Current Trends in Technology Education in Finland

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It is an old tradition in Finland to teach a school subject dealing with the use of machines, materials, processes, techniques, and tools. Since 1866, educational *sloyd* (handicraft) has been a compulsory school subject for both boys and girls. Even today in Finnish technology education, which is nowadays called *tekninen työ* in the Finnish national curriculum guidelines, students still design and make products (Kankare, 1997; Kolehmainen, 1997). Comprehensive schools provide compulsory basic education for pupils between the ages of 7 and 16. Education beyond the age of 16 is voluntary, taking the form of either three years of study at a theoretically oriented high school or a two-to five-year course in a vocational school.

The activity of students is concentrated on problem-centered design projects (inventions) that transcend the limitations of materials and techniques. Finnish technology education can be characterized as mainly a design approach that has evolved from the craft-oriented approach . Additionally, it involves elements of the high tech approach, using computers, computer-aided design, and electronics. These tools are often included as either part of design projects or in construction kits.

The national core curriculum and curricular guidelines are very vague; they only provide brief outlines. Although this allows for local flexibility, it also increases the diverse ways in which technology education is taught from one school to another. In the latest national core curriculum (Opetushallitus, 1994), the main emphasis is on the “idea-to-product” process with the pupil fully involved in design. Although designing and making products is a central part of the national curriculum guidelines, they also refer to the need for a broader technological understanding and capability. Student-centered instructional strategies are encouraged by a 16 student per technology classroom limit.

In informal discussions between teachers and teacher educators, technology education typically includes more out-of-date technological processes, such as the making of wood and metal items, than modern technological processes. Studies by Alamäki (1999), Kananoja (1997), Kantola (1997), Lindh (1996), Parikka (1998), and Rasinen (1999) come to similar conclusions. Thus, technology education should be more connected to the modern technological world, although it already covers activities related to computers, construction kits, electronics, electricity, machines, and technical drawing. Technological concepts, such as communication, construction, energy, manufacturing, and transportation should be taught because they are an essential part of students’ surroundings. In fact, students’ projects focus on these key concepts, in a somewhat narrow way. These concepts are rarely reviewed in broad contexts such as global, ecological, and social issues. In this regard one can say that particular approaches and student activities determine the nature of technological knowledge and processes that students learn. The approaches of tasks in technology education determine the kinds of technological knowledge and processes students learn. For example, Autio (1997) found that teaching of design was more sketching and shaping than systematic problem solving.

Technology Teacher Education in Finland

The Department of Teacher Education in Rauma, University of Turku, is the only institute that prepares Finnish-speaking technology teachers with a technology education major. The technology teacher education program enrolls 36 male and female students each year. Åbo Academy at Vaasa, which educates Swedish-speaking technology teachers, has admitted 10 students for its technology education program every fourth year, but beginning fall semester of 1999, seven students will be admitted every second year. Other departments of teacher education also teach technology education, but only as a minor. The University of Jyväskylä and the University of Oulu have recently improved the technology education component of their classroom teacher education programs.

Admission to Finnish universities is highly selective and is usually based on previous performance (e.g., Finnish Matriculation Examination) and an entrance examination. The technology teacher education program has a single entrance selection procedure that includes a written examination, an individual interview, a technological reasoning test, and a practical product-making test. University studies are mainly free and funded by the state. Therefore, students enrolled in the technology teacher education program pay no tuition, except for the compulsory student union fee. In addition, students have to pay for books and other materials. Traditionally, the teaching profession is appreciated in the Finnish society. Many more young people apply to the technology teacher education program than are accepted. Also drop-out rates are very low and students are usually highly motivated, technically oriented, and talented (see Kohonen & Niemi, 1996). Since 1979, all technology teachers have received a master's degree in technology education; teachers in comprehensive school must hold a master's degree from a university.

The University of Turku's Technology Teacher Education Program

In the technology teacher education program at the Department of Teacher Education in Rauma, University of Turku, students are able to take the curriculum for either one or two teaching subjects. In addition to technology education, a second teaching subject, such as an elementary education or mathematics, entitles them to teach in primary school as an elementary or mathematics teacher. The program leads to a Master of Education degree comprising 160 credit units (1 credit unit = 40 hours of work) and accomplishes the aim of the Faculty of Education (1996) which provides that students will:

- Become familiar with the relevant terminology, materials, and technology; be enabled to follow the general development of technology; gain a sufficiently broad mastery of practical work in their field to be able to convey the central knowledge and skills of the subject to their pupils.
- Become familiar with the physical, psychological, and social development of children and young people, with scientific theories and their applications in education, technology educa tion, and the teaching process, thus enabling them as teachers to promote the development of the whole personality of a child or young person and to achieve the goals set their education.
- Acquire the expertise in technology education and education in general that will enable them to master the main basic theories and terminol ogy of education, general didactics, and the didactics of technology education.
- Acquire knowledge of society and the sectors of business, professions, and production, enabling them as teachers to comprehend current situa tions and changing needs of society, and to use these as a basis for solving and observing prob lems in their subject in accordance with the requirements of technology and the nature of the work.

In the technology teacher education program, students study a variety of technologies, mechanical and electrical engineering, product design, project studies, research methodology and statistics, educational sciences and ethics, developmental psychology, didactics of technology education, administration, evaluation, and sociology of education. Furthermore, students have to pass four teaching practice periods. Three levels of study comprise the technology teacher preparation:

- Basic Studies: In this module, students learn to apply product design to the solution of technical problems, to choose correct materials, and to apply various technologies correctly, while bear ing in mind the need for occupational safety. The integration of various technologies and con sumer and environmental education are empha sized.
- Intermediate Studies (Product Project Studies): This module introduces students to (a) the application of special techniques and materials science in production, (b) control and regulation tech-

niques, and (c) mechanical construction. The emphasis is on design work carried out by groups in tasks which involve integration of technology education with the natural sciences and general technology. These require problem- solving skills and technological know-how.

