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ABSTRACT

This paper discusses using technology education in the elementary school to encourage innovation and adaptation, technological literacy, and creative problem solving. Technology education is seen based on hands-on activities where pupils make things and become familiar with their technological environment. The hands-on activity should evolve like the creative problem-solving process, which begins with an idea and ends with a product or solution via searching, trying, and realizing. If hands-on science is reviewed in a larger context than merely arts or aesthetics, one can learn to understand how man creates his technological world. If technology education is viewed from the viewpoint of students, one notices that students must be taught the knowledge, skills, readiness, and values which they will need later in life. Postmodern society and economic life will require young adults to have the capacity for innovation and adaptation, technological literacy, and creative problem-solving skills. Includes an example of teaching about different transportation systems in order to plan production of water vehicles. (Contains 18 references.) (PVD)

Technology Education in Elementary School:

Why and How?

by
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TECHNOLOGY EDUCATION IN ELEMENTARY SCHOOL – Why and How?

This paper discusses using technology education in the elementary school to encourage innovation and adaptation, technological literacy and creative problem solving. Technology education is seen based on hands-on, where pupils make things and become familiar with their technological environment. If we review hands-on in a larger context than merely arts or aesthetics, we can learn to understand how man creates his technological world. If we look at technology education from the viewpoint of pupils, we notice that we have to teach the knowledge, skills, readiness and values, which they will need later during their life. Our postmodern society and economic life look for young adults, who have the capacity for innovation and adaptation, technological literacy and creative problem solving skills. What actually is the role of technology education in the elementary school?

Key words: elementary education, technology education

Introduction

Technological awareness and literacy can be developed by becoming familiar with technological equipment and systems. Technology study stations and exploring activity are tools for this. Developing innovation, creativity or new productive thinking requires more. It is not always possible to educate for these because learning and educating have to start from the pupil's own desire. Pupils should have opportunities to apply their own assumptions and ideas to practice. At that time it is not becoming familiar with what others have already accomplished in the field of technology, but pupils are truly becoming involved in the technological process. Doing technology by themselves they learn its control

and manage processes, man's role in design process and first of all they themselves grow during this technological production process.

Technological creative problem solving process requires technological knowledge for realizing. Solving technological problems pupils need to get into earlier technologies, how this and that problem has been solved in different situations. Technology has not developed without work. Passing technological production process is already a sustained challenge for pupils in school. In the beginning there is a problem, which should be changed to a concrete form. The pupil is responsible for its success and progress. There can be found elements of work education in activity like this. When figuring the final shape of the product there is involvement in artistic aesthetic elements.

What would be the proper age for starting technology education? Children's learning in technological things starts very early. Actually it starts pretty soon after their birth. According to this kind of thinking it is never too early to start teaching technology. More important question would be how would we start technology education so that it corresponds to children's stage of development and it would support their later learning situations? Wrong methods can even cause antipathy against technology education in later years.

Technology education is a diversified school subject. Teachers in elementary education do not always recognize that they are involving technological things in their teaching. Technology education is much more than computers or high technology. We can say it is the way to teach higher order thinking skills too. In elementary school technology education can be an integrated into school subjects, but it also can be taught as an individual school subject, as is done in some counties.

The technology education of the elementary education may not only be the instruction of facts of technology and technological knowledge. More essential is to teach the nature of technology. Pupils have to learn to use technology in a meaningful way, understand its cultural meaning and the issues raised by or use of technology (Dugger 1997; Dyrenfurt & Kozak 1991). The most important goals, which can be included into technology education are to teach the readiness, which are still useful in the future. These kinds of higher order thinking skills such as ability for innovation and adaptation, creative

problem solving as well as just technological literacy with a learning to learn ability have to be the primary goals of technology education in elementary school.

Starting points of developing for technology education in elementary education

Children like to do things that can be used, in other words, they like to do technology (Raat 1993, 79). Eggleston (1994, 20) argues that technology education is the unique school subject directly concerned with the use of materials and to understand the significance of technology. This is not all. Technology education also extends human potential; it stimulates cognitive faculties as well as affective and psychomotor faculties. Parikka and Rasinen (1993, 204) have found that technology education aims to three main goals. The first goal is positive development of the child, that is connected to the before mentioned development of three personality faculties. The second goal is understanding technological functions of home, and the third is connected to understanding technological systems of society.

