

## **Humanistic and Scientific Inquiry Oriented method from the teachers' point of view**

In class, regardless of the country there is always exist a central figure – the teacher. The teacher knows how to work with students, in order to involve them to participate in teaching process. The teacher is responsible for the delivery of curriculum content to the students. Therefore, the teacher must have appropriate education for this activity. In the Finnish comprehensive school teachers still have a respectable position in society. The education of physics teachers takes about 5 years and is carried out by local universities, and as additional training to obligatory specialization. After this training teachers receive a Master Degree in subject and a Teacher Certificate. For example, a teacher may have a Master Degree in Physics and Certificate of Teacher in Physics at Lower Secondary and Upper Secondary Schools. In order to receive this certificate candidates must have at least 60 credits in Pedagogy Studies and Practice. In recent years in the Finnish comprehensive schools the tendency in a shortage of Physics teachers is observable. In the Finland-Swedish comprehensive schools year 2008 only 57,1 % physics teachers have a Teacher Certificate [1]. There are several reasons for the physics teacher shortage: lack of candidates, preference to work as a physics teacher at upper secondary school due to problems with discipline and low level of curriculum content, low salary compared to the amount of work and responsibilities. The common responsibilities are : teaching, preparation of lab-works and demonstrations, ordering of material and instruments, compilation of assessment tests for students, upheld contact with students' parents and etc. The teaching process in school physics is a teacher-centered activity. It means that the teacher is the presenter of school physics content and students are the recipients. In the Finnish comprehensive schools the teaching of school physics and others school sciences is variation of IRE [2] and describes as a TCM [3, 4]. Traditionally, teaching of school physics in Finnish comprehensive school is based on behaviorism and it is the reason why teachers choose TCM. Therefore, following of the instructions is a main stream teaching method. Because of the curriculum content teachers presents only illustrative interdisciplinary relations in their own teaching activity. The teaching in school is a result-oriented process and this is the reason to the teacher-centered process. The teacher becomes a mentor.

### **Behavioristic teaching of school physics in Finnish comprehensive school**

As noted above, the teaching process of school physics in the Finnish

comprehensive school is done according to TCM model. The behaviorist approach appears in many occasions. According to the behaviorist theory teacher should create a teaching environment which brings in the positive feelings to the students. The teacher avoid situations which are associate with unpleasantness [5] such as evaluation of lab-work reports, critical examinations of sources, positive and negative response to the students' comments and ideas, response and comments to students' different solving strategies, e t c. As a result, the teacher presents the content of the teaching topic according to the content in the textbooks and students' workbooks. Analysis of textbooks in school physics shows that training questions are directly connected to the texts. The teachers role is to train students to give right answers. In order to eliminate unpleasant situations during lab-works all instructions for students are detailed and there is no place to form a false hypothesis. Since the content of the textbooks is a reflection of the curriculum content which is based on the sequence (1), the problem-based teaching is preferable. Generally, there are two options for the solution of problems – true or false. Teachers perceive the meaning of the “pleasant environment” as a creation of entertaining activities such as lab-works and demonstrations. The roots of the entertaining activities lies in several behaviorist concepts such as modeling, shaping, cueing and extinction. Modeling is also known as observational learning [6]. For example, in order to show how a body's density influence their buoyancy teacher takes three different bodies with the same volume and place them in the water. Conclusion is simple – bodies with higher density sinks further under the water. There is no discussion about why boats appear not sink. Another example on how modeling works is seen in the information about warning text in the textbook [7, p. 189] - “do not touch the socket with wet hands”. The teacher follows the comments in the textbook: “... because water conducts electricity it is prohibited to touch the socket with wet hands.” A simple experiment shows that water does not conduct electricity. Shaping takes place when teacher want to solve disciplinary problems in the class. The teacher wait when students takes their seats and stay quiet. Students receive the improvement in form of credit/praise. Cueing is associated with a verbal or non-verbal cue to the appropriateness of a behavior. In order to answer the teachers questions students must raise a hand. Extinction decreases the probability of a response by contingent withdrawal of a previously reinforced stimulus. An instructive example of extinction is how students react to one student answers. During the several lessons one student comments and answered to teacher question. Classmates reinforce the student's curiosity by laughing. The teacher tells the students not to laugh but then did not support the curiosity of the student. Extinction took place – classmates finished laughing and

