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Model of the Students' Key Competences Development through Interactive Whiteboard in the Subject of Technology

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Abstract. The basis of the submitted study are the continuously rising demands to alter the curricula with the aim to develop students' key competences in order to increase their professional versatility. The lack of scientific research and discussions show that little investigation has been done on the issue of development of key competences. Therefore, the primary objective of our study is to present the teaching methodology, the process of creating the educational model and the pilot verification aimed at the development of key competences through interactive whiteboard in the subject of Technology. The partial results of the pilot research conducted on the research sample of 6th and 8th grade students of primary schools on Slovakia show its usefulness especially in the development of teamwork, in terms of interpersonal competences, problem solving in terms of learning competences and reading comprehension in terms of communication competences. The presented educational model reflects the contemporary requirements in terms of using information and communication technologies in the teaching of the subject of Technology, in which the acquisition of key competences becomes considerably important.

Keywords: key competences, education model, interactive whiteboard (IWB).

1. Introduction

The issue of the development of key competences began to develop in the 80s as a result of significant economic changes in the developed countries (Canada, USA, and Australia). In recent years, however, the term "key competences" has gained importance both on the political level and the level of all types of schools (EACEA, 2012). By analysing the previous, as well as, recent theoretical debates we have made the conclusion that many countries exert the efforts to introduce, characterise and define the key competences in relation to work as well as lifelong learning. The subject of

Technology, whose main objective is the development of individuals in terms of appropriate integration in social and work relationships, occupies an important position in terms of developing practical work habits and basic user skills in various fields of human activity.

In the context of improving the adaptability of young people for the life in society and making them able to enter the labour market in the future, the competences that have gained ground are the ability of individuals to cooperate and communicate, as well as, their professional knowledge. Motivation, the ability to learn, identify and creatively solve problems are also skills which seem to be becoming the more permanent values of education (Žilka, 2010).

With growing demands on the development of key competencies, the European Council has supported the idea that in terms of lifelong learning strategies it is important to ensure that all citizens are equipped with necessary skills. Their implementation is tied to the application of advanced methods and organizational forms of teaching.

2. Basis of the Key Competences Development Model

Current educational programmes are not focused on the content of the subject, however, on the graduate profile, i.e. everything the student should know, handle and carry out at the end of the educational activity. In other words, the focus is on the choice of key competences that should be developed. This is proved by curricular documents which emphasize the active acquisition of knowledge, skills and abilities of students. It is these activation methods (e.g. self-study, learning from the text, search for information, problem solving, project teaching, games, role-playing, brainstorming, teamwork, cooperative teaching, discussion, case study) that are considered the appropriate educational methods for the development of key competences (Žilka, 2010).

The requirement of student activity, creative acquisition of knowledge, respect for the interests of children, activity as a means of education and training (Petlák, 1997) are amongst the main requirements of pedagogical-didactic theories of humanistic education that underpin various modern innovations in didactics, as well as, in pedagogy. In the above mentioned theories we also include constructivism, frontal learning and active learning (Fig. 1), according to which, the key factor of skeletal knowledge is the active and aware participation of the child in the educational process (Wilson, 1996; Duffy and Jonassen, 1992; Larochelle *et al*., 1998; Jonassen and Murphy, 1999).

It is possible to achieve the requirement for active involvement of students in the educational process by implementing purposeful and systematic information technologies in education. Various foreign researches confirm (Ormanci *et al*., 2015; Drigas and Papanastasiou, 2014; Depešová and Tureková, 2014; Serow and Callingham, 2011; Záhorec *et al*, 2010) that the use of information technologies in educational process increases the children's interest and involvement in the educational process.

