertainty (i.e., chance) cannot be excluded: Bridges collapse, the weather is often different than expected, air pollution is worse than predicted, and unjust convictions sometimes occur on the basis of unreliable data.

The aforementioned illustration highlights the importance of not only emphasizing the cross-connections between concepts in the teaching of scientific and technical concepts but also taking the *relevance* of what is learned as the starting point for the supplemental training of teachers. Given that many teachers (and their students) are not familiar with many technical and scientific concepts, this gap must be bridged via the connection of abstract concepts to *clearly recognizable and relevant contexts*. Relevance can be found in the personal sphere, daily professional practice, the neighborhood, society, or - for instance - further study. With the use of clearly recognizable contexts, it can also be made clear that one and the same concept can play a role in widely differing contexts and systems (Waarlo, 2007). By making these connections and any changes of meaning explicit, the transfer of conceptual knowledge can be expanded and comprehensive knowledge within the broad domain of science and technology can emerge.

Scientific process skills

Within the domain of science and technology skills, the scientific method stands central. The following elements play a critical role in the scientific method: asking the right question (i.e., a scientific question born out of curiosity), sufficient justification of one's question, identification of relevant information, design and conduct of experiments, measurement including insight into the degree of uncertainty in the data, and critical evaluation of the results. In addition, hypotheses, logical reasoning, and critical reflection play an essential role. Stated concretely and based on Harlen (1999), the following can be understood as critical science skills:

- **observation**: a fundamental skill that allows people to select information via the use of all senses;
- **drawing of space-time relations**: learning to judge how much time an event takes and the volume or area that an object occupies;
- **classification**: recognition, identification, sorting, and ordering according to similarity or difference;
- **hypothesis formation**: on the basis of consistent, general information from observations and other data, explication of those assumptions that can possibly explain a given occurrence or observation;
- **prediction**: the formulation of the results of a study in advance (i.e., on the basis of a given hypothesis);
- **experimentation**: the testing of hypotheses via actual research using carefully controlled circumstances and methods;
- **manipulation and control**: the imposition of systematic conditions and determination of whether these produce the intended effect or not;
- **measurement**: determination of sizes, time, areas, speed, weights, temperature, volume, etc.;

- **analysis**: the distinction of meaningful (i.e., systematic) information from noise and insignificant artifacts;
- **conclusions**: the drawing of conclusions on the basis of all the observations and data collected in order to evaluate the hypotheses put forth;
- **interpretation**: attempts to understand the data collected and connect the conclusions drawn on the basis of this data to other data and ideas;
- **communication and dissemination**: one should be able to present that which was discovered or observed in a powerful manner using various media.

Technical process skills

Under technical skills, one can think of practical reasoning that occurs in addition to theoretical reasoning. Practical reasoning entails the capacity to reason means-ends relations and the relations between the functions of a planned construction (i.e., artifact) and its physical realization or structure. These forms of reasoning constitute the components of the technical process of designing in which the skill of visualization also plays an important role. Just as for many scientific skills, technical skill is the ability to model reality and use physical models for this purpose.

The aforementioned skills - in conjunction with knowledge of the relevant concepts - should be included as a whole in the professionalization of elementary school teachers. In keeping with this, it is relevant that attention be paid to the philosophy of science and technology. Aspects of particular importance are: 1) recognition that the different sciences constitute "lenses" that can be used to view reality and 2) recognition that there are, for this reason, different sciences: such as, the social sciences, the liberal arts, and the natural sciences, which differ methodologically from each other. The philosophy of technology concerns predominantly the conceptualization of artifacts (i.e., manmade items), technical functions in contrast to biological functions, and the normative component of technological knowledge (i.e., prescriptive knowledge (de Vries, 2005). The interaction between technological and societal developments is also an important theme here.

