SUBJECT MATTER : MEANINGFUL LEARNING IN TECHNOLOGY EDUCATION

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ABSTRACT

In Finland teaching of technology has traveled a long road during its 140-year history. It has gradually gone from the copying of the model series dating back to 1860´s to the building of computer controlled robots. Materials, techniques and technology have developed wildly but the pedagogic contents are restricted regrettably still often only around the product to be made.

In technology education subject matter teaching model, which includes motivation, planning, working and evaluation is striven for out of narrow minded object thinking and out of merely copying working. In this article subject matter teaching model is approached from the point of view of meaningful learning.

Keywords: subject matter, technology education, pedagogic of technology education.

1. INTRODUCTION

Concept subject matter has been brought into use in technology education of the Finnish comprehensive school because some generic skills should also be learned in the process of working. The early model of subject matter includes: motivation, planning, working and evaluation. The aim of it is to introduce alternatives to object thinking and lead students out of merely copying working. Subject matter learning has been developed already in the early 1970's and has further been developed in the 1980's. These models have later been examined by Suojanen (1991; 1993) and Autio (1997; 2005).

The model of subject matter learning remained nearly unchanged with regard to its contents for a long time and its interpretation and carrying out in the comprehensive school teaching of technology has been always very heterogenous. Peltonen (1988) does not see in subject matter learning any other starting point than the fact that in the early 1970's certain quarters have been familiar with some pedagogical concepts which are mainly from educational psychology.

If subject matter learning is narrowly examined and based merely on the curriculum for the comprehensive school guide (1970) simplified model, one can perhaps find this claim justifiably. However, Suojanen (1991) during the subject matter working, clearly emphasised the significance with which knowledge and skills are developed and the importance of the whole working process. Further the subject matter developed by Suojanen (1993) is based on the theoretical model of the planning process and manufacturing process of the product. Presented below one can find the early models of subject matter teaching:

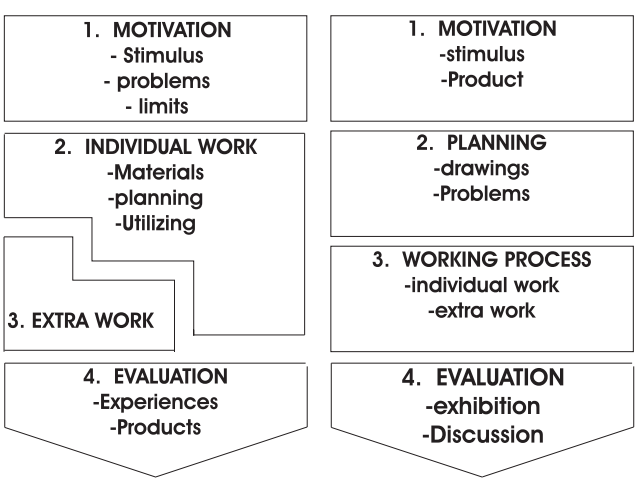

Figure 1. Stages and development of subject matter teaching (Curriculum for the comprehensive school guide 1970; 1988)

In a larger context subject matter has several similarities to project-based learning, which also has the potential to enable pupils to research, plan, design and reflect upon the creation of technological projects (Doppelt 2005). Besides that it is close to activity categories: design, make, utilize, assess presented by Weber & Custer (2005).

2. From subject matter to meaningful learning

Up until now subject matter teaching has been briefly outlined mainly from the point of view of the didactics of technology education, but in fact it has several similarities to the theory of meaningful learning as well. The simplified model of meaningful learning consists of five stages: motivation, orientation, internalizing, application and evaluation. In the following the summary of the idea of meaningful learning gives to the subject matter a clearer theoretical engagement, which Engeström (1981;1990) has developed from the theory of the adopting of mental acts (Galperin 1972; 1979) and the theory of developing the operations of theoretical thinking (Davydov 1977;1982).

