The Development of Technological Competence from Adolescence to Adulthood

Finland has a well-known reputation in technology, but technology is still not taught as a separate subject in the national curriculum. The position of technology education in Finland is quite different from that in most other European countries, even Finland's Nordic neighbours. Technology education is incorporated within the scopes of other subjects such as physics, chemistry, biology, home economics, and craft education. Craft education is, in practice, further divided into technical work and textile work.

No special differences exist between Finnish schools' curriculums and usual international practices. At the primary level (grades 1-6) pupils are 7 to 13 years old, at the secondary level (grades 7-9) 14 to 16, and upper secondary 17 to 19. In grades 1 to 7, craft and technology education is a compulsory subject taught 2 or 3 hours a week, although in grades 1 and 2 its contents are closer to those of hobby crafts. In grades 8 and 9 there is no compulsory technology education, but pupils can take elective studies for about 2 to 4 hours per week. Nowadays, it is possible to take elective courses in technology education even in upper secondary school, but this was not typical in Finland 15 years ago. Perhaps the main difference in the Finnish education system, as compared to usual international practice, is that University level studies are free of charge. This means that demanding entrance exams are the norm.

This article builds on earlier research that defined and assessed technological competence among adolescents. It tracks students who took part in a measurements of technical abilities study fifteen years ago. The researcher had no previous knowledge of the test subjects' current employment status, but in favorable circumstancs, these test subjects are now professionals in the field of technology.

The aim of this research was to examine how technological competence was attained during the test participants' lives. In addition, we tried to determine the elements accounting for the participants' technological competence. The main research questions were as follows:

1. How was the test participants' technological competence developed over the course of their lives?
2. What were the main elements in technology education that affected the test participants' competence?

This follow-up study was carried out as a qualitative case study. Data from interviews with three participants were tape-recorded and translated. The research data were then analyzed using content analysis. The analysis was

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carried out by assessing which of the essential elements in the participants technological competence contributed to success in their lives. These findings were later classified in terms of themes or factors and, finally, reported in the conclusions. The results from each participant interview are shown in a competence curve, which will later be explained in more detail. The competence curves indicate each person's development in technological competence during their life.

Theoretical background

Technological competence is fundamental to human existence (Burke & Ornstein, 1995; White, 1962). At each stage within the cycle of life, humans continuously strive to acquire new skills, or to refine existing ones, in the hope that productivity and quality of life will be enhanced. Despite the fact that skilled behavior underlies nearly every human activity, our understanding about the factors that contribute to the attainment of expertise in technology education is far from complete. However, some attempts to define technological competence have been made. For example, based on Dyrenfurth's (1990) and Layton's (1994) work, Autio and Hansen (2002) defined *technological competence* as an interrelationship between technical abilities in psychomotor, cognitive, and affective areas.

Defining and measuring technological competence as a construct was achieved by extending the work of Dyrenfurth (1990) and Layton (1994). They identified three components that correspond with what the authors considered to be the dimensions of technological competence. The first is *technological knowledge*. Citizens in a democratic society, according to Dyrenfurth (1990), know something about technological concepts, principles, and connections, as well as the nature and history of technology. This kind of knowing is often referred to in the educational sciences literature as the cognitive domain. Common examples include troubleshooting and understanding a circuit diagram.

The second dimension of technological competence is *technological skill*. Technical and technological skills are part of most human activities and are essential for the survival of humankind. These skills are often labeled by psychologists as psychomotor skills and are an important component of technological competence. They involve tactile or kinesthetic ability, as well as practical intelligence. Such skills include manual coordination and steadiness when using welding or soldering equipment, for example.

The third dimension is *technological will*, or being active and enterprising with regard to technology. Technology is determined and guided by human emotions, motivations, values, and personal qualities. Thus the development of technology in society is dependent on citizens' technological will to participate in, and have an impact on, technological decisions (individual and/or societal). This is the affective or emotional aspect of technological competence. Technological competence, in short, involves a balance between knowledge, skill, and emotional engagement. In its fullest sense, it is the act of using human ingenuity, or, being ingenious (Hansen, 2008).

