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Inquiry-based Approach in Technical Education

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Abstract

The article is based on fundamental social-cognitive theories that are based on a natural way of cognition of the world. The research process itself (the formation of hypotheses and predictions and their subsequent verification, the formation of conclusions that are supported by the facts, generalization) contributes to a modification of preconcepts and the development of the specific cognitive abilities of students. Moreover, it is also a matter of the development of the willingness to cooperate, development of enthusiasm and interest in exploring of the world around them.

The aim of the paper is to clarify the theoretical bases of the inquiry-based approach in technical education and didactic specifications of anchoring of the sequence of the educational steps in the technical education. In the empirical part, the article is focused on teachers' competences to the realization of the inquiry-based instruction.

Key words: technical education, inquiry-based instruction, teachers´ competences.

Introduction

The contemporary society requires the education that prepares an individual wholly on the life, on their full employment which will be beneficial not only for them but also for the other members of the society as well. It demands an individual who is creative, ambitious, able to overcome the obstacles of life, but is still cooperative, tolerant and protecting the weak ones. The alumnus of a basic school is not "compete" but still a developing individual. It is substantial to teach a pupil how to think, solve problems, in order to be able to develop further more. The interest in technical fields of study is linked to this, because the majority of technical education concepts were oriented in a product-centric way and focused on development of manual skills of pupils. This problem is not related to only one country but it is a problem of the whole Europe. The dissatisfaction with this state of how schools represent the way of the scientific work and lead the obtained knowledge of a pupil was expressed at a conference of European countries' representatives in Barcelona in 2002. It was stated that the way of teaching of mathematics, science and technical subjects is not adequate to real needs and is considered to be a main source of a lack of interest in the stated

subjects. The traditional education negatively influences the formation of attitude to a subject and professional orientation. The natural and technical science could offer a great potential for exploring and searching for answers on many questions that the young people have a right to ask because they are characterized by a natural curiosity. The main aim of the science and technical education should be a *cognition* and *explanation* of the reality via exploration comparing to the traditional education that is more focused on description and naming of the reality.

The contemporary technical education should be focused on development of specific qualifications that are in general called a capability to perform inquiry work. The inquiry-based instruction (IBI) is quite a new term; however, it is possible to see its elements already in past. A significant source of the inquiry-based instruction may be seen in the pragmatic education of J. Dewey [1917]. According to Dewey [1917], a significant method for the acquisition of new knowledge is a practical activity and experimenting. The pupils learn by solving tasks and problem situations at school.

The essence of the inquiry-based instruction

The aim of IBI is to teach pupils to think, solve problems and work in an inquiry way. These activities are a set of partial abilities that may be developed integrally or more or less separately. As the basic skills of the inquiry work are, in accordance with P. N. Broteton and P.F. Preece, considered abilities: *to observe, communicate, classify, measure, conclude (interpret) and create assumptions.* It means that the contemporary basic school education should be focused by a significant degree on development of specific skills that are summarily called inquiry skills. There are many possibilities to develop the inquiry skills, but a significant presumption for their development is a school experiment. It is an integrated ability to work in an inquiry way while also other pupil abilities are strengthened, i.a. working with different information sources and ability to learn from them, ability to solve problems and work individually. Thanks to these factors, the learning becomes an activation factor and, under certain circumstances, it may also have a stimulating effect. It means that the current basic school education should be focused on development of the specific skills that are in general called a capability of the inquiry work.

The inquiry work at the basic schools is understood as an ability to use scientific and technical findings, ask questions and make conclusions that are supported by facts and help during the process of creation of a certain image about the natural and technical world and changes that happen in it [according to the definition of OECD; PISA 2009].

Teachers' competences for inquiry-based instruction

The teacher and a pupil play the main role in the inquiry-based instruction. This fact is obvious in both the teachers' activity who builds up a specific pro-

ject of instruction and performs it and then concludes its success, and pupil who is the "recipient" of the teachers' activities. The aim is to develop the pupil universally. In order to do so, the teacher prepares suitable situations that enable the development of the pupil based on their inquiry.

In accordance to authors E. Alake-Teunter, H.J.A. Biermans, H. Tobi et al. [2012: 2624], we look at the teacher as at the "architect" influencing the instruction concept, i.e. the key element. If we require the respect of a child personality and if the instruction should be adjusted to the previous experience of a pupil, the role of the teacher is irreplaceable. The other elements, i.a. methods, organisation forms, material resources, etc. are set mainly by the choice of a teacher and may have more an acceleration or inhibition nature in the way of achievement of the set aim of the pupil´s personality development. The significant role is also played by curricular documents that create the framework in which is the teacher moving during the conceiving of the instruction.

We paid more attention to the definition of teachers' competences in the monographs of J. Dostál [2015], and J. Dostál and M. Kožuchová [2016] on which we base our article. In the first of the mentioned publications, we mainly focused on the creation of a competence model. In this article, we will focus more on the most important competences of teachers that emerged from the empirical research.