Every situation in practical life contains much more information than the human being is able to receive effectively and is able to store into his memory, still the learning stays regrettably often to receive information and storing merely mechanically. It is especially difficult to remember the loose functions and subject catalogues because the human being usually aims his mental resources at the objectives which are essential from the point of view of his own life, his work and his hobbies. However, the human being demands sensibility and significance from the point of view of his own life from the material to be learned. In regard to the information there must be functionality and use also in the real assignments and situations in life. This in particular is the starting point for meaningful learning.

2.1. Motivation

The meaningful learning starts moving from practical real life problems and conflicts. When a human being notices that his information and his skills are not enough for performing a task or for commanding a situation, an internal conflict will be created. If a human being is able to realize and is able to perceive this conflict as an interesting and educational challenge, meaningful learning starts.

2.2. Orientation

The human being will try to orientate after having realized the problem. He tries to find as clear as possible, the perfect and universally applicable solution to the problem, which he is also able to solve independently in the future. This kind of solution or explanation model is called an orientation basis. This is perhaps the most crucial stage in the learning.

2.3. Internalizing

It must be possible to concretize the formed orientation basis to facilitate internalizing and to illustrate if necessary, with the help of a simplified model construction. At the same time required operations models and thinking models are driven at a mental level in a problem, in a solution or working because the model of the concrete at the last stage of the internalizing in an external form becomes a model inside the student, gradually in the use of which the external instruments are not needed any more.

2.4. Application and use

The real internalizing of orientation basis requires its long use and adapting as the instrument for the solving of new concrete tasks. At the application stage an attempt will be made to use the explanation model from as many sides as possible but however, several different aspects, for the

performing of the same tasks or functions related.

2.5. Evaluation and control

This consists of two parts: first of all, self from evaluation of the matter to be learned and second evaluation and control of own learning. At the first stage the validity and usability of the matter to be learned, a mental model and orientation basis will be analyzed especially from the point of view of practical tasks. The second stage is a matter of evaluation, control and repair of own learning. If in the working, shortcomings have occurred, an attempt is made to clarify what I have understood really and I am able to adapt to learn in the future in similar situations and still how one should act better next. Presented below one can find the model of meaningful learning:

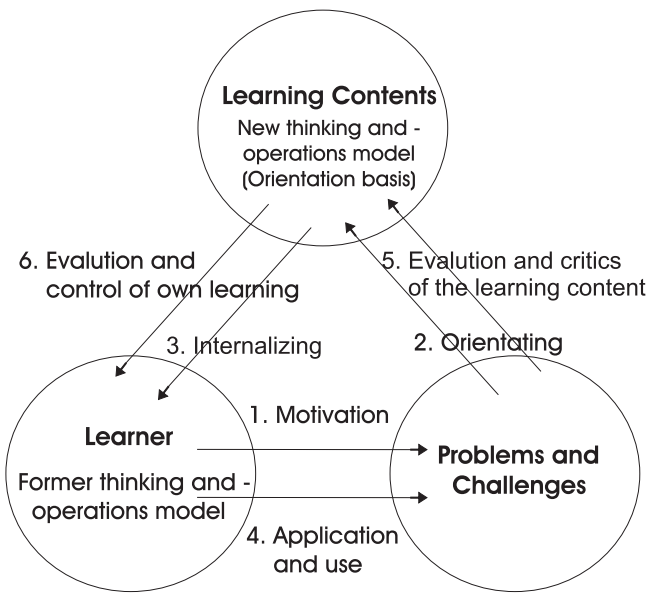

Figure 2. Modern idea of meaningful learning (Engeström 1981)

3. Comparison of the subject matter and of meaningful learning

Both the subject matter and meaningful learning start progressing towards motivation. However, the essential difference is the fact that in the subject matter motivation is based on different stimuli, binding usually to external factors by the product to be made. In meaningful learning, motivation, however, is based on the problem based internal motivation given birth by cognitive conflict.

Orientating in meaningful learning is somewhat similar to the planning stage in subject matter learning. The forming of the orientation basis is considered the most important stage in the model of meaningful learning. Also in subject matter learning one would carry out, a distinctly larger share particularly of planning and usually the operation, which is based on anticipating thinking is emphasized because it provides the basis for the success of all other operations.