In the present study, technological competence was defined as an aggregate of the three aforementioned measurements: knowledge, skill, and emotional engagement. This definition has been criticized because it seems to be too simple for defining the complex interrelationship between psychomotor, cognitive, and affective areas. It is also true that in every psychomotor action a certain amount of cognitive thinking and emotional engagement is involved; in addition, every cognitive action always includes an affective element. Despite the difficulty involved, it is worth trying to determine if it is possible to predict student potential for career success with this instrument. A simplified model of technological competence is described in Figure 1.

Figure 1
Technological Competence

TECHNOLOGICAL COMPETENCE		
Technical Abilities In		
Cognitive Area Examples:	Psychomotor Area Examples:	Affective Area Examples:
• Spatial Reasoning	• Coordination	• Motivation
• Troubleshooting	• Dexterity	• Attitude

During the interviews typical elements affecting technological competence were identified. These were classified according to the Peltonen and Ruohotie (1992) model of school learning, which consists of four factors or themes: *personality*, *environment*, *social relations*, and *subject content*. Personality includes a person's character, needs, interest in technology education, talent, and hobbies. Environment includes the classroom environment, home environment, tools and machines in the classroom, material used in lessons, and class size. Social relations include teacher-student interaction, classroom atmosphere, parental opinion, and friends. Finally, subject content includes school curriculum; items to be made in class; freedom to choose items, materials, and techniques; student's internal feedback; and evaluation. As the Peltonen and Ruohotie (1992) model was originally designed for general school learning, following the interviews, we changed the classification slightly to better fit the context of technology education.

Study Method

The research was carried out as a qualitative case study (Merriam, 1988) and the data was collected from individual theme interviews. The interviews were first tape-recorded and transcribed. Themes were identified, and portraits of each subject were established (Lightfoot, 1983). Later the data were analyzed using the content analysis methodology (Anttila, 1996; Baker, 1994). The analysis was carried out by assessing which of the essential elements in the participants technological competence contributed to success in their lives. These findings were later classified according to the themes and were reported in the conclusions. Prior to the interviews, the researcher had a short discussion with each test participant about the concept of technological competence. Each understood that technological competence was defined in the study as an aggregate of three areas: knowledge, skill, and emotional engagement. In addition, they understood that a competence curve is a self-report having no absolute value, and they drew competence curves indicating how their technological competence was developed over the course of their lives. The competence curves were later discussed in more detail during the interviews. The curves indicated each person’s competence in technology during his life.

Study Participants

The study group consisted of three individuals now in their late twenties (two aged 28, one aged 29) who, when tested for technological competence 15 years ago as students, achieved the best results in terms of the three abovementioned measurements—cognitive, psychomotor, and affective. Technological competence was defined as an aggregate of these measurements. Therefore, the test subjects were selected according to overall accomplishment in all three areas. In the original test group 15 years ago, comprising 267 participants, a number of individuals performed better in certain areas (e.g. psychomotor), but did not succeed as well in the others. More information about the research group, test instruments, etc. in the original study is available in Autio (1997) and Autio and Hansen (2002).

The researcher had no previous knowledge of the test subjects’ current employment status. Fortunately, the background of each test subject was somewhat different, but there were enough similarities in the elements behind their technological competence to make some conclusions. The test participants were difficult to trace, but with the help of their old teachers and the internet this was done after three weeks of investigation. Although 267 students were tested 15 years ago, coincidentally, two of the test participants attended the same school in a small rural village. The third participant came from Helsinki. The participants’ school curriculums did not differ from those of other Finnish comprehensive schools.

Two participants had studied at the University of Technology. The first was quite sure of his decision to choose a technology career already after secondary school, but the second was interested in several other areas as well. He could have chosen a number of other careers. The third test subject was equally talented in technical matters and was not particularly interested in other subjects when in comprehensive school. So, he began to study computers and automation technology in vocational school, instead of continuing in a more academic direction. The test participants were named characteristically as follows:
Subject 1—academic technology researcher
Subject 2—academic multi-talent
Subject 3—non-academic technology talent

Results

In the following section, the educational path of each test subject is described more precisely and the competence curves are presented in Figures 2-4. The competence curves were first drawn by the test participants, who assigned values from 0 to 100% based on their opinions of their competence, and then discussed in more detail with the researcher during the interviews. No absolute value was given for the strength of the particular competence.