Technology education of elementary education should be founded on learning hands-on activity. The hands-on process usually starts from problem and idea and ends in an artifact, passing through the phases of designing and making. It also can be a process where pupils do not produce anything concrete, but they look for a solution for a technological problem. Hands-on learning gives very good possibilities to extend the daily interesting topics into learning tasks in technology education (e.g. Richards 1990). An illustration of teaching and its connection to environment are two very important factors especially in the elementary education. When we are teaching the technology in the elementary school, we should observe children's ability to think, especially at an abstract level. Such as Inhelder and Piaget (1958) have indicated, children are not able for abstract thinking in the every period of life. Thus the teacher has to be aware of the children's cognitive development, their fundamental representational capacity and ability to understand relationships (see Carey 1990). The role of the teacher when teaching technology is to use children's capabilities and build upon them, as well as introduce them to a variety of new techniques and skills that will extend and widen these experiences (Makiya & Rogers 1992, 16). Teaching has to be base on earlier concepts of pupils. Teacher also has to be clear on how pupils

observe reality and how learning to understand happens. This kind of teaching, which is required in many studies of today, can be characterized as constructivist teaching.

According to Shapiro (1994) the constructivist perspective emphasizes the active agency of the learner, asserting that each learner builds or constructs his or her reality. She continues that it departs from traditional approaches in its view of such ideas as the nature of reality and knowledge, the purpose of knowing, the role of learner and of learning, the role of the teacher and of teaching, and the organization of the classroom and of the curriculum and its evaluation. This constructivist paradigm demands that the focus of teaching be on learning of pupils rather than transforming of knowledge.

In technology education as in the practice of constructive learning, children should mould their learning environment themselves, an environment where the self-made product or solution is connected to real life. With the help of the problem solving process and hands-on activity it is possible to become familiar with the environment and to learn about the surrounding economical, technological, and social culture as well as nature and their importance for the individual and the whole of society. This sets demand on technology education as a learning process.

In elementary school children should have possibilities to become familiar with the technological world. This demand is fulfilled in some cases, but there is still a developmental need in this field. This sets opportunity to the professional development of teachers. However, we found very few studies of technology education concerning learning and teaching for kindergarten and elementary school aged pupils. Thus I try to clarify the starting points of developing for technology education in elementary school.

Hands-on activity as a learning method

A conceptual model for teaching technology

In the following sections is reviewed technology education from the perspective of the teaching situation. As Figure 1. shows, teaching should be in connection with children's environment, in other words with external reality. In technology education this demand is fulfilled in most cases when it follows its practical and commonplace nature. Internal reality, children's thoughts, memories and earlier concepts, can be in interaction with external reality with the help of hands-on activity. In this article hands-on activity is reviewed as a learning measure. The interaction of external and internal reality enhances children's internal reality. This event is called learning. Hence the hands-on activity where pupils works with creative problem solving is creating a bridge between the external reality and pupils' internal reality. One method for this learning process is none other than hands-on activity.