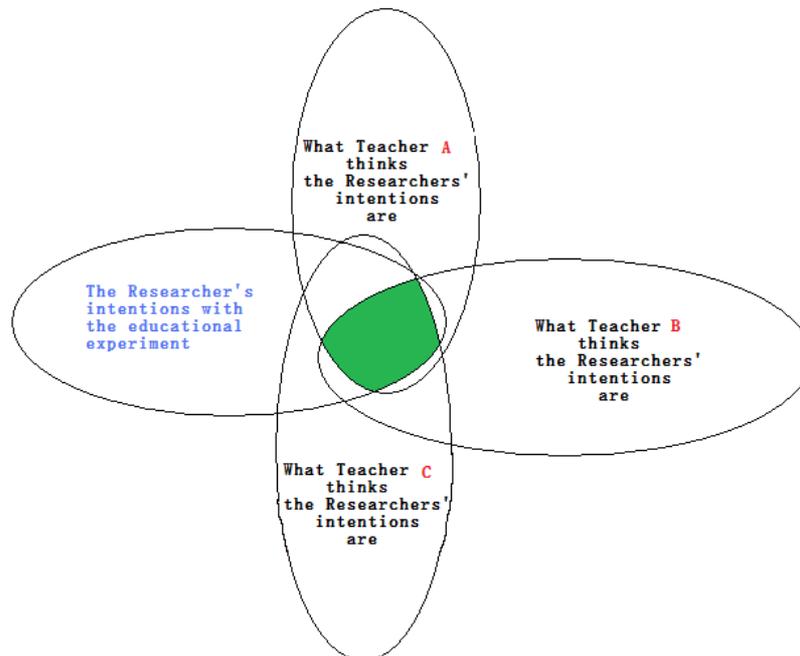
the curious student finished to be curious toward the school subject. However, the behaviorist theory have advantages and disadvantages. The main advantage of this theory according to Skinner is “the things we call pleasant have an energizing or strengthening effect on our behavior” [ 8, p. 74]. The main idea of the Skinner's behaviorist pedagogy is development of the “technology” of students behavior and the teacher is a central figure of this process. And finally, any didactic system has a status associated with some kind of philosophy. Philosophical theories determine the directions in didactic of school physics. The sequence (2) for modern philosophy could be presented as following:

***Conceptual pragmatism ⇒ Analytical philosophy ⇒ Philosophy of critical theory ⇒ Postmodernism***

The behaviorist theory associated with the postmodernism and constructivism associated with the Philosophy of critical theory. The transition from behaviorist theory to constructivist theory has already occurred [9]. It means that the teacher-centered teaching (TCT) transforms to the student-centered teaching (SCT).

### **Transition from TCT to SCT**

In order to conduct the educational experiment three teacher were recruited. The teachers' main role is to be able to teach the experimental class according to the HSIO method. To do this, teachers need to understand the transition from TCT to SCT. The HSIO method has three aspects based on the TIMSS framework [10]: the intended HSIO, the implemented HSIO and the attained HSIO. It means respectively, the teachers experiences of students' learning according HSIO method with respect to content of school physics curriculum; how students were taught to apply scientific inquiry method with respect to content of school physics curriculum; and what the teachers think about the HSIO method (are they have attained the HSIO intentions). The situation that all parts in the educational experiment have attained the intentions of HSIO is represented in Figure 1. The green-colored intersection represents the researcher's intentions that three teacher's have attained. There are other intersections in the Figure 1. The intersections between teachers represents what teachers think the researcher's intentions are. As noted above, the recruited teachers teach school physics according to TCM. The transition process for the recruited teacher took place through the following stages: perception of the HSIO, understanding of the HSIO,



**Figure 1: The relations between the Researcher's intentions and what the Teachers have attained.**

reinforcement of the knowledge about HSIO and applying of the HSIO in teaching process. The teachers need to believe in the advantages of the HSIO method in order to attain the HSIO intentions. It is not enough to have only a positive attitude towards the HSIO method. Attitudes can change before the teachers will be able to let the intentions influence their own teaching process [11]. Teachers need to be acquainted with HSIO and therefore to have knowledge about it. Otherwise, recruited teachers are going to claim that the HSIO method is valuable way of teaching school physics, which students enjoyed. It means that teachers do not attain the HSIO method intentions and as result, the teachers “just smile politely” and keep their teaching practice according the TCM. In order to acquaint with the HSIO method recruited teachers have had possibilities to observe the researchers' lessons taught according to the HSIO method. Before lessons the researcher and the recruited teachers have discussed about the structure and goals of the lesson. Then the recruited teachers observed the lesson and after they analyzed the progress of the lesson with emphasis to the teaching strategy and style. In order to explain the teaching strategy according to the HSIO method

the recruited teachers needed to complete their knowledge in didactic. The recruited teachers attended to the advanced training course about HSIO which was held by the School Resources (The structure for advanced training of teachers in school sciences at Finland-Swedish schools) [12].

The reinforcement of knowledge about HSIO took place in two dimensions: familiarization with teaching of interdisciplinary content of school physics and familiarization of the collaboration process in the scientific inquiry-based lab-works. In order to be acquainted with the collaboration process the students were made leaders of the scientific inquiry-based lab-works. During the familiarization of the teaching strategy among the recruited teachers they tested their knowledge about HSIO during the lessons in the researcher's class and in their particular own schools. Hence, all three recruited teachers taught the experimental class during the all phases of educational experiment.