The elements accounting for their competence are described in Tables 1-3, which show the elements that had the greatest effect (shown in bold and underlined text) as well as those that affected the participants' competence less (shown in bold or normal text). The significance of the factors is based on the participants' direct comments, which were documented during the interviews.

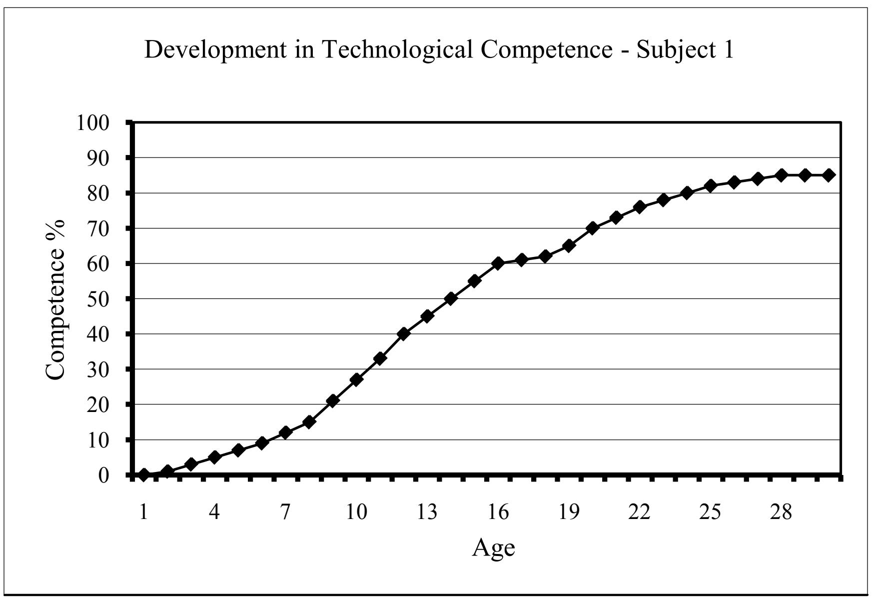
Subject 1—Academic Technology Researcher

Subject 1 was a 28-year-old man who spent his school years in a rural village of about 4,500 inhabitants in southern Finland, approximately 150 kilometers north of Helsinki. He was exposed to technology education in primary and secondary school. In addition, he had an opportunity to take elective courses in technology education in upper secondary school, which was not typical in Finland 15 years ago. He lived with his parents, three brothers, and one sister. His father worked in forestry, and his mother was a homemaker.

Subject 1 was already interested in technology in early childhood, and his competence in technology developed steadily throughout his school years. His first progression occurred when technology education classes began in primary school, when for the first time he received sound instruction from a teacher and could perform tasks himself with tools that he had earlier seen and tried using at home. In secondary school his competence increased when he could concentrate more on electronics, which was his main area of interest. However, for a period of time in upper secondary school he concentrated more on academic subjects.

Subject 1 finished school in 2000 with good grades (average of all school subjects 9.2 / 10.00). After finishing upper secondary school, he started computer science studies at the University of Technology. In 2005 he graduated with a Master of Science in technology and continued to doctoral studies in computer science and engineering. He finished his doctoral thesis in January 2010. He is willing to continue his research career, and he will apply for a scholarship from the Finnish Academy. He assumes that his technological competence will develop further in the projects he undertakes in the future. How test subject 1's technological competence has developed throughout his life is presented in Figure 2.

Figure 2
Competence Curve in Technology Education of Subject 1



Analysis of Subject 1

Subject 1 had become familiar with technology in early childhood, using Legos and constructing huts in the forest with his younger brothers. His father had worked with various tools fixing cars and machines at home. "*My father was a woodsman and there was always something interesting going on. His chainsaw was especially fascinating.*" School was the first identifiable element to affect his competence. Subject 1 responded positively to technology education; already, early in comprehensive school, craft and technology had become his favorite subject. He was also good in other subjects, e.g. mathematics and physics, but technology was of special interest. In particular, electronics and computers provided him with an increasing intellectual challenge.