In the context of the given issue, we consider interactive whiteboards a highly activating didactic means. Thanks to multimedia teaching and whole-class interactions it has the potential to become the basic tool for improving the visualisation and experience of learning (Brečka and Olekšáková, 2013). Through interactive whiteboard it is pos-

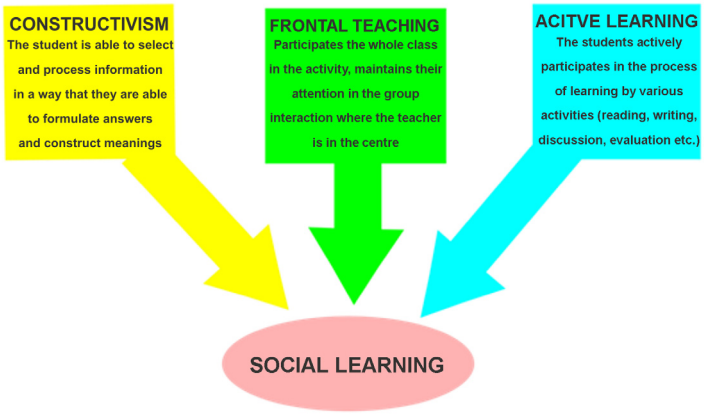

Fig. 1. Educational theories (Interactive Whiteboards and Learning, 2006).

sible to realise learning based on active work with information. That is why we include this interactive means of teaching in the draft model of development of key competences in the subject of Technology.

3. Defining Key Competences

Recently, we are witnessing a successful inclusion of key competences into the curricula, study programmes and other governing documents in order to meet the society demands, however, the definition of this term is still very ambiguous, as evidenced by various definitions of many authors. Under competences we can understand the performance of people in form of knowledge, skills, abilities etc. According to Blaško (2010) the term competence was originally used in the context of vocational training, referring to "…the ability to perform a specific task… ."

Key competences are the most essential ones from the general set of competences. They are appropriate for solving a wide range of mostly unpredictable problems, which enables a person to successfully cope with rapid changes at work, personal and social life (Hrmo and Turek, 2007). They represent the intersection of several determining units and scientific fields. Therefore, we can characterise them as the knowledge, skills and attitudes, necessary for individuals in order for social associations to take place, for employment and even for personal fulfilment and development (Salganik *et. al.*, 2005). The European Framework of Reference (2006) defines key competences as the combination of knowledge, skills and attitudes. All individuals need key competences for personal fulfilment, active citizenship, social inclusion and employment.

According to the European Parliament and the council on key competences for lifelong learning, every individual should have a command of these basic competences in order to adapt to a rapidly changing and interconnected world:

1. Communication in mother tongue.
2. Communication in foreign languages.

3. Mathematical competence and basic competence in science and technology.
4. Digital competence.
5. Learning to learn.
6. Social and citizen competence.
7. Leadership and enterprise.
8. Cultural awareness and expression (European framework of reference, 2006).

School as an educational institution plays an important role in the development of the competences mentioned above. This is proved by the concepts of all the subjects which are composed in a way that helps to achieve the development of key competences and the students' overall personality in the given subject area. The subject of Technology is no exception. The content of the subject aims to develop cognitive, psychomotor, and socio-affective key competences which enable the students to comprehend natural phenomena, technical devices and equipment, use and control advanced technical means, solve simple technical problems, cooperate with other people etc. (Pavelka, 2015). The model of the graduate is based on the development of key competences which include comprehensive knowledge, skills an attitudes enabling the individual to integrate into social relationships and develop their personalities (ISCED 2).

Based on the requirements for the development of key competences from the national education programme for the subject of Technology we have designed the following groups of competences:

- Communication competences (Com.) – (reading comprehension – RC, oral presentation, written presentation, graphical presentation – WS).
- Interpersonal competences (Int.) – (effective work – EW, team work – TW).
- Personal competences (Per.) – (honesty, responsibility – HR, self-control – SC).
- Learning competences (L.) – (self-motivation and motivation of others towards problem solving, active participation in the learning process – PS).
- Cognitive competences (Cog.) – (evaluation, self-assessment, critical thinking – CT).

