CONCEPTUAL CONNECTIONS IN TEACHING OF TECHNICAL EDUCATION AND PHYSICS

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Abstract. This paper considers the main characteristics of contents' connections between technical education and physics curricula, in the sixth, seventh and eighth grade of the Serbian primary school. The undertaken logical and didactic analyses of interconnectedness between contents structure of the two school subjects are based upon comparisons which have made between contents' interconnectedness of the crucial scientific concepts, their scope and construction. The observed scientific concepts in the two school subjects appear to be essential for technical education teaching and physics teaching in primary school. It should be very important to establish adequate contents' and scientific concepts' connections between knowledge in the two fields of teaching, for the quality of curricula and the efficiency of their implementation in technical education teaching and physics teaching in primary school.

Key words. Technical education, physics, teaching contents, scientific concepts, contents' connections.

Different forms of contents' connections between separate school subject curricula are very important for improving overall efficiency in teaching process. In some school subjects and their curricular contents, there are interconnected concepts, which are taught on similar ways in teaching of belonging school subjects. This field of relationships between school subjects' curricula is very important, because concepts' role in the scope of curriculum, especially role of the scientific concepts, is appear to be very significant for the overall quality of teaching contents (Archer, 1966). Scientific concepts in the scope of curriculum represent crucial and fulcrum points for interconnecting students' knowledge in teaching process and make it deeper and more systematic as well.

There are some kinds of general and partial connections between school subjects' pair, such as mathematics – physics, biology – chemistry, physics – chemistry, biology – geography, biology – environmental education, technical education – chemistry, technical education – physics, etc. In the domain of curriculum scope and its implementation in teaching process, it is important to make adequate opportunities for contents' conceptual connections, which are needed to be made between the crucial scientific concepts of these similar areas of teaching and learning activities. In the sense, there are also many cases of contents' interconnections between scientific concepts in the domain of technical education and physics. In the construction of the technical education curriculum there are many needs to make connections to the physical concepts in the physics curriculum. Generally, technical education teaching finds naturally strong and deep-based support in many scientific concepts, which are taught in teaching of physics.

There are some differences between two overall kinds of achievement in the teaching process of technical education and physics. It is significant to make appropriate distinguishes between knowledge-based and skill-based process and their outcomes and identify the best way of achieving both kinds of the outcomes. The skill-based outcomes are more characteristic of the teaching of technical education. Despite of the fact that students have to attain knowledge in this area, it is also important for technical education process to enable students be more acquainted by some technical abilities and skills. It means need to develop appropriate capabilities to use some technical devices, machines, etc. The knowledge-based outcomes are more characteristic for the physics teaching than in the area of technical education (Asoko, 2002).

On the other hand, development of students' understanding of the ways of functioning of some of the devices and machines, what is some of the aims of technical education teaching, belongs to the domain of knowledge-based subject-matter in technical education. And furthermore, it is more or lesser directly connected to the contents of some physical concepts, that were previously attained by students in physics teaching. It is strong expressive in the field of connection between teaching and learning properties of some electrical and electronic devices, and some basic and general scientific concepts in the physics teaching, such as "electricity", "electric current", "voltage", "electrical resistance", etc. It is also important to understand presence of the complex relations between these physical concepts, in order to make them as parts of students' knowledge system in domain of physics.

Many authors tend to consider about exploration opportunities, both in teaching of technical education and physics. In their discussion about teaching of physics and the ways of conceptual development Álvares-Bravo, Álvares-Sánchez & Gonzales-Cabrera (2006) have mentioned the following: "Our goal is to realize improvements in the learning processes using a learning environment based on qualitative reasoning and by guiding the students' explorations according to their levels". The main elements in the authors' view about conceptual development in the domain of physics teaching have targeted to the thinking operation of "qualitative reasoning" and generally to the different ways of students' exploration models in teaching of physics, as models of knowledge attaining and development of abilities and skills in this area. Development of scientific reasoning abilities and skills and providing practice of using them in relating scientific concepts, representations, and models, all of those are some educational aims of physical education and development of physical thinking and theoretical thinking operations in process of teaching and learning physics. It is broad field, in which we can observe and find some essential connections to the technical education teaching, because of the importance of some basic knowledge in the domain of physics for better understanding of the technical world and efficient learning in the field of technical education. All the teaching contents and methods applied in the physics and technical education teaching have been explicitly designed to develop scientific reasoning skills and to provide adequate practice opportunities in relating scientific concepts, representations and models to real world phenomena.