Subject 1 was also gifted with his hands and so could concretely witness his own development in terms of things he produced (e.g.a metal detector and twilight switch). Yet he received the best encouragement from being able to understand how things work and being able to develop his own ideas. "*Electronics was a new and interesting area and now I even understood how those things work.*" For its part, the entire school environment shaped his competence. According to him, in technology classes, there was always a sufficient supply of materials, and tools and machines were in good condition. The teacher was also a significant element. The teacher did not cause stress and could create an open, intellectually challenging atmosphere. Although his internal feedback was usually enough, he still appreciated the positive and encouraging feedback from his technology teacher, because teachers in other subjects did not do the same.

Once the technology education courses were over, computers became Subject 1's main interest in upper secondary school. This provided him a new kind of challenge after working with wood, metal, and electronics. "*In upper secondary school, when technology classes were over I could fulfill my interest in technology with computers.*" His competence in technology was further developed by these studies in computer science. Later, in his academic career, he concentrated on carrying out research in a supportive and challenging working environment, and, despite relatively low salaries, after finishing his doctoral thesis he remains willing to continue his research career. This is a clear sign that the main source of his motivation has always been intrinsic. The elements accounting for Subject 1's technological competence are described in Table 1 (next page).

Table 1
Elements Behind Subject 1's Technological Competence

PERSONALITY	ENVIRONMENT	SOCIAL RELATIONS	SUBJECT CONTENTS
• Intellectual challenge • Hobbies (Legos, electronics, computers) • Talent	• Machines and tools • Home environment	• Teacher • Father • Atmosphere in technology lessons • Feedback from the teacher	• Internal feedback • Electronics

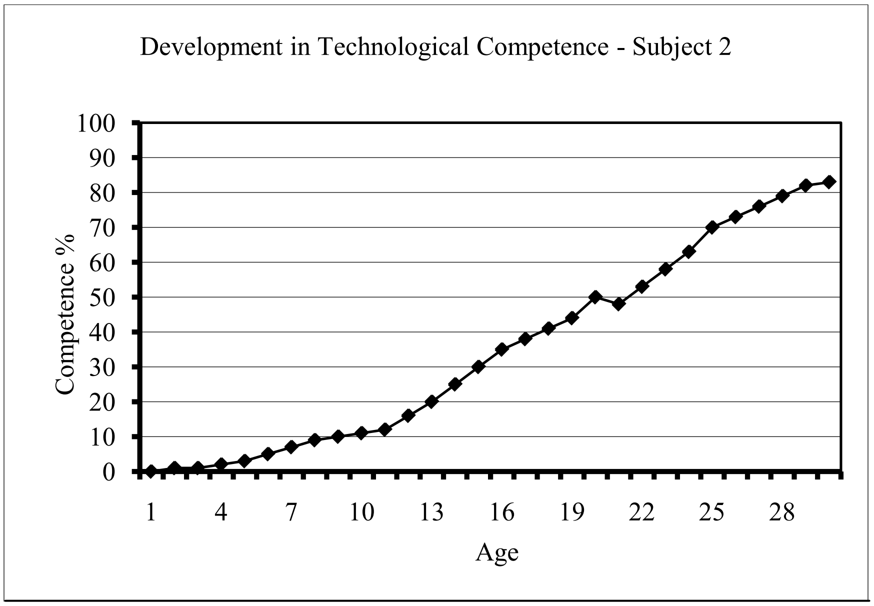
Subject 2—Academic Multi-Talent

The second participant was a 29-year-old man who was born in Helsinki, which is the capital of Finland. His first school years were spent in a normal primary school, but at secondary and upper secondary level he studied at one of the highest ranked upper secondary schools in Finland. He lived with his parents and one younger brother. Both parents had earned Masters of Science in technology and worked at the State Technical Research Centre. Many of his older relatives had also studied at the University of Technology.

Already in early childhood, Subject 2's family was very supportive of his technology-related hobbies. However, in primary school he was not especially interested in technology education. Technology education became more interesting for him in secondary school. In upper secondary school he concentrated more on academic subjects, but his attitude towards technology remained very positive.

He finished upper secondary school in 1999 with good grades (overall 9.4 / 10.00) and was planning to study medicine. However, following his compulsory military service in 2001, he decided to study automation technology at the University of Technology. In 2007 he completed Master of Science in technology and began working for an international company that manufactures hospital automation devices and other products. He feels comfortable in his job, enjoys the innovative working atmosphere, and thinks that his technological competence will still improve in the future. How test subject 2's technological competence has developed throughout his life is presented in Figure 3 (next page).