Our list of competences is based on a set of general competences of educational standards requirements and the employer survey in which employers from the 500 most successful worldwide organizations consider these competences the most essential in the 21st century (Turek, 2008): teamwork, problem solving, interpersonal skills, oral communication, listening, personal and professional development, creative thinking, leadership, goal setting and motivation, writing and organizational development.

4. Pre-requisites for the Development of Students' Key Competences through IWB

Skill development is a complex lifelong process which is impossible to achieve simply by constant innovation of documents. Is essential to develop a strategic plan or teaching model (Mercer *et al*., 2009) which would include clearly defined teaching methods, work principles, objectives and by means of which the teacher would know or at least had an idea of how to implement the required changes.

From the theoretical backgrounds and current educational issues emerged our intention to create such educational model which would lead to effective teaching, achievement of educational objectives and in particular, the development of key competences through IWB.

In relation to the proposed educational model we have established the following, as the assumptions for successful development of key competences through IWB:

- Making a quality **didactic curriculum analysis** resulting from the content instantiated in the school educational programme, with the emphasis on the detailed analysis of relations between subjects, key terminology and topic field (basic curriculum, supplementary curriculum, explanatory curriculum), which is the basis for the creation of effective interactive teaching material.
- Careful selection of teaching methods for the analysed content, so that the interactive teaching material is effectively connected to other activities in the teaching process (Hennessy *et al*., 2013; Barber *et al*., 2011) e.g.:
    - planning of activities previous to work with the interactive teaching material,
    - planning of follow-up activities after work with the interactive teaching material, topics for individual/group work (project solutions, problematic task resolving, specific practical activities implemented in specific teaching areas).
- Use of **activating methods**, such as: dialogic (discussion) method, group learning and cooperative learning, project methods, methods developing critical thinking, case method (including situational method), simulation methods, methods of discovery and controlled discovery, research methods, teaching games) (Tóthová in Fulková, 2006, Warwick and Mercer, 2011).
- A clear statement of **educational objectives**, particularly cognitive, psychomotor, socio-affective (conative – expressing dexterity).
- Apply the **principles of teaching** dominantly aimed at: activity of the learning – each students actively participates in the process of learning by means of concrete actions and spirit activity; constructiveness – builds on the experiences, knowledge, skills, abilities of the student, learning is the construction of new ones and their incorporation into the existing knowledge system; cumulativeness – knowledge, abilities and skills are interconnected; targeting – the students knows the objective of the teaching and identifies themselves with it; situatedness – the learning always takes place in a certain global, social, economic, multicultural, political or environmental context which influences the everyday life and which has to be taken into account; auto-regulation – the student gradually takes responsibility for their own learning whilst taking into account different assumptions and learning styles (Čáp and Mareš, 2001).
- Seeking cooperation with other members of the teaching staff for the wider range of interdisciplinary relation exertion of the acquired content.
- Further education orientation activities, e.g. innovation or update training of the teaching staff to increase the digital competence and its didactic application in the given subject. Also, focusing the further education activities on upgrading skills by means of courses and trainings on IWBs and support programmes.

5. Draft of the Key Competences Development Model

Based on the above interpreted theoretical assumptions on the development of key competences we have proposed a key competence development model (Fig. 2) in the subject of Technology, which was developed through the project "methodology for implementation of IWB in education to competences of teacher training in Technology, Physics and Mathematics for lower secondary education".

The scheme presents the educational model consisting of the basic activity attributes – subject (teacher) and object (student) in the teaching process based on the work with IWB. The taught lesson applies the above mentioned teaching methods, forms, principles, theories and practices through which we have managed to implement progressive acquisition of the selected key competences.

In relation to the application of IWB aimed at the development of the mentioned competences, we have established the following key drivers for our model:

Sharing information on IWB is a prerequisite for effective use of information, motivation, maintaining the attention and activity of the students. As a result, students discover new, often hidden dependencies, which help them seek and create new original forms of problem solving.