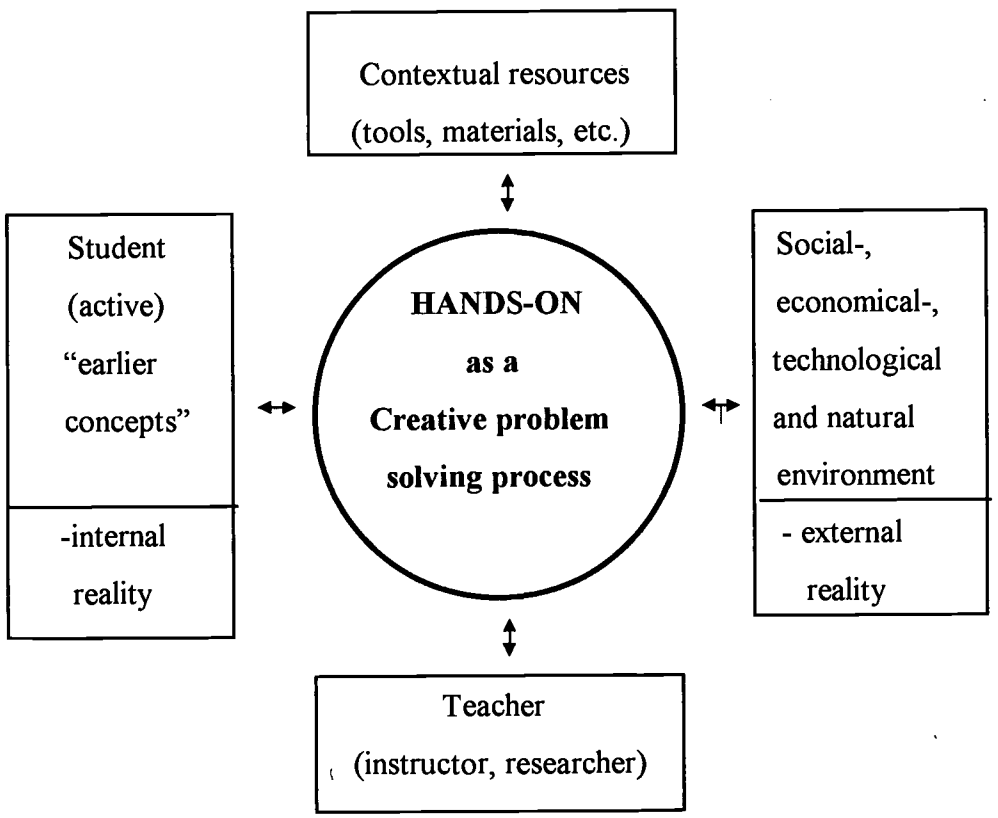

Figure 1. A conceptual model using hands-on activity as a learning method.

As a good teaching and learning situation presupposes, in this model there is a teacher who is the instructor of learning. On the other words the teacher is not the transferer of knowledge, but rather the tutor of learning. Shapiro (1994) says that the teacher who works according to this kind of teaching practice becomes a researcher in the classroom. It includes deliberation about what, how and why I teach this way. In other words, it is essential to question comprehensively the technology education, which is involved in the teacher's own actions, curriculum, school and society. Thus he or she has a reflective grip to his or her teaching (e.g. Osterman & Kotkamp 1993). In this way the teacher is able to develop teaching work just as good research teachers do. He or she has energy and courage to question the current understanding by asking, studying, examining, clarifying facts and trying them in his or her teaching work.

In this model we find also contextual resources such as tools, materials, and workspace. Especially this part of the model alternates in elementary education internationally. In some countries there are technology education as a compulsory school subject in elementary education. Hence there usually is a classroom with proper furnishing for technology education. In some states and countries they lack classroom or proper workspace for the technological hands-on activity. On the other hand there is a demand to integrate technology education to other school subjects too. Then the problem concerning the contextual resources can be solved easier. However as in many general discussions has been taken out, we loose an essential part of technology education; learning through technology, if it is taught in connection with other school subjects.

The object of teaching and learning is the student, who should be the active learner in this process. The core of this model is hands-on activity, in this case the creative problem solving process. The hands-on activity should evolve like the creative problem solving process, which begins from an idea and ends in a product or solution via searching, trying, and realizing.

Technology education is looking for cooperation from other school subjects. It offers good possibilities to integrate different areas to hands-on and productive learning. The part of other school subjects alternates in different phases of making and problem solving process. The problem which is solved also determines to which area of environment learning is focused on. Although learning is focusing on

transportation, manufacturing, communication or construction technology as well as energy, all of them include social, economical, technological and natural aspects.

Technological knowledge versus technological innovation

Dugger and Yung (1995) argues that technology education includes three levels; awareness of technology, technological literacy and technological capability. Technology education in elementary school clearly focuses on awareness of technology, but also on technological literacy and capability. The essential goal is to develop understanding of technology in different areas. Pupils become familiar with technology. Is this all what we can do in technology education in elementary school? Technology education gives a lot of possibilities to develop diversifiedly whole personality of pupils. We do not need to come back to work or craft education, or manual training or even vocational skills, but we can utilize educational elements arising from traditional ideas to product process, which is designed by pupils.