Attitudes towards Science and Technology

In the relevant research literature, the concept of "attitude" is construed as an internal, personal, psychological tendency to evaluate a particular object or construct in a positive or negative manner (Eagly & Chaiken, 1993). This personal tendency can persist for a longer or shorter period of time and involves cognitive, affective, and behavioral components. The *cognitive* component of the concept of attitude consists of *thoughts* or *opinions* about a particular object or construct. The *affective* component consists of *feelings* and *moods* with respect to a particular object or construct. The behavioral component consists of actual behavior or the intention to do something or avoid doing something with respect to the object of the attitude. In such a manner, a positive attitude with respect to learning or studying can consist of thoughts or opinions about the importance of learning for the attainment of a good job or a good future, personal feelings of pleasure derived from learning, or actual behavior in the form of studying hard or the intention to undertake a particular study.
Within the field of social psychology, attitude is traditionally seen to be one of the most important motives behind numerous processes and clearly

related to motivation and interest. In keeping with this, attention to the notion of attitude in the literature on science education has strongly increased over the past few years. Critical in this regard, however, is the distinction between a scientific attitude and attitudes towards science (see Osborne, 2003). A scientific attitude manifests itself in the form of scientific thinking: curiosity, creativity, perseverance, critical reflection, and so forth. Such a scientific attitude was described in the outline of the necessary scientific process skills (see previous paragraph) and will also be considered in the section on inquiry-based learning below.

A different set of thoughts, values, feelings, and behaviors can be understood under attitudes *towards* science and technology - thoughts, values, feelings, and behaviors that address - for instance - one's thoughts about the level of difficulty characteristic of the sciences and technology, the value attached to science and technology for society, feelings of pleasure or interest with regard to science and technology, and the desire or intention to learn more about science and technology. Considerable international research has shown that elementary school teachers often have little scientific and technological knowledge, and in addition have quite negative attitudes towards the natural sciences and technology (e.g., Palmer, 2004). These teachers do not like science and technology subjects and they hold low estimates of their capacity to teach these subjects, which often relates to negative experiences during their own elementary or high school education (Tosun, 2000). Such a negative attitude can lead teachers to devote less time to science and technology and may make it difficult to stimulate the knowledge, skills, and positive attitude of their pupils within the field of science and technology.

The situation described above is unfortunate, and it is important that the self-esteem, interest, and enthusiasm of teachers in science and technology be stimulated and supported. Research shows that such an endeavor can have a positive effect, not only on the teachers themselves, but also on the knowledge level and attitudes of elementary school students towards science and technology (e.g., Jarvis, 2004; Palmer, 2004). In addition to an integrated offering of knowledge and skills within the domain of science and technology and in addition to more insights in inquiry-based learning (which will be discussed in more detail in the next section), a very important (and often overlooked) element of the professionalization of elementary school teachers should thus be the explicit focus on teachers' own attitudes towards science and technology. It is important that teachers and aspiring teachers be aware of their own thoughts, values, feelings, and behavior in the field of science and technology. Such an awareness may be stimulated within teacher-training by paying explicit attention to the cognitive, affective, and behavioral dimensions of attitude, through:

- **discussion** (e.g., of the breadth and historical significance of science and technology within society)
- **reflection** (e.g., upon one's own elementary and high school education history within the domains of science and technology and a prior tendency to avoid learning or education in these domains)
- **training** (e.g., to provide new and positive experiences with regard to science and technology in order to increase teachers' pleasure and self confidence in the domain of science and technology)
- **lectures** (e.g., in which attention is paid to gender differences, stereotyped images of science and technology, and the lack of positive role models in science and technology for girls in particular)

Pedagogical skills for inquiry-based learning and leaning by design

Science and technology education have their roots in Victorian England (1850-1900) where agrarian society made way for a society based on scientific and technological expertise. This new society could only be sustained with the training of people in science and technology. Disagreement existed, however, with regard to the exact nature of this education and, since that time, the form and content of science and technology education have regularly been the topic of debate. In the Victorian era, people were of the opinion that science education should be part of the education received in primary school. At that time, it was believed that such an education should be presented as "the science of everyday things" and thus aimed at the observation of nature: botany, zoology, physiology, and so forth. This perspective was concerned mainly with the establishment of knowledge and an understanding of the basic principles of natural science. Early in 1900, an alternative view of science education emerged. Thomas Huxley (1918, in: Osborne & Hennessy, 2003) viewed science education as predominantly a means for intellectual development. For Huxley, it was not so much the content of a particular science that was of significance but, rather, the unique capacity of science in general to train one's intellect.