A subsequent factor for interaction of the students is the use of **oral and written communication**. Students write, fill in, draw, circle the answers and at the same time

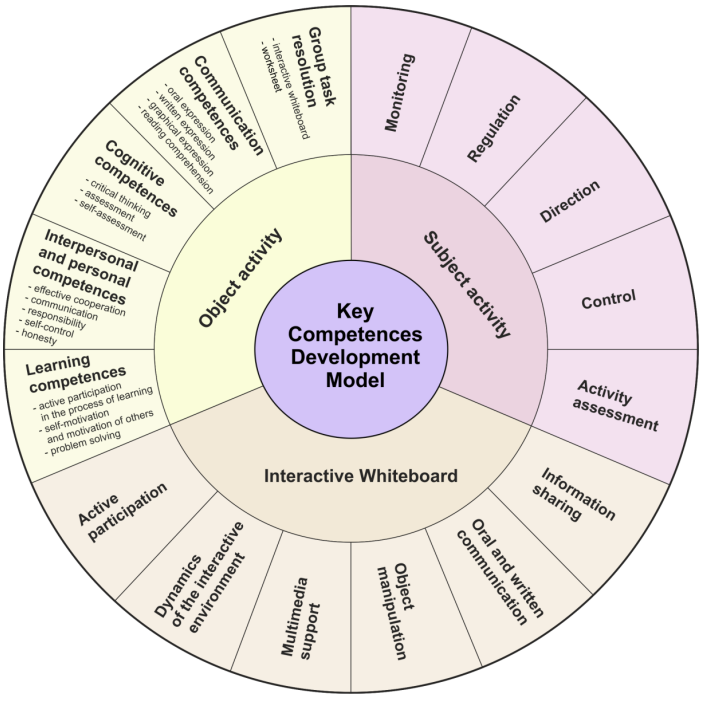

Fig. 2. Key competences development model.

they express their opinions, hold discussions and evaluate the results of their work.

Another advantage of the IWB is that in many cases it enables **manipulation with objects**. By turning objects on a plane, distribution of object in an area or transposition of the objects, students acquire the ability to easily manipulate objects through which they develop spatial imagination, visual-motor coordination, shape perception and the ability to recognize objects. In addition to these skills students also fixate technical terminology and imagery. Visualisation of the notions plays an important role in the process of their fixation. Students apply the acquired knowledge and experiences in practical tasks through which they develop their technical thinking.

Multimedia support – the use of multimedia in working with IWB is mainly based on the possibility of interaction and multi-sensory effect on the student. This results in constant repetition (e.g. the students first hears the information, then reads it). This multi-sensory repetition of information is typical for multimedia, the application of which increases the possibility of capturing and long-lasting memorization of the information.

Dynamics of the interactive environment represents the movement or the development of a phenomenon. It changes the static attitude of the presented techniques into the possibility of a dynamic response. The teacher's objective, when working with an interactive system, should be the students' sense of active participation in the ongoing action which is related to the application of other elements. Individual activities within the key competences development model are designed so that students are able to process and select information, formulate answers and construct meanings. The students remain active throughout the whole education process through various activities such as reading, writing, discussion, desire for success, self-evaluation etc.

The teacher as a guidance and organizer who prefers open communication with the students plays an important role in the process of developing key competences by helping the students to be independent and active, leading them towards seeking and applying the available information and supporting their activity, responsibility and self-assessment.

6. Teaching Methods

The implementation of the model into to educational process was preceded by preparation of the necessary methodological materials and research tools. An IWB presentation had been made for each of the topics along with a workbook for the students and a workbook (methodological guide book) for the teacher.

IWB presentation informs the teacher and the students about the topic, objectives and the organisation of the lesson. It contains practical tasks on a particular topic, by means of which it is possible to achieve a maximal activity of pupils and the development of key competences.

