3. SCIENCE AND TECHNOLOGY EDUCATION FOR THE FUTURE

INTRODUCTION

Our current society is deeply influenced and shaped by artefacts, ideas and values of science and technology, for example in health care, energy, transportation and communication. Also, issues such as pollution and nuclear energy become objects of public debate. In their jobs, professionals are confronted with an increased use of information and communication technologies and the need for flexibility and life-long learning. ‘Non-science-jobs’, such as nursing, increasingly require an understanding of science and technology. It is thus not only important to educate people in science and technology for science-related jobs, but for work in general (Rodrigues et al., 2007). Science and technology education should enable future citizens to live and work in this society with reasonable confidence and comfort (Forman & Steen, 1994; Osborne, 2007). In the Netherlands, a start is being made with innovating science and technology education in primary school with the Dutch VTB-Pro project that aims at promoting and improving science and technology education. A sustainable innovation has to anticipate the demands of the society in which the students will come to live in. Changes in the curricula of primary education and professional development of primary teachers are long-term endeavours. Therefore, this chapter looks at the content of science and technology education from the perspective of the needs of employees of the future.

Levy and Murnane (2005) present an economist perspective on current labour market developments, which is increasingly shaped by computers and globalization. For example, computers can substitute for human workers when tasks can be expressed in series of rules. This implies that routine cognitive and manual tasks are likely to be taken over by computers, leading to the loss of this type of jobs. On the other hand, computers can complement or help professionals in other types of jobs, in which computers for example visualize complex processes by means of graphs or models (Gravemeijer, 2009). This requires an understanding of science and technology, as using a model without understanding leaves one vulnerable to mistakes. Goos and Manning (2007) confirm the Levy and Murnane study. They studied labour market developments in the UK in the last decades, and found that jobs in upper wages and the lowest wages (i.e., non-routine cognitive and non-routine manual) indeed increase, whereas jobs in the middle
region (i.e., routine jobs) disappear. Related to these labour market developments, Binkley et al. (2010) pose that success in working life does not lie in content knowledge, but in the ability to communicate, share and use information to solve complex problems, and to adapt and innovate in response to new demands and changing circumstances. The fact that non-routine jobs seem to prevail also indicates that at all levels of an organization, flexibility, creativity and innovation are necessary to stand up to global competition (Forman & Steen, 1994). Telling in this respect is that in Singapore a discussion arose about the existing labour force being non-critical and obedient to their superiors, leading to a lack of creativity, risk-taking and continuous learning in organizations (Gopinathan, 1999).

Altogether, various studies have argued for the need to redefine the scientific and technological knowledge and skills taught at school. However, these studies tend to focus on very general skills such as communication and problem solving (e.g., Holbrook & Rannikmae, 2007), and do not provide any specification of what should actually be taught. Other studies provide long and detailed lists of scientific and technological content to be taught in schools (e.g., AAAS, 1993). These lists run the risk of quickly becoming outdated as the amount of new technical information is doubling every two years (Binkley et al. 2010). That is, the knowledge and skills we now teach our children will have become obsolete by the time they enter the workplace. This begs the question whether we can identify knowledge and skills that are general in the sense that we may expect them to stay valuable for a long time, but at the same time are not too general to offer directions for a science and technology curriculum. Research questions are: What knowledge and skills in the domains of science and technology do they need to adequately function in their jobs? In answering this question we hope to provide a basis for the discussion about the contents of science and technology education.

DEFINING SCIENCE AND TECHNOLOGY

There is no clear consensus even among scientists on the definition of ‘science’ or ‘technology’, or on the relationship between science and technology. In most English literature, science refers to the natural sciences, that is, chemistry, physics and biology. The OECD and PISA (2006), for example, divide the knowledge of science into the domains of physical systems, living systems, earth and space systems and technical systems, categories that go back to the Science Standards defined in the US (1996). Technology is sometimes referred to as the range of man-made materials and processes developed in society to address people’s needs, including ‘simple’ tools like shopping bags and nail clippers (Holbrook & Rannikmae, 2007). It includes not only the artefacts themselves, but also their analysis, design, evaluation and the procedures to organise and use them (Benenson, 2001). Unlike scientific knowledge, technological knowledge comprises normative judgments: a function is well or badly fulfilled (De Vries, 2005). Barnett (1995) argues that non-expert users have a tunnel vision on technology which is restricted to its context outside the ‘black box’, that is, the ability to use devices. Experts also have a tunnel vision, but centred on the content...