Such discussions - of the importance of acquiring scientific content knowledge as opposed to mastery of the scientific thinking process - still occur today. Much of science and technology education in primary schools today, however, is still aimed primarily at the acquisition of so-called scientific literacy via the transfer of factual knowledge. Knowledge is seen to be a product of instruction, and the assumption is that having such knowledge will lead to a greater interest in and adoption of the values of science and technology. Research, however, has shown that the transfer of scientific and technological knowledge alone is not sufficient for the creation of a broader understanding of science and technology (Zint, 2002). During the past few years, we therefore see a renewed international plea for science and technology education that not only devotes attention to conceptual knowledge, but also promotes inquiry-based learning. This form of learning draws upon social-constructivist idea s about learning in which: knowledge is construed as a construct as opposed to a product, the learner him/herself must experience things, both context and social relevance are of importance, and a scientific attitude is developed.

It should be noted, however, that this inquiry-based learning often functions as 'a magic word' and that all kinds of projects within the context of "hands-on science" are considered as inquiry-based learning. As some authors have recently shown, this qualification is not always justified (e.g., van Graft & Kemmers, 2005; Rudolph, 2005). Children are challenged in most "hands-on" science projects to primarily work together on, for example, the building of a construction (Schimmel et al., 2002; Weerden et al., 2003). Although such projects can realize a number of important objectives for science and technology education (e.g., collaboration, responsibility, reflection, observation, prediction, generalization), the fact that science is more about the construction of ideas than the construction of objects or machines is missed in these projects (Rudolph, 2005).
For the implementation of actual inquiry-based learning, it is thus important that not only "hands-on" but also "minds-on" science activities be undertaken and that inquiry-based learning be distinguished from learning to inquire (van Graft & Kemmers, 2005). Having students (children ánd adults) learn to do research and acquire the knowledge and skills relevant to the scientific method is generally understood under learning to inquire. For inquiry-based learning, in contrast, students must undertake an inquiry (i.e., research) to learn about *something else*. For inquiry-based learning, the conduct of research is a means; for learning to inquire, the conduct of research is an end.

In the field of science and technology, learning by design can be seen to play a role in addition to inquiry-based learning. Once again, the notion goes further than the aforementioned construction of an object or machine. By thinking more or less systematically about how the environment can be adapted to meet the needs and desires of people, children learn to think about not only the existing reality but also about other possible realities. Used in combination with the scientific method, learning by design is a manner to stimulate creativity. Just as inquiry-based learning, learning by design is a question of both "hands-on" and "minds-on" learning.

For the application of all of the above, the professionality of teachers in the field of science and technology must be strengthened on two fronts. First, the *generic level* of knowledge and skills on the part of teachers must be strengthened by having them become more comfortable in the world of doing research in science and technology. This boils down to greater attention being paid within all disciplines to understanding the necessary concepts, the conduct of practice-based research, and the guidance of student research.
The second front for improvement is to strengthen the *specific competencies* of teachers for the guidance of student research within the field of science and technology. In fact, student research encompasses both inquiry-based learning and learning to inquire. And for teachers, this means learning to create a challenging learning environment and respond to the inquisitive questions of children in such a manner that their curiosity is satisfied and further stimulated.

The best way to teach teachers this is via "learning by doing." In such a manner, they *themselves* actually experience what the empirical and regulatory cycle of production and application really means and how one can operate with regard to this. In such a manner, they also learn to adopt a scientific attitude in which curiosity, perseverance, appreciation of originality, creativity, responsibility, productive critique (including self-critique), and the adoption of an independent stance in one's thinking all play an important role.