The worksheet for teachers includes all the necessary organisational and material requisites for teaching the given topic. Also, it contains a specifically defined lesson

topic, number of lessons devoted to it, the grade for teaching and especially, specifically defined key competences that students should develop or acquire through resolving certain tasks. The workbook also informs the teacher about the time frame for the realisation of particular tasks in the presentation and the amount of points each student can obtain for their accurate resolution.

The worksheet for students contains directions for the completion of the tasks on the IWB. Through IWB the students resolve tasks and then verify the correct solution in the worksheets. In terms of developing key competences, the IWB provides variable elements of multimedia visualisations. Therefore, the resolution of the tasks on the IWB had been substantial for our pilot research.

In terms of successful implementation of the key competences development model we draft the following structure of the lesson:

In the introduction part of the lesson the teacher informs students about the objectives, arrangement and methods used during the lesson. The main part of the lesson is focused on the use of IWB and completion of the tasks on the board and in the workbooks. Before the start of each lesson the teacher directs a short discussion on the issue aimed to motivate the students. Then the teacher selects two students to resolve the task on the board. The students note down the results of each task into their workbooks. Groups of two students gradually take turns at the board. The rest of the students check the accuracy of their solution and note the number of points they have obtained down to their workbooks. At the end of the lesson, the students count the overall number of points they obtained throughout the workbook and the teacher evaluates the lesson.

A major role in the pilot research is played by the observer whose task is to note the occurrence of the key competences, in other words the situations which require the application on key competences, during the lessons into the observation sheets. The construction of the observation sheet is similar to that of the workbook. The person observing the phenomena, the selected key competences, is thoroughly informed about the progress of the lesson which prevents mistakes regarding the observation. The observer observes the key competences of random couples, however, maximum 2, to ensure absolute objectivity and accuracy of the observed phenomena. The teacher makes sure that IWB activities are solved predominantly by students from the selected focus groups. In order to increase validity and reliability, a two stage rating scale is used. Situations when the application of key competences occurs, the observer notes down to the observation sheet as “yes” or by means of a vertical line, or “no” or a horizontal line if it does not The key competences are recorded for each task separately. At the end of the observation sheet, there is a summary table where the observer counts the overall key competency occurrence rate.

The applied educational model has been developed so that the students acquire knowledge (meet the lesson objectives at the desired level) during the lesson and at the same time so that there occur learning situations and activities that contribute to the development of the selected key competences (group work – pairs of students, use of IWB, use of workbooks and worksheets).

7. Pilot Research

Considering that the verification of the presented key competency development through IWB model is in-process, the main objective of the study is to describe this model, communicate its creation process and practical results of the tests.

The pilot verification of the presented educational model was aimed at the selected thematic areas of the educational area Man and the World of Work from the subject of Technology. In this section, we will analyse the partial results of the thematic area History of Science and Technology (ISCED 2).

The worksheet for this topic consisted of 10 tasks concentrated in 4 quizzes. The tasks have been designed so that they lead students to close cooperation. Students worked in pairs (groups) and the observer focused on the observation of selected groups, which ensured objectivity. In this case, the sample consisted of four groups of girls and four groups of boys (total of 32 students) in the 6th and 8th grade at the elementary school in Trnava region.

Each quiz consisted of different number of questions from history of science and technology aimed at the most important years, inventions in those years and also the inventors (Fig. 3).

Quiz 1 consisted of 7 questions from the history of science and technology. All the questions (1–7) were structured similarly. In each of them, the students received 1 point for marking the correct answer**.**