• Advanced Studies: This module deals with technological and pedagogical planning and research of technology education, and with producing, processing, and evaluating new information in the field. The Advanced Studies module begins with theoretical observations of production processes and proceeds to deal with the general possibilities for making use of technology. After planning and implementing a project, students must produce a written report of their evaluation of the process and product (Faculty of Education, 1996).

Students' Projects in Technology Teacher Education

After they have finished their undergraduate studies, most students go on to the master's degree because it is required for a teaching position in general education. During their master's studies, students develop technological knowledge and capabilities through many different product projects. The students' product/project for the master's thesis (15 credit units) is the largest project in the program and consists of a written report and a product. Kolehmainen (1997) stated that this consists of (a) the development of a product which evidences newly generated technological knowledge, (b) applying experiences to teaching which reflect the students' professional growth as a teacher, and (c) critical evaluation and development of students' own practices as a basis to develop new action and thinking strategies.

The product/project is carried out by collaborative pairs and must be innovative, unique, and focused on solving a problem related to the students' life or the needs of a local community or industry. Following the creative problem-solving process, progress resembles a spiral starting with defining a problem, to ideating, selecting the best idea, and making and testing a prototype.

In this process students' learning can be characterized as self-directed, collaborative, and experimental combining both abstract and practical learning. Kolehmainen (1990) found that the convergent learning style is typical for students in the technology teacher education program. Kolehmainen (1997) stated that strengths in the convergent learning style are associated with decision-making skills and the ability to solve problems and to apply ideas in practice. The central aim of the technology teacher education program is to develop such capabilities so that students are able to solve technological problems in authentic and novel situations. Therefore, students develop technological knowledge, metacognitive skills, and general strategies to deal with technology through problem-centered product projects.

The product/project begins with a planning seminar in which students and a professor discuss the needs to be addressed or solved and appropriate methodological approaches. Scientific, technological, and social factors related to the problem are reviewed. Theoretical solutions to proposed problems are considered. More and more students invent, design, and build products that respond to needs of local industry and institutions. Such products are usually associated with industrial production. In addition, local industry sponsors students and gives them competent guidance. Recently, a research and development program to promote collaboration between the technology teacher education program and industry was established and funded by the Ministry of Education and the European Social Foundation.

The written report of about 100 pages that forms a master's thesis is accompanied by a product. It includes a general description, such as the historical, scientific, social, and technological aspects about the field related to the original problem. In addition, the theoretical basics of design strategies are reviewed. The written report must also include a presentation about the students' own problem-solving and design processes and prototype testing. Students must also review their own learning processes and experiences during the product project, including reflections on their own professional growth in this field.

Several examples of students' study projects are described here: Two students designed and built a production line for anodizing small aluminum pieces. A component of the study determined the effects upon manufacturing equipment to the chemical basics and processes of anodizing that impact forming anode-covers on aluminum pieces. Another student-team helped local farmers by designing and building the "frost-guard" that monitors temperature changes in a field and sounds an alarm in the farmer's bedroom if the temperature has fallen below the minimum. Another team made a melting furnace capable of melting such metals as tin, lead, and zinc at low temperatures.

A pupil with communication difficulties needed a communication device in a primary school in the city of Rauma. Students from the technology teacher education program made a device that utilizes the FC-method, which is an alternative practice and communication method based on finger pointing. A team designed and built an engineering shop press in collaboration with a local industrial plant. They had to study ergonomics, work safety, mechanics, and other things to solve the problems. The press is now in use in that industrial plant as are other student-made devices. Although there are many kinds of drawing tables, a team designed and built a multi-purpose table for technical drawing, picture-making, photographing, and other leisure hobbies. A linseed oil bottling stand was designed and built by another team. The bottling stand is a movable device equipped with a motorized regulator that controls the device's wheels and the height of its cover. Two students, who are interested in gliding, designed and built a folding towing system needed to launch a glider in fairly flat Finland.

Some Additional Observations

Finnish technology education emphasizes design and making activities because they form an integrated and holistic learning environment, which is flexible according to students' preparedness and learning styles. Furthermore, in Finnish schools and in many kindergartens, a complete workspace, furniture, tools, other equipment, and a long tradition of accomplishing design and making activities already exist. More research is necessary, however, on students' cognitive and affective processes in technology education concerning, for example, the conceptual and procedural thinking processes that design and making activities evoke in students. Without sufficient guidance, students' design and making activities in schools happen in a conceptual and intellectual vacuum, and the nature of the activity changes to one of artistic-aesthetic busywork. Currently the situation is conflicting; in technology education the cognitive content should be increased, but at the same time students demand more and more practical work that typifies busywork, hobby, or therapeutic activities.

In this article the Finnish system was not compared to other countries. In fact, it is difficult to compare technology education or any educational programs because history, tradition, and politics result in different educational systems in many countries. In Finland, as in many other countries, technology education is a school subject with its own identity. Nevertheless, Finnish technology education is still seeking its final shape and value in schools. Although it has been evolving since 1866, considerable effort is still necessary. Furthermore, some educators believe that technology education should be design-process based because of the quantity of new content and educational requirements. Others believe that it should be a more theoretical "classroom-type" school subject. In most countries, however, the main focus seems to be on technological literacy or technological capability focused on the skills needed to cope in the technological world.

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