Figure 3
Competence Curve in Technology Education of Subject 2



Analysis of Subject 2

Subject 2 had become acquainted with technology in early childhood through familiarity with Legos and radio-controlled (RC) cars. His family was competent in technology, and his mother in particular was very supportive, often fixing toys with the children. "*The whole family was interested in technology, although when something was broken, it was my mother who tried to fix toys with me.*" Subject 2's motivation was based on a child's curiosity and he always wanted to know how toys worked. In primary school, however, he was not especially interested in technology education and did not learn many technological skills. Secondary school offered him more freedom of choice in projects, and studying was in general more challenging. According to him, in technology education classes were well organized; there were plenty of different materials, and machines and tools worked well. The teacher was also very competent and could create an open atmosphere, while maintaining rational planning, investigation, implementation, and evaluation processes. "*Working in technology lessons was not just copying. The teacher always guided and convinced us to a rational working process.*" It was easy to talk with the teacher, whose feedback was rewarding, and he developed his skills and technical thinking further.

In upper secondary school Subject 2 had to concentrate more on academic subjects and was not at all sure that he would choose a technology-related profession in the future. "*In our school most of the students were planning ambitious studies at university, but I was not at all sure. I could have been a doctor or something, even being a technology teacher was sometimes in my mind.*" He was interested in physics, chemistry, and mathematics, but still wanted to find a balance between theory and practice. Computers gave him a new chance to develop his technological competence without being too theoretical. This was one of the main reasons why he chose automation technology as his major subject at the University of Technology. Today he sees the inspiring and technically open environment of his work as the main factor in his development. Also, his good friends with a common interest in technology provide him with support and new ideas to develop his competence further. The elements accounting for Subject 2's technological competence are described in Table 2.

Table 2
Elements Behind Subject 2's Technological Competence

PERSONALITY	ENVIRONMENT	SOCIAL RELATIONS	SUBJECT CONTENTS
• Curiosity • Hobbies (Legos, RC, computer) • Interest • Talent	• Machines and tools • Inspiring and technically open environment (school, academic studies, work) • Home environment	• Teacher • Technically oriented and supportive family • Friends with common interest • Feedback from the teacher	• Freedom of choice • Process (planning, investigati on, implement ation, evaluation)

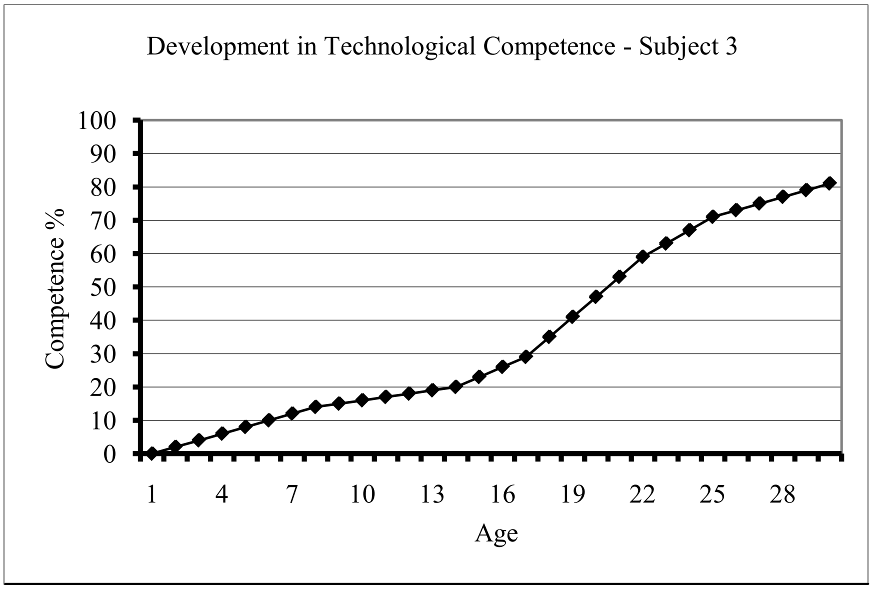
Subject 3—Non-Academic Technology Talent

The third test subject was a 28-year-old man who spent his school years in the same village as Subject 1. Both were exposed to technology education in the same primary and secondary schools. Following secondary school, he moved to a larger city with approximately 100,000 inhabitants to study in vocational school. He lived with his parents and had two elder brothers and two sisters. His father worked as a taxi driver, but was a main owner of a local bus company. His mother worked in a bank.