In the model of meaningful learning the application stage is similar to the subject matter, which corresponds essentially to the stage where the main stress is on individual working. This stage is based on the adapting of the made plan or of the formed orientation basis from as many sides as possible in the solving of several different tasks. At this stage obvious mistakes will seldom be made, but all the mistakes that have been made at the previous stages accumulate and will be manifested when only the actual working wears out concretely. In the model of meaningful learning it has its totally own stage for the internalizing of the orientation basis and the missing of this stage can be considered perhaps as the clearest thing lacking in the model of the subject matter.

In the subject matter the evaluation emphasizes more product engagement of technology education. Even though when examining the work which has been completed, an attempt is made to emphasize also the pupil's original solutions in addition to the ready work. The outgoing very far conclusions of own learning and of the orientation foundation that has been used in the evaluation of the matter to be learned are achieved very

seldom in the analysis. In the following subject matter teaching is compared with the model of meaningful learning.

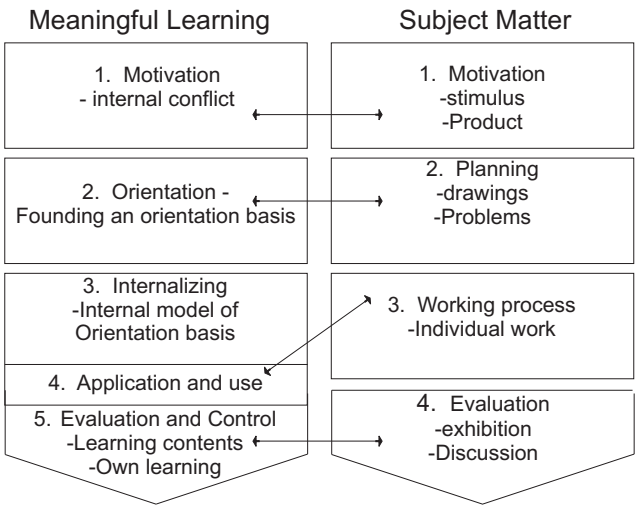

Figure 3. Comparison of the stages of the subject Matter and of meaningful learning

4. Discussion

In last twenty years materials, techniques and technology have developed wildly but the pedagogic contents in technology education are restricted regrettably still often only around the product to be made. Concept subject matter has been brought into use in technology education of the Finnish comprehensive school because some other aspects such as motivation, planning and evaluation should also be noticed in the process of working. Numerous models for curriculum changes in technology education are available nowadays both in technology education literature and school textbooks (ITEA, 2000; Johnsey, 1995). Nevertheless, there still appears to be an overemphasis on passive learning and the old traditions of craft learning (Kimbell, 1997).

However, in practice students are very motivated and attracted to technology education because they enjoy working with their hands and like the independence and chance for creativity provided by these classes (Silverman & Pritchard 1996). In this situation, one should think if more attention would be paid to the teaching arrangements if the motivation were not this high naturally. Particularly through the meeting of the cognitive conflict, an attempt should be made to give birth to the internal motivation already at an early stage, even if it at the beginning it seemed much more difficult than the giving birth of the motivation, which is based on external factors.

The significance of planning is usually understood well, but a correct solution in practice is very seldom found. The mere A 4 paper sketching, which takes place on the paper and pencil usually is not helping students much in the meeting of future problems and not in the real internalizing of orientation basis. It is not surprising that some studies have tended to show, that children are more interested on actual construction, rather than on other aspects of activity, such as design (Cajas 2001).The practice of a systematic technical drawing and the drawing of circuit diagrams should begun much earlier because this way the model of rational working would also be obtained at an earlier stage than before. Furthermore brainstorming and creative problem solving should be practised already with lower class levels. When students begin the planning with applications, which are simple enough, the motivation also would increase.

The mere working stage is usually arranged well and students are motivated and active in their work. Mental image and critical targets are tried to made clear in the teaching, which takes place at the beginning of the lesson, but still there are clear shortcomings in the real internalizing of the learning contents. In more detail and more persistently the fact whether the pupils are often let off in these kind of difficult cases too easily should also be thought about, as the development of the student's own problem solving capacity has been given too little

attention, if we stay acting this way.