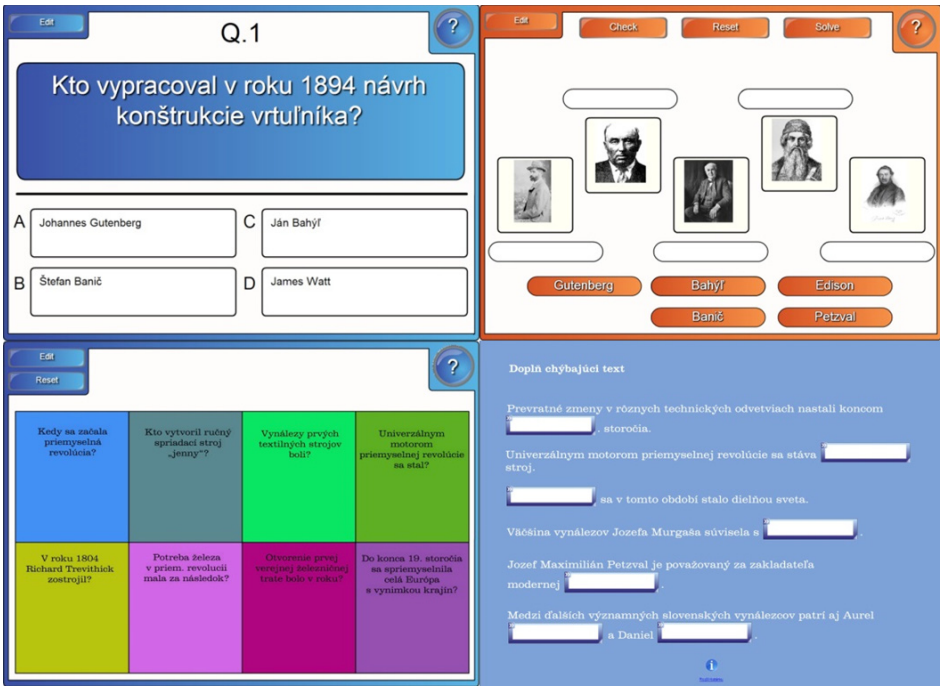

Fig. 3. Examples of tasks for students from particular quizzes

Quiz 2 only consisted of 1 task aimed at the recognition of the most famous inventors. The students could receive 5 points for the successful completion**.**

Quiz 3 also consisted of only 1 task. In it, the students had to give correct answers to the questions aimed at the most important milestones in the development of science and technology. 8 points could be gained for the proper resolution of the task.

In **Quiz 4** the students had to complete the missing parts of sentences. This task has been focused on the area of history of science and technology. 7 points could be gained for a proper resolution.

8. Summary of the Observation Results

In all observed groups we observed the most significant changes in **interpersonal, learning and communication competences** – reading comprehension. After comparing the grades we have found that the occurrence of these competences was higher in the 6th

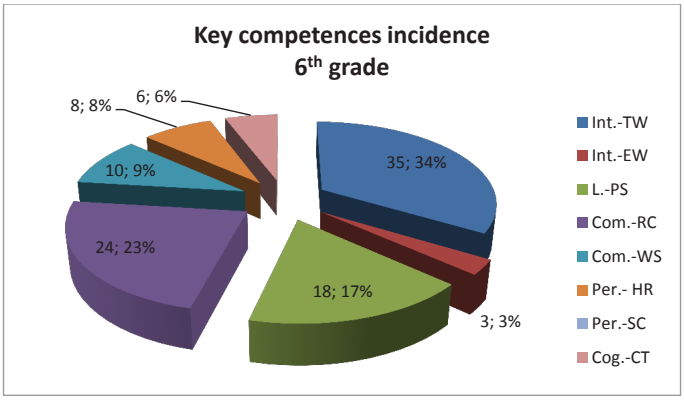

Fig. 4. Key competences incidence overview for the 6th grade of elementary school.