When teachers have developed in such a manner, they can also develop the competence needed to impart science and technology concepts, skills and attitudes to their students in an inquiry-based manner. They can do this by having students look, listen, touch, smell, and taste (i.e., observe); encouraging them to ask more questions; having them try to predict what will happen; having them collect and use information from different sources that can range from rocks, sticks, and beetles to numbers, tables, and diagrams; stimulating them to seek and apply creative new applications for particular constructs; having them talk about their experiences and ideas using their own words; and having them examine those patterns that stand out in observations and measurements (Murphy, 2003).
For the aforementioned developments to occur, it is of importance that considerable attention also be paid to *reflection* during the professional development of teachers. This includes not only personal reflection (e.g., Who am I? What are my capacities in the field of science and technology? What do I want to achieve in the field of science and technology?), but also reflection upon the learning process (e.g., What have I learned? How did I learn this? How can I apply what I have learned to my own teaching situation?). Such forms of reflection have the important objective of *empowerment* for teachers and aspiring teachers. In addition to enhanced self-confidence and instrumental professionality within the domain of science and technology, such reflection increases the probability that teachers will continue to learn in a self-guided manner and stimulate colleagues to do the same.

Discussion

In the above, a description was provided of the qualities that teachers and aspiring teachers should have for elementary science and technology education. It was argued that teachers should acquire knowledge of important science and technology concepts *and* the skills needed to gather such knowledge. It was also argued that a positive attitude towards science and technology is essential, and that the cognitive, affective, and behavioral aspects of such an attitude should be explicitly discussed and reflected upon during teacher-training. Last, it was contended that the most important didactic instrument to present science and technology in an inspirational manner is to foster inquiry-based learning and learning by design.

While these three pillars of science and technology education were discussed in three separate sections, it should be clear that they are closely connected. For instance, the principles associated with the third component of science and technology education - namely, the stimulation of inquiry-based learning and the concomitant assumption that learning can occur via exploration, asking questions, and self-discovery - are closely associated with the inferential knowledge and skills required for the scientific process. The attitude component can be viewed as a more comprehensive component that relates to both other components of science and technology education. Starting from the assumption that the attitudes of people determine their actions, thoughts, feelings, and choices to at least some extent, it can be asserted that having a positive attitude towards science and technology is just as important as, for instance, having a positive attitude towards reading. One can indeed learn to technically read to a sufficient extent, but only when a positive attitude towards reading has developed will one also read at one's own initiative and increasingly more for one's own pleasure. The foundation for a high quality professionalization program in the field of elementary science and technology education can be laid with the incorporation of all the aforementioned pillars into the program and making the connections between the different components sufficiently transparent.

In closing, it should be emphasized that strengthening the competence of teachers in the field of science and technology education can also enhance the level of teacher functioning *in general*. At its core, working on "the teacher as researcher" has a much broader spectrum than just the domains of math, science, and technology. When teachers learn to treat their own amazement and that of their pupils in a more systematic manner, this can also have significance for the domains of language, reading and writing, or the social-emotional development of students. By jointly going through processes, such as from perception to concept formation, from concept formation to causal relations, from causal relations to prediction, and from prediction to evaluation, teachers can help their students with the systematic solution of practical problems in all sorts of domains. In such a manner, working on science and technology education can serve a more general objective, namely improvement of the level of the teaching profession as a whole.

Part II About the VTB-Pro Program: Professionalisation of science and technology in primary education

The VTB-Pro Program enables 5.000 teachers and 5.000 prospective teachers to obtain in-depth knowledge and proficiency in science and technology in primary education. This is an area of education where technology and science are not approached at a high and abstract level, but where asking questions, curiosity, inquiry based learning and their practical application are central - not in a remote place such as a laboratory, but actually very close to us in everyday educational practice.