He was already interested in technology in early childhood, emulating his two older brothers who were technologically oriented. They were skillful mechanics, working with motors and repairing cars. Subject 3 was used to working with his hands and was not especially interested in other school subjects. Technology education provided him at least some form of intellectual challenge in terms of concrete things, but there was no significant increase in his competence during primary school. At the secondary level, however, his competence increased more rapidly when he could concentrate more on his own area of interest, electronics, and when he became aware that his skills were developing.

Subject 3 finished secondary school in 1997. His grades were not particularly good (overall 7.3 / 10.00), and instead of choosing an academic career and upper secondary school, he began to study computers and automation technology in vocational school. After finishing in 2000, he did his compulsory military service, where he had an opportunity to work with optical cables and computers. He also became interested in the mechanics of tanks and other vehicles. His technical competence was thus even higher after military service. Then he began his studies in automation technology in polytechnics. In 2005 he graduated as an engineer and started working in an engineering office as an electrical wiring designer. In his current post at an international mining and construction company, he feels comfortable and enjoys the innovative working atmosphere. How test subject 3's technological competence has developed throughout his life is described in Figure 4 (next page).

Figure 4
Competence Curve in Technology Education of Subject 3



Analysis of Subject 3

Subject 3 had become familiar with technology in early childhood, using Legos and emulating his older brothers. There was plenty of stimulation at home. His father had good facilities for working on cars, tools of all kinds, and available machines. Thus school was the first identifiable element to affect his competence. He thinks that there was no significant increase in his competence during primary school. "*After I had seen my older brothers working with real cars, there was nothing interesting in making wooden toys.*" In secondary school, however, electronics in particular provided him a challenge, and he generally felt much better, as he had more freedom and his choices were respected; this was not the case with several other school subjects. According to him there was always a sufficient supply of materials, and tools and machines were in good condition. The teacher was also a significant element, as he could create an open, intellectually challenging atmosphere.

Subject 3 was gifted with his hands so he could concretely witness his own development in the products he produced (e.g. an infrared light gate and metal detector). He felt comfortable in technology education classes, but his competence developed even more through his hobbies than through school. When he was older and more skilful, his two older brothers allowed him to repair cars with them. "*I still remember that day when my brothers accepted me as a respected co-worker and not just a pain in the neck.*"

After finishing secondary school Subject 3 went on to study in vocational school. This presented him with a new kind of challenge, as he could concentrate on areas of special interest and develop his technological talent. Later his competence in technology was developed by his studies in automation technology. Although he was not especially good in several school subjects during his earlier school years, he graduated from polytechnic school near the top. "*Maybe I was a bit lazy in school, but I was not stupid. Unfortunately, our Swedish teacher did not know what the difference was.*" In his current post in an international company, he feels he could have learned more languages at school, but his choice of moving straight into vocational school was the best decision in terms of his talent and interests. According to him, how his technological competence develops in the future will depend on interesting and challenging future projects. The elements accounting for Subject 3's technological competence are described in Table 3.

Table 3
Elements Behind Subject 3's Technological Competence

PERSONALITY	ENVIRONMENT	SOCIAL RELATIONS	SUBJECT CONTENTS
• Interest • Own needs • Hobbies (Legos, cars) • Talent	• Home environment • Machines and tools • Inspiring environment (further studies, work) • Technical facilities in military service	• Teacher • Atmosphere in technology education lessons • Parents and brothers • Challenging and inspiring working atmosphere	• Product • Freedom of choice • Internal feedback • Working process

Conclusion

The competence curves indicated how test participants' technological competence was developed over the course of their lives. There seemed to be three crucial phases in the development of technological competence. The first was noticed when technology lessons started in primary school. The second seemed to occur in secondary school when there was more freedom of choice in projects, and studying was in general more challenging. Thirdly, competence in technology was further developed by studies at university or polytechnical school. The secondary school phase seemed to be the most important for all test subjects. Two participants assumed that the increase in their competence was not as significant during primary school.