Technical education and physics curricula for primary school must be conceptualized and designed coordinately. It means that all contents must be disposed in a manner which enables to teach and learn topics in technical education teaching, with strong support made by theoretical knowledge, which comes from the field of physics teaching. In the other words, attaining concepts in the physics teaching represents preliminary plane in process of the concepts' attaining in teaching. Firstly, students have to be enabled to attain basic theoretical knowledge in physics and than teach them about some technical issues, in

which there are applying of these knowledge. For instance, in order to understand functioning of transformer of alternative current in the technical education teaching, it is important for students to be taught with row of physical concepts, such as “alternative current”, “voltage”, “frequency”, “electromagnetic field”, “electromagnetic flux”, “induction”, “conductor”, “dielectric”, etc. One of the physics teaching aims have to be demonstrated through need that students must be introduced to the main characteristics of the concepts and their interconnectedness and causality which can be discovered between them.

Understanding of basic physical concepts leads to understanding more complex ones (Flores *et al*, 2000). For instance, there are series of physical concepts that students have to attain and really understand their contents, in order to understanding one complex physical concept, such as the concept of “zero-mass behavior of electrons”. It is obviously needed to teach students the series of physical concepts, in the purpose of advancing and improving understanding of each next attained more complex concept, by the contents of previously attained and understood physical concepts. This order of concepts’ attaining in teaching of physics can also improve and make better understanding of technical education subject-matter. The concepts attained in the field of physics teaching may more or lesser be applicable in the field of technical education teaching. For instance, previously talked about the concept of “zero-mass behavior of electrons” is not directly applicable, in process of understanding the ways of functioning properties of micro-chips at computers, on what are the contents of technical education teaching. In the sense, students have to previously be known about some properties of the electromagnetic flux, and answer the question, such as what is electromagnetic flux, does it come from a magnetic field, how can electromagnetic flux be varied, how does electromagnetic flux is connected to electrical current and voltage intensity, etc.

One of the main applied methods of knowledge attainment in the physics and technical education teaching has to possibly be *learning by discovery*. This method of learning may be a kind of structural bridge between teaching of the school subjects, such as physics and technical education. Arrangement of some opportunities for the practice of knowledge discovery and attaining in the teaching process, in any school subjects’ curriculum, immediate enable students to get knowledge, a kind of knowledge which is new for them, attaining it in the process of teaching, activating different thinking activities (Egan & Greeno, 1974), such as reasoning, theoretical thinking operations, etc. Learning by discovery is often connected with problem-solving and in the physics and technical education teaching may be efficiently carried out across the series of simple or multi-step problem-solving tasks. In the case of connections in this sense, there will be arrangement, which means that students in cognizing process do *discovery by surmounting of an obstacle*, which is normally structured in problem solving tasks. The knowledge attained on that way can be involved in entire students’ knowledge system, as a stabile basis for attaining new knowledge.

There are many opportunities for contents’ connections between the physics and technical education teaching and it is one of the main aims for the curriculum experts in domain of the physics and technical education teaching (Berube, 2000). Implementation of the opportunities in the field may significantly advance and improve teaching of these two school subjects. On account of that fact, the physics and technical education curricula mast be conceptualized and structured in a way, which means emphasizing of these kinds of connections between them. Partially, it is important to enable inference and transfer of previously attained knowledge and concepts in the domain of physics teaching to the process of technical education teaching. It means that we can achieve the model of more efficient

teaching process of technical education in primary school, which is targeted in curriculum conceptualization of this school subject.

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