Science and technology contribute to the development of children's curiosity, creativity and problem-solving ability. Children are by nature curious and inquisitive. That is why it is so important to devote attention to science and technology at primary school. After all, all those inquisitive pupils of today are tomorrow's qualified technologists and expert researchers. In order to encourage this, the teacher's enthusiasm, knowledge and skills are vitally important. And that is where VTB-Pro can help. Teachers will learn in an inspiring way to broaden and deepen their knowledge of and develop their skills in science and technology, while themselves adopting an inquisitive attitude. This will encourage children to develop a positive attitude to science and technology too. The overriding aim is to make science and technology a permanent, integrated part of the curriculum in primary schools.

Teacher training colleges for primary education and Expert Centres provide a framework for VTB-Pro

The 10.000 teachers and prospective teachers are trained at one of the participating teacher training colleges for primary education in their region. The nineteen teacher training colleges taking part in VTB-Pro work together with specially formed regional Science and Technology Expert Centres. These Expert Centres bring together general and technical academia as well as higher professional institutes to work together with the teacher training colleges. The Science and Technology Expert Centres design the educational courses, develop knowledge, carry out research and are responsible for disseminating this knowledge to teacher training colleges and primary schools. They are supported by businesses in the region, VTB Regional Advice Centres and science centres. The first Expert Centres have already started up in the South, East, Gelderland, Noord-Holland and West regions of the Netherlands.

Personalised training courses

The training courses are suitable for participation by both individuals and teams, and are in response to the demand from schools. Participation is free of charge, but does of course demand an investment in terms of effort and time. In addition, there will be opportunities for schools to work with specially trained interns on science and technology as part of their school's development. The training courses are designed around a broad and integrated approach to science and technology through a theme-based approach to support the educational vision, which also involves for example arithmetic/mathematics, geography and languages. A special place is also reserved for the results of the Program Curious Minds (TalentenKracht), which studies the talents for science of pre-school children (see www.talentenkracht.nl). In this way science and technology links up perfectly with pupils' natural curiosity, their talents for science and their inquisitive and exploratory nature. Besides knowledge of science and technology, the training courses also include teaching skills.

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Colophon

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Jacqueline Kuijpers (Mare*Com*, Breda, The Netherlands)

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Bert van Zutphen (Plan B, Amsterdam, The Netherlands)

Photography:
DigiDaan (www.DigiDaan.nl, The Netherlands)

Platform Bèta Techniek & Programma VTB-Pro
Lange Voorhout 20
P.O. Box 998
2501 CZ The Hague
The Netherlands
+ 31 70 311 97 15
info@vtbpro.nl
www.platformbetatechniek.nl
www.vtbpro.nl

VTB-Program
Sylvia Peters, Project Manager
Shanna Wiegerinck, Executive Coördinator

VTB-Pro is een programma dat aansluit bij de aandacht voor wetenschap en techniek in het basisonderwijs. Het gaat om een brede kijk op wetenschap en techniek, die erop gericht is scholen handvatten te bieden om wetenschap en techniek in het basisonderwijs in te passen.

Binnen VTB-Pro staan de (aspirant) leerkrachten centraal. Zij gaan op ontdekkingsreis naar kennis. In velerlei opzichten. Kennis over wetenschap en techniek. Maar ook kennis van wetenschappelijke onderzoeksmethodes. Kennis van hoe je de goede vertaalslag maakt in de klas. En zelfkennis: wat vind ik eigenlijk van wetenschap en techniek?

Ontdekkingsreizigers spreken tot de verbeelding. Maar om hun verwondering écht te voelen, zou je mee op reis moeten kunnen gaan. Die nieuwsgierigheid is precies het uitgangspunt van VTB-Pro. Laat (aspirant) leerkrachten ervaren hoe wonderlijk de wereld van wetenschap en techniek is. Inspireer hen, zodat zij hun leerlingen kunnen inspireren.

Zoals Daan op de foto, die trots zijn Magnetics bouwwerken aan zijn juf laat zien, ómdat zij zijn inspanningen waardeert en er geïnteresseerd over doorvraagt. Wetenschap en techniek = nieuwsgierigheid. Ruim baan voor de verwondering!