The most important personality elements that affected test participants' competence in technology were curiosity, interest, students´ own needs, and intellectual challenge. Technology-related hobbies (e.g. Legos, computers, cars, and electronics) were definitely another important element. In the measurement of technical abilities fifteen years ago the test participants were also found to have technological talent, and according to Byman (2002), students usually prefer and choose subjects and tasks in which they are proficient and can show their competence. Research in other life contexts, such as education in general, has also shown that high levels of autonomous motivation toward education lead to high academic performance (Burton, Lydon, D'Alessandro, & Koestner, 2006; Gottfried, Fleming, & Gottfried, 1994).

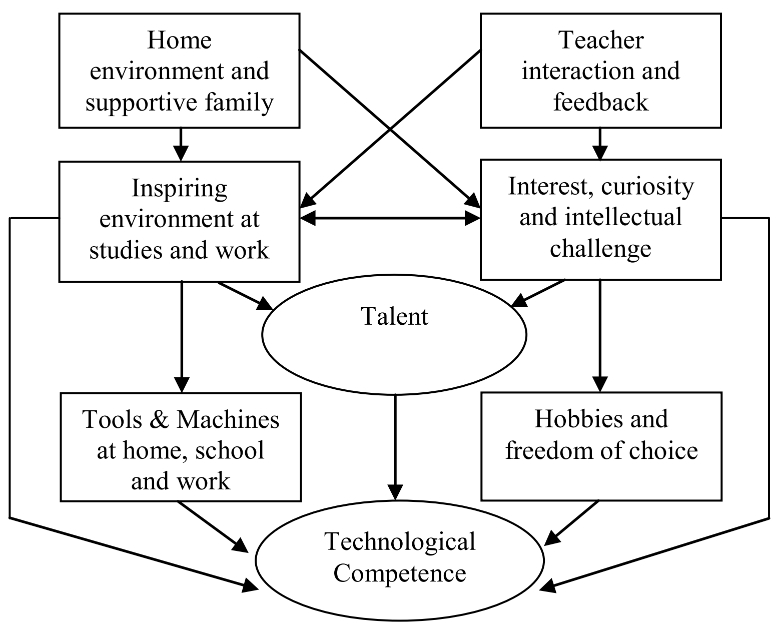
Furthermore, the entire classroom environment appeared to be an important factor in technological competence. According to the test participants, the classroom in technology education always provided enough materials, and tools and machines were in good order. In addition, most of the test subjects could work at home, in further studies, and finally at their present jobs. According to Stipek (1996), it is even more important to pay attention to providing an optimal and suitable learning environment than to concentrate on students' personal problems in terms of motivation. Deci and Ryan (1985) argue that informal learning environments (e.g. hobbies) which offer optimal challenges, plenty of different stimuli, and a chance to be autonomous result in effective motivation. In this study all test participants engaged in many technological activities outside of school in their leisure time. This can be seen as a clear sign of intrinsic motivation.

Social relations—teacher-student interaction, the classroom atmosphere, and the family—were also found to be important elements in creating technological competence. We can suppose that classroom atmosphere and teacher-student interaction were more important in making the whole environment suitable than in directly influencing competence in technology. A suitable learning environment and atmosphere are seen as typical factors for producing a positive affect. A positive affect, for its part, facilitates flexible thinking and problem solving, and enhances performance, even when the tasks at hand are complex, difficult, and important (Isen & Reeve, 2005). Furthermore, Isen and Reeve (2005) indicate that positive affect fosters intrinsic motivation, as well as optimal performance and enjoyment of tasks, but not at the expense of responsible work behavior in uninteresting tasks that must be done.

Surprisingly, technology education's subject content was found to be less important than personality, environment, and social relations. The artifact to be made is usually seen as one of the most important elements in students' motivation (Autio, Hietanoro, & Ruismäki, 2009). In Autio's (1997) factor analysis, the practical advantage gained from having produced an artifact is emphasized more than the process of doing so, which for its part would have emphasized the external motivation or situational interest. In this study, the test participants placed greater value on the working process and freedom of choice as elements that generated their technological competence, which certainly refers to intrinsic motivation in their behavior.