### **The Teachers' Attitudes**

The transition from TCM to HSIO based on the teachers' attitudes and on “the recognition of conflict between what one wishes to do, or believes oneself to be doing, and the perceived reality of one's teaching that can bring about change” [11, p. 234]. During the interview before the educational experiment the recruited teachers shows that they have something in common – an extincted self-esteem. All three recruited teachers directly or indirectly described their own self-esteem. After finishing the compulsory studies at the universities teachers accumulated a big amount of knowledge in their area of specialization. With this luggage of knowledge they faced the TCM reality – there is no space to use that knowledge. The recruited teachers experienced the extinction of their knowledge and as result extinction of their self-esteem. However, they recognized that something must be done in the classroom in order to enable the students interest toward school physics. The conflict between the recruited teachers' personal goals and what they experienced in their classrooms made them ready for changes in their teaching practice. Lets analyze the teachers transition from TCM to HSIO.

As teacher A started to understand the teaching process of HSIO method, she was “shocked” about following concepts: “humanistic approach”, “not cool but interesting”, “interdisciplinary relations”, “create situations for the usage of modern technology”. She also felt slightly uncomfortable when the students found out that she had not the knowledge they sought, however then she recognized that her lack of knowledge was an important basis to organize a discussion on. Students accepted her as a companion. She thinks that this experience improved her self-

esteem. Preparing for the lessons were stimulating, because she needed to look up after new interesting facts about phenomena. She noticed that she spent more time now on the internet than what she did before. She concluded that students must learn to take a computer as a working tool. Teacher A was very afraid of organizing her first lab-work lesson. After the first lab-work she was very “happy” because she saw that “an idea works!” She remembers how the situation “changed her life as a teacher”. Before the investigation of the phenomena acceleration, she prepared the necessary materials and apparatus, such as stopwatch and a video-camera. When the students started the lab-work one girl noticed that it is uncomfortable to use a stopwatch and video-camera simultaneously, so she used her mobile-phone which could do both simultaneously. Teacher A was surprised how easy it was to allow her students use the mobile-phone during this lab-work. She noticed that lab-works became interesting because of their interdisciplinary content. Teacher A noticed that it is very important to update her knowledge. She noticed that it is not a problem to ask her students for help. Teacher A found it remarkable how her students taught her how to use PowerPoint presentations and after that she tried out her Smart-board. Today teacher A can not imagine teaching without her Smart-board.

The teacher B claims that working with students in the Experimental class was a great experience. She realized that knowledge in didactics is important, she agrees that the teaching process must be “targeted”. She now considers it to be very important for everybody to know what teaching and learning means. She claims that the planning process of lab-works change its content when they need not to be “cool” but rather “interesting”. Teacher B noticed that discussions and planning, increases the “creativity of students” because several students wanted to continue their investigations, although it was not possible to do so due to the lack of time. She considered that these students must have the possibility to immerse themselves in Physics. She also noticed that the students' results in tests improved. What is more, she considered that interdisciplinary relations increases the creativity in lab-works and helps students to better understand Physics. Modern technology such as mobile-phones, data-loggers and sensors is an important part of the teaching process if teachers are going to teach according to the HSIO method. She considers that the teaching process must create opportunities for her students to use their knowledge in sciences. Teacher B considers to do research in the area of didactics and she revealed about her unfinished Master thesis. Teacher B also reassessed her role as a teacher - “to be a companion with her students means to keep her knowledge updated and understand the students' subculture”.

Teacher C thought that the most difficult concepts to review were going from “entertaining teaching” toward “interesting teaching”, “didactics is a science” and “interdisciplinary relations”. He claims that the reviewing process aided him to understand the role of lab-works in teaching. He found that the amount of the lab-works to be unimportant. What is important is the “depth” of the topic which can create opportunities for the students to use their knowledge from different sciences. He noticed improvements in tests and how active the students were participating in discussions. He also noticed that several students were willing to immerse themselves in the subject. He was surprised about the amount of students who choose his optional course. Teacher C considered that his failure to found the science club was due to his high regards for “entertaining teaching”. He also claims that the students' practical skills are important and became more important for them if the students have opportunities to use their skills during lab-work. Interdisciplinary content of lab-work activates the students' skills. Interdisciplinary content demands the usage of modern technology and investigation process' become easier and shorter. He also noticed that teachers can learn through the students; for example, to find new ways to use the mobile-phone during lessons. However, the changes in teachers' attitudes after the educational experiment are noticeable because nowadays all recruited teachers use the HSIO in their teaching practice at their schools. What is more, today there are more physics teachers who have been trained according to HSIO and started to apply the HSIO in their teaching practice. The quality of school physics teaching and other school sciences as well, correlates with students' learning experiences which includes increased interest toward school sciences [13, 14].

Finally, educators around the world cannot disagree with words that “good science teachers are knowledgeable about science and its nature; have some understanding of basic educational ideas; use a range of teaching strategies; have excellent communication skills; and last, but not least, hold a passion for science” [15].

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