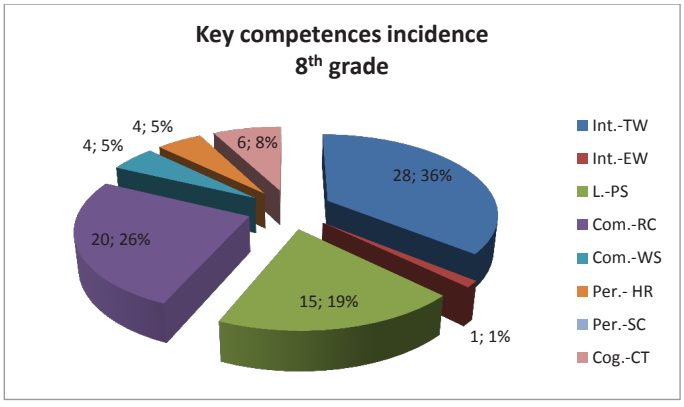

Fig. 5. Key competences incidence overview for the 8th grade of elementary school.

grade. The pupils of the 8th grade, especially boys, exhibited the competences less frequently due to biological factors – students refused to work in pairs, groups of the same gender. Nevertheless, the finding that there was a significant demonstration of team work (6th grade – 35,34%; 8th grade – 28,36%), problem solving (6th grade – 18,17%; 8th grade – 15,19%) and reading comprehension (6th grade – 24,23%; 8th grade – 20,26%) among the representatives of the observed groups, enables us to state that this educational model using IWB has the potential for the development of key competences.

The development of **cognitive** (6th grade – 6,6%; 8th grade – 6,8%), **communication** – written presentation (6th grade – 10,9%; 8th grade – 4,5%) and **personal** (6th grade – 8,8%; 8th grade 4,5%) competences while working with IWB was equally important as the students of both grades demonstrated the ability to analyse the acquired information and knowledge, and apply them in resolution of various tasks. By means of these tasks we have created the conditions for the development of graphic abilities as well as written expression of students.

The demonstration of work efficiency was the least significant in both grades – in the 6th grade it was only 2% higher. The reason for poor work efficiency in the 8th grade was perplexity, disinterest, and the concern of the examination that followed the next lesson. The students' reactions were choleric, they did not read the task assignment properly and therefore were less successful.

There was no demonstration of **personal competence** – self-control in either of the grades. From the observation we can conclude that students of both grades did not show this competence as despite the constant repetition of the fact that they will not be evaluated for the answers in the worksheets, the students constantly copied the answers from their classmates, changed the answer after the right answer had been revealed etc. However, the overall results, even with the small research sample, confirm that the tasks in the given topic contribute to the development of the selected key competences.

9. Conclusion

As previously mentioned, the basis of this research are the continuously rising demands on the realisation of curricular changes with the objective of developing students' key competencies for their successful professional application. This demand of innovation or change in education arises from the rapid development of natural and technical sciences.

The expected changes, particularly those in content, however, also, those in the methods and forms in order to achieve the development of the desired key competencies and at the same time keeping up-to-date with the present state of science and technology are also assumed in the subject of technics. In technologically oriented subjects the students are expected to acquire and develop those competencies emerging technical thinking, which is a precondition for their further professional as well as personal orientation.

From the theoretical background and pilot results of the research on a selected sample we can conclude that the educational model that we have designed to work with IWB

aimed at the development of key competencies has its justification in the methodology of subject of Technology. Considering that the research team conducted initial research with this focus, which was intended to solely demonstrate the practicality of the educational model, we can only verify the results on the level of research sample. The greatest advantage of the presented model in the context of teaching the topic history of science and technology was the development and instigation of whole-class interaction, team work and problem solving which from the social point of view belong amongst the most required competencies.

The primary objective of this study was to mediate the process of creating the model for the development of key competencies – its theoretical basis and verification of its usefulness. Considering that the issue of development of students' key competencies in technical subjects is an unexplored area which in the future calls for a deeper analysis and research, we are going to provide a detailed methodology of the continuing research and its results using a more relevant research sample shortly.

We believe that teachers should create educational models based on constructivist approach to using IWB aimed at problem-solving, learning within a group, self-evaluation, discussion with pupils, self-expression of the pupils, exercises containing certain elements of a game in order to develop key competencies of the pupils in terms of lifelong learning.

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