Figure 5 shows the interaction between the main elements of technological competence based on the empirical data from the interviews with the test subjects'. The interaction is not self-evident, and obviously there are certain limitations in this generalized figure. Hence, from the interviews with test subjects' we can conclude that the interaction was based on a supportive environment at home, in studies, and at work. The environment also provided suitable tools and machines to be used. The significance of the teacher was noticeable in all test participants. These elements effected interest, curiosity, and intellectual challenge—which were further developed in hobbies and in freedom of choice in several different formal and informal learning situations—and finally generated technological competence.

Figure 5
Interaction Between the Main Elements Behind Technological Competence—Summary of Test Participants.



Discussion

In this study, the three students who had the best overall results in the measurement of technical abilities fifteen years ago were followed. The researcher had no previous knowledge of how these three test participants were currently employed. In addition, the researcher tried to determine if is it possible to predict student potential for career success in the technical professions with the instrument used in the measurement. Although we must be cautious about the final conclusions, the study shows that, at least among these participants, it was possible to predict student potential for career success in the technical professions. The study had obvious limitations; the research group was small, and we can't be sure how well the participants remembered their pasts. Furthermore, we did not determine the effect of other school subjects on technological competence.

In the original measurement of technical abilities, all test participants proved to be technologically talented. However, their subsequent circumstances were somewhat different. Two participants had studied at the University of Technology. The first was sure of his decision to do so quite early on, but the second was talented and interested in several other areas as well. He could have chosen a number of other options, but ultimately went for a technological career. The third test subject was equally technologically talented, but he was not especially interested in other school subjects in secondary school. So he began to study computers and automation technology in vocational school instead of continuing in upper secondary school and aiming for an academic career.

In Finnish schools it appears to be the case that some students value neither crafts nor vocational education. In their opinion, a university is definitely a better and more respected place in which to study than a vocational school. These views usually reflect values and attitudes originating from the home, attitudes that are adopted already at an early age (Autio et al., 2009). An academic career is usually more valued than practical work, but in reference to the case of Subject 3 (non-academic technology talent), we can suggest that there should have been a better balance between practical and academic subjects, at least in the primary and secondary school.

It is obvious that, among the test participants, curiosity and intellectual challenge had affected even intrinsic motivation by expanding the amount of internal feedback. According to Deci and Ryan (1985), one way to achieve intrinsic motivation is to expand students' feelings of autonomy. This occurs when work is based on students' own curiosity and there is freedom of choice in materials, techniques, and in things to be made. A feeling of autonomy is especially important for older students who want and need more autonomy when making decisions.

Furthermore, according to Hidi and McLaren (1990) individual interest develops slowly and tends to have long-lasting effects on a person's knowledge and values, whereas situational interest is an emotional state that is evoked suddenly by something in the immediate environment and may have only a short-term effect on an individual's knowledge and values. This phenomenon seemed also to be true in this study, as the test subjects' individual interests had long-term effects even on their career decisions.

Social factors, as discussed, were also found to be important elements in creating technological competence. Although it seems that these elements were more important in making the whole environment attractive than in directly influencing technological competence, Reeve, Bolt, and Cai (1999) have shown that teachers who support students' freedom of choice and autonomy in decision-making create more intrinsic motivation than those who intend to control their students. Support of autonomy is evident when an authority figure respects and takes the subordinate's perspective, promotes choices, and encourages decision-making (Ratelle, Larose, Guay, & Senecal, 2005).

Motivation has been viewed for a long time as the primary determinant of students' learning and school success. Motivation is critical, not only to academic achievement, but also to students' beliefs in their future success as professionals. This study seems to agree. Students' own interests and intellectual challenge, combined with a favorable environment at home and in further studies, is the key to success in the field of technology education as well. However, the question is how can we find these intrinsically motivated technologically talented students, especially those who are not interested in academic subjects, before they lose their natural potential by becoming bored at school? This is a real challenge, and we are continuing our efforts in this regard in related projects. Further, it would be interesting to learn how the best girls have progressed. Are they working in technology as well, or did they end up in other professions?

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