The "from idea to product" process designed by pupils is strongly focusing on developing whole personality of children, especially to mental readiness and promoting balanced growing and development. The essential goal focuses on developing thinking skills. If the pupil wants to design a candlestick, which seems to be a pretty simple artifact, the design process from the start to the end includes many decision making phases, which include material, shape, procedure, and so on. For example Scandinavian sloyd education strongly focuses on hands-on activity, where the essential point is just from idea to product process (see Johanson 1995; Lindfors 1997; Peltonen 1996). In other words production operation. This area should also be utilized in technology education. Technology education should not only be studying technology, but also developing thinking for creativity and innovation in technological context. This way it also develops whole personality, all faculties. At the same time is also learned to understand, utilize, produce and manage technology as well as is developed positive attitude toward it. These kinds of skills develop only if the pupil's activity includes enough decision making and self directed working. It cannot only be working at the technology station with notebooks and textbooks, such as given question – one correct answer method.

If we want to develop whole personalities of pupils in a meaningful way, a hands-on process may not be just copying, but it should focus on creative problem solving processes. The products of ordinary making processes such as copying activity, only change the world in quantity (Heikkilä 1987). According to Heikkilä (1987) these kinds of products are received with no emotional involvement and they do not create new images in school education. He continues that a creative activity produces always some new information of intention and the deep "sedimentaries" of a person. In processes like this pupils can handle their emotions, and at the same time their relationships between themselves and their external reality deepens. According to him a person doing a creative act and activity changes the quality of internal and external reality. According to Heikkilä (1987) the extreme aim is to get pupils to grow according to a presupposition of their own. Hence formal education changes self-education, where the teacher's role changes to tutor.

The educational factors, which rise out from the "idea to product" process designed by pupils, such as in sloyd education, should be seen in technology education also. The core aim of this process brings an essential element for the technology education of today and tomorrow. If we limit our extremely versatile school subject to only education for technological consciousness and literacy, we loose a lot of good educative elements in hands-on activity. The educational factors, which John Dewey (1915) talked about one hundred years ago. Earlier children learned many useful mental skills and attitudes in agricultural societies and in farms, which are not the present growing environment of today's children. Certainly the stressing of goals in teaching alternates, but especially from the "idea to product" process these kinds of possibilities should be utilized. It is such as a challenge, which requires mental efforts to realize the goal.

Different ways to teach technology

It can be reviewed the necessity of technology education from the standpoint of children's personality, technological environment and the technological systems of society. In elementary school technology education starts from elements and understanding basics.

Technology education in elementary schools can be realized by many ways and means. An essential determining factor is suitability of working spaces for hands-on activity. If there are tools and a working space for handling different materials, pupils can realize different artifacts, such as electric items or vehicles, which they can use later. Pupils are able to build and design similar applications and things which are used in their living environment, on the other words in their external reality. It can start as a creative problem solving process, such as they can have a transportation problem, they need to build a lifter and a bridge. How does a real lifter work in the harbor or in the construction area? The same problem can be solved using construction kits. Pupils learn similar scientific and technological things rather than working with making processes. However the idea to product process is more all-inclusive than only working with construction kits. There are much more possibilities for creativity and realizing emotional feelings and personal solutions, if pupils are involving design processes.

The goals of technology education can also be reached by using educational technology. More and more software is being developed, which can be used in teaching technology. Computer aided design is also suited for idea to product process where pupils are looking for proper shape for their solution. The fourth way to teach technology is to become familiar with technological appliances, to look at and explore how they work or have been built. Thus technological appliances do not look like black boxes to pupils, but they usually include input, process and output phases. Many electric toys have these phases. Technology education in elementary school can also be realized as a learning project, which starts from technological problem. The pupils become familiar with a problem and look for solutions for it. In the end they write a written proposal for a solution. They can try to find solutions for local technological problems in various areas of technology, for example. Using imagination they can try to invent new innovations, too. One way for technology education in elementary education are visits in industry. The contents of technology education can also be taught in connection with other school subject.

How could we realize technology education in practice? Let's take as an example transportation. This example is used Eileen Chadwick's (1990) ideabook named Hickory Dickory Dock focusing on teaching of different clocks in design & technology in kindergarten. Similar phases can be used in technology education in elementary education. Although the following example is pretty simple, it illustrates the phases of constructive teaching and gives us ideas for further developing.