The aim and research presumption

The aim of this part of this quite a broad research was to find out which of the researched teachers' competences to perform the inquiry-based instruction are considered significant. The research question was: which competences to perform the inquiry-based instruction at the primary schools are important for the teachers of technical and science subjects?

The following research presumption was formulated; *The following competences belong among the ten most important competences to perform the inquiry-based instruction:*

- *To motivate pupils to learn via the inquiry activities;*
- *To connect the inquiry activities with the practical life;*
- *To develop thinking of the pupils via the inquiry activities;*
- *To demonstrate the inquiry activities to the pupils;*
- *To interpret the process and results of the inquiry activities;*
- *To ensure the security during the inquiry activities.*

Selection and description of the research method

The Q-methodology was selected for the realisation of the research. Q-methodology includes a combination of rating-based, psychometrical and statistical procedures which serve not only to discover the respondents' statements

(*Q-shorters*), but also to discover the correlation between the reactions of answers of various respondents on the submitted Q-samples [Chráska 2007].

W. Stephenson [1953] presented the Q-methodology as an opposite to the common factor analysis in a way that instead of tests (test items), the persons are correlated – it is common to have a large number of respondents (P-sets) which are given a relatively small number of items. In case of the Q-methodology, a small number of respondents is sufficient, while they are given a relatively large number of test items (Q-samples).

The researched was performed in a way that the respondents were submitted the Q-samples in a form of cards (or, nowadays, in the electronic form). The Q-samples are represented by statements (in this particular research represented by the individual preconditions of a person), which may emerge from deductive considerations, published findings, interviews, etc. In our research, the paper cards on which the statements will be printed will be used. The numbers differ, however, in our case, 120 cards were be used.

This follows the Q-sort while the respondents attach a certain importance to an individual statements; this is expressed by a placement of a corresponding card to a given field in a sort sheet (matrix). The results of this sorting are recorded and transferred into an electronic form in order to evaluate them statistically.

Distribution of the classification sheet, cards, questionnaire, and the characteristics of the research sample

The research sample was selected with respect to the solved problem, set aim and stated presumption and hypotheses. Because the Q-methodology was chosen, the research was performed at different places, 34 experts arrived at our workplace and we visited 20 experts at their departments. The nature of the selected research method required a personal contact of the researcher and the respondent, who was informed about the meaning of the research, its aims, way of filling-in of the questionnaire and the principle of the Q-sort. It was proved that the personal contact of the researcher and the respondent is necessary also for the needs of filling-in of the questionnaire in a correct way.

The experts were chosen in advance based on the filled-in questionnaire that was focused on the proving of realities, e.g. length of teaching practice, needed qualification, whether they considers themselves respected by their colleagues, and their range of knowledge in their fields. During the consideration of the reality whether the teacher belongs to a category "expert", the works of the following authors were used: R. Škvaříček [2006], J. Průcha et al. [2009], and D.R. Cruickshank and D. Haefele [2001]. The research was performed from February to June 2013.

Results of the assessment of Q-samples by the respondents

Before we started to deal with the presentation of the measured results, we considered the range of reliability and accuracy, i.e. the reliability of the used measurement tool. To prove whether the measurement was reliable, we used the **Cronbach's alpha** (0.97) which assesses the inner consistency. To confirm this calculation, also the method of halving was used (0.95). For this calculation, the system Statistica was used. The results of the reliability analysis confirmed sufficiently high reliability. In both cases, the value is significantly higher than the minimally required 0.70 in case of the Kline rule, and 0.94 according to the Helmstadter rule. This proves a very high reliability of the measured results.

The measured results were processed in a form of table in such a way that the individual Q-samples were classified according to their average assessment by respondents – from the best to the worst assessed. The results of research to confirm the defined research presumption may be summarized that the competences stated below belong among the most important competences measured:

- To motivate pupils to learn via the inquiry activities.
- To connect the inquiry activities with the practical life.
- To demonstrate the inquiry activities to the pupils.
- To interpret the process and results of the inquiry activities.
- To ensure the security during the inquiry activities.
- To develop the independent pupils' exploration via the inquiry activities.
- To develop thinking of the pupils via the inquiry activities.
- To perform the inquiry activities in connection to the previous knowledge and ideas of the pupils.
- To develop the imagination via the inquiry activities of pupils.
- To link the inquiry activities to the theory

Comparing the set of the ten most important competences to the competences included in the research presumption, we may conclude that the presumption was correct, which is obvious from the list above, where the competences (included in both presumption and research) are in bold.

Conclusion

By its focus, this article reacts to the newest trends in the field didactics of technical education that can be seen in the international scale. In the historical development of concepts of education, we can see an important source of the concept of the inquiry-based instruction already in the pragmatic pedagogy. Its principles were defined by J. Dewey. He considered the practical activity as a basic method of knowledge acquirement. The integral part of the pupil's practical activity was the experimenting. Pupils at schools are solving practical problems and proving the correctness of solution by experimenting. The technical education is based on practical experience; however, in the following historical

development of the technical education concepts, the craft-based instruction was emphasized more when speaking of the practical activities – the product was more important than the process itself.

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