In the evaluation stage a considerably wider process is quite often striven for instead of the mere number evaluation. Although Weber & Custer (2005) have found out that students tend to favor application-oriented activities over reflection and analysis, the motivation usually increases, when students ready work are collected in an exhibition and based on the executed solutions a discussion about the nature of scientific and aesthetic points of view by the devices is tuned. Teachers own pedagogical background is clearly helping in the evaluation stage and more such pedagogic education would be needed for teacher training in the future. However, it seems there is still much to do before we get our ideas into practice.

5. References

Autio, O. (1997). *Oppilaiden teknisten valmiuksien kehittyminen peruskoulussa. (Students development in technical abilities in Finnish comprehensive school). Publications 177 of the teacher training college of the University of Helsinki.*

Autio, O. (2005). *Project-based Meaningful Learning. In Papadourakis, G. & Lazaridis, I. (Eds.) New Horizons in Industry Business and Education (pp. 135-140). Heraklion: Technological Educational Institute of Crete.*

Cajas, F. (2001). *The Science / Technology Interaction: Implications for Science Literacy. Journal of Research in Science Teaching 38 (7), 715-729.*

Curriculum for the comprehensive school guide. *(1970). Tekninen käsityö (technical handwork). Helsinki: VAPK*

Curriculum for the comprehensive school guide. *(1988). Tekninen työ (technical work). Helsinki: VAPK.*

Davydov, V.V. (1977). *Arten der Verallgemeinerung im Unterricht. Berlin: Volk und Wissen.*

Avydov, V.V. (1982). *The psychological structure and content of learning activity in schoolchildren. In Glaser, R. & Lompscher, J. (Eds.) Cognitive and motivational aspects of instruction (pp. 37-44). Berlin: Deutscher Verlag der Wissenschaften.*

Doppelt, Y. (2005). *Assessment of Project-Based Learning in a Mechatronics Context. Journal of Technology Education 16 (2), 7-24.*

Engeström, Y. (1981). *Mielekäs oppiminen ja opetus. (Meaningful learning and teaching) Valtion koulutuskeskus, julkaisusarja B 17. Helsinki: VAPK.*

Engeström, Y. (1990). *Perustietoa opetuksesta. (Basic knowledge about teaching). Helsinki: VAPK.*

Galperin, P.J. (1972). *Die geistige Handlung als Grundlage fur die Bildung von Gedanken und Vorstellungen. In Probleme der Lerntheorie (pp.33-49). Berlin: Volk und Wissen.*

Galperin, P.J. (1979). *Johdatus psykologiaan. (Introduction to psychology). Helsinki: Kansankulttuuri.*

International Technology Education Association. (2000). Standards for Technological Literacy: Content for the Study of Technology. Reston, VA.

Johnsey, R. (1995). *The Design Process: Does it exist? A critical review of published models for the design process in England and Wales. International Journal of Technology and Design Education 5, 199217.*

Kimbell, R. (1997). *Assessing Technology: International Trends in Curriculum and Assessment. Buckingham: Open University.*

Peltonen, J. (1988). *Käsityökasvatuksen perusteet. (Basics of craft education). Publications A: 132 of the University of Turku.*

Suojanen, U. (1991). *Käsityöllisten työprosessien ja niiden opetuksen kehittäminen toimintatutkimuksen avulla. (Development of the working processes and their*

teaching in craft education with the help of action research). Publications C:86 of the University of Turku.

Suojanen, U. (1993). *Käsityökasvatuksen perusteet. (Basics of craft education). Porvoo: WSOY.*

Silverman, S. & Pritchard, A. (1996). *Building Their Future: Girls and Technology Education in Connecticut. Journal of Technology Education 7 (2), 41-54.*

Weber, K. & Custer, R. (2005). *Gender-based Preferences toward Technology Education Content, Activities, and Instructional Methods. Journal of Technology Education 16 (2), 55-71.*

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