Transportation includes air-, road- and water transportation as well as space. Teaching can be grounded in that way that pupils observe different transportation systems in their living environment. Then is examined, compared and discussed different kinds of transportation systems and their meaning for people and society yesterday and today. When we have received a sufficient orientation level to our theme, we can start to plan the production of our own vehicles. In this case we can limit our interest to transportation on the waterway and deeper our understanding about it. The following phases are the real hands-on process in this whole educational teaching and learning situation. Discussion before that is becoming awareness of transportation systems. As was mentioned a while ago, the hands-on process should be based on creative problem solving. The most important thing is that children think carefully about what they will do, or can they actually plan their own water vehicle? We can suppose that it usually is a boat, ship or hydrocopter.

First of all children think about the problem, because inventors also work like this. We have to think about who needs the vehicles on the waterways? What will our vehicle look like and how will it work? We can also think about what kind of vehicle we want to make. It is very useful to draw a picture of the vehicle we want to make. This way we can illustrate our ideas and planning. After we have invented our own vehicle for waterway and we know what it will look like, we have to make a work plan. We should think about what to do first. Do we need to glue something together for example? What are we going to use for the top of our vehicle, and so on. After our vehicle is done, we get more thinking in our hands-on process by asking if the children think they could improve on the vehicle. Asking if a student's self-made vehicle looks like the plan is also a very important question for self-evaluation and learning.

When everybody has done their own vehicle, we can again look at our real water vehicles. Like in the constructive concept of learning, children have built their learning environment by themselves, an environment where the self-made product is connected to the real life. In this case it is their self-made water vehicle. With the help of the self-made vehicle it is possible to observe the environment and to learn about economical, technological, and social culture and their importance for the individual and all of society.

When we were making our vehicle, we had to think of many kinds of things in advance. But did anybody think what makes real vehicles work? We will find many types of vehicles for waterways, when we examine real ones; canoe, sailboats, motorboats and cycling boats, atomic submarines, gas ships, steamers, hovercrafts, and rowboats. We can ask children to find out what keep vehicles in motion and why do they not sink? We can also ask if they can see the screws in the boats or ships? We can ask if children know of any and can they figure out how they work.

Pupils can look at the oldest and the newest boats. What are the differences and the similarities? Long before modern ships were invented, people used to use the raft as a boat and sails as a source of energy. At the same time we learn something about the natural environment.

We can learn about communication, construction, energy or other technological phenomena using these same phases of teaching. We can make a lighthouse where we need to get light on the top of our self-made structure for example. It is essential to bring the dimension of technology education as an integrated entirety. From the previous theme can easily be moved to the next theme, for example with the help of construction kits can be explored function of cogwheels and their motion or from vehicle can be moved to construct lighthouse, to where come a bulb and a battery from a flashlight.

Desirable development of thinking and acting practices does not happen quickly, but this kind of education has to be started at the early ages. In elementary education it should be given the first readiness of technology and basic skills for utilizing and managing technology, but at the same time with the help of abundant doing and designing are developed whole personality.

In elementary education there should be created basics for technological thinking and attitude. It is important to learn to take a stand in technology questioning out its meaning and to thinking about technological items, "could it be an other way?" or "what meaning has this for individual, society and nature?"

Discussion

Like Figure 1. pointed out the essential matter for technology education is hands-on learning. It is more of an advantage if it appears as a creative problem solving process. That makes technology education in elementary school different. Children like to do things and create their own solutions. With the help of a self-directed process they become familiar with the surrounding world and its technologies. Education especially in elementary education includes something other than merely cognitive goals. The aim is to develop whole personalities, to educate citizens, who are able to get over difficulties which they will meet later in their life, not only increase knowledge.

The general assumption has been that elementary teachers don't always recognize that they are teaching technology. Technology is not as magic a thing as they might suppose. We can assume that a lot of development is needed and desired in this field. The use of technological tasks in elementary education should be promoted, particularly from the standpoint of a technological society. Then the first preparations for children's developing of technological literacy is given. It has later impact in new learning situations that arise within a technological environment.

Creating idea-books and learning materials is a challenge for technology education. The internet is becoming more common in elementary school, and it makes a new and easy way to achieve this kind of material. The departments of teacher education, however, have the most important role in developing technology education of elementary schools. We have to pay a lot of attention to basic education in the departments of teacher education. In the student teaching period they should also have the opportunity to become familiar with teaching technological activities. Technology education should be a more notable part of basic training at the departments of teacher education than it is now in many places.

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