ASSESSMENT OF THE INNOVATED STATE EDUCATIONAL PROGRAM IMPACT ON TECHNOLOGY LITERACY OF LOWER SECONDARY EDUCATION PUPILS (ISCED 2)

[a]ALENA HAŠKOVÁ, [b]DANKA LUKÁČOVÁ

Constantine the Philosopher University, Faculty of Education, Department of Technology and Information Technologies, Dražovská cesta 4, 949 74 Nitra, Slovakia
email: [a]ahaskova@ukf.sk, [b]dlukacova@ukf.sk

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Abstract: The paper deals with realization of technology education in Slovakia on the level of primary and lower secondary education - so called basic schools. (ISCED 1, ISCED 2). At the first part of the paper, there is analysed impact of the curriculum reform from 2008 and innovated State educational program from 2015 on the scope and content of technology education. Consequently, in the second part of the paper there are presented results of a research aimed at the impact of the reform and innovated State educational program on the level of knowledge acquired by pupils 7th grade of basic schools in frame of teaching the school subject *technology*.

Keywords: Technology education. Technology literacy. Primary and lower secondary education. School subject technology. Pupils` learning achievements. Curriculum reform. Innovated State educational program. Content and performance standard.

1 Introduction

Technology has always constituted an important part of culture in each type of society. On the other hand, progress of technology has influenced, even determined, further development of any type of society. Application of technology knowledge in practice has created preconditions of the society prosperity, and not only the recent ones but also the next ones. As the main initiator of any application of technology knowledge, technology innovation or change has always been, and still will be, a man. That is why beside creative educated people in general each society needs also creative educated technicians and engineers. And that is why technology education has always been an integral part of school education, although in different types of societies and different countries this education has been carried out in different ways. In some countries we can find it to be taught incorporated within the scope of science subjects while in others we can find it incorporated within the school curricula as an independent school subject.

In Slovakia technology education has always been an integral part of general education. Before 1995 technology education was carried out within a freestanding school subject called work education which was taught with the lesson allocation 2 lessons per week at each grade of the second stage of basic education (relevant to lower secondary education – ISCED 2). This situation was changed twice, at first in 1996 and secondly in 2008. At the first change the name of the subject *work education* was changed to technical education and the number of lessons allocated for its teaching was decreased from 2 lessons per week to 1 lesson per week, still in each grade of the lower secondary education. The next change was done within the curricular reform which came into operation through enactment of the new Law on Education in 2008 (Law No 245/2008).

The most significant feature of the curricular reform in 2008 was introduction of so-called State educational program and School educational programs. As to the technology education, in frame of the curricular reform the school subject *technical education* was renamed to *technology* and was incorporated into the educational area *A man and the world of the work* comprising of three subjects: *manual training* (primary education ISCED 1: 4th grade, 1 lesson per week), *world of the work* and *technology* (lower secondary education ISCED 2, both subjects taught equally: in 7th grade 0.5 lesson per week and in 8th grade, 0.5 lesson per week). This means that the lesson allocation for technology education (subject *technology*) was cut from 1 lesson per week to only a half of a lesson per week taught already only in 7th and 8th grade, or the school could determine the grade in which the subject has been taught.

2 Background of the research

Standards-based initiatives in Slovakia have arisen after 1989, when an effort to measure students` learning achievements has started.

Standards describe the goals of schooling, the destinations at which students should arrive at the end of some milestones of their school attendance. They are usually composed of statements that express what a pupil or student knows, can do, or is capable of performing at a certain point in his/her learning progression.

In the above mentioned definition of standards two kinds of standards are referred to -- content standards (also called learning standards, subject matter standards or academic standards) and performance standards. Content standards indicate what students should know and should be able to do. At the same time the content standards describe the knowledge, skills, and other understandings that schools should teach in order for pupils or students to attain high levels of competency in challenging subject matter, i.e. they reflect the ideas, skills, and knowledge in each discipline that are important enough for everyone to learn They are elements of declarative, procedural, schematic, and strategic knowledge that, as a body, define the specific content of an educational program. Performance standards (sometimes identified as indicators) measure how well (at which level – basic, proficient or advanced) a pupil or student`s work meets the content standard, i.e. they define various levels of competence in the challenging subject matter set out in the content standards.

The genesis of educational standards in Slovakia started with a gradual liberalization of pedagogical documents in the Educational Research Institute (now-a-days the National Institute for Education) in Bratislava. In the second half of the year 1991 the Educational Research Institute started to deal also with issues of norms related to basic school (primary and lower secondary education) pupils` knowledge and skills. The goal of these efforts was to develop and introduce into the practice educational standards to selected school subjects. However, the school subject *work education* (subsequent *technical education*) was not included among the selected school subjects. In 1995 the Educational Research Institute prepared *Project of experimental verification of educational standards for the 1st and 2nd stage of the basic school* (basic education, i.e. primary and lower secondary education) but the school subjects *work education*, neither *art education* and *music education*, was not included in the project.

The first proposal of the *technical education* educational standards was prepared in 1995 by the subject committee of the technology education, the commission of the National Institute for Education as the *Content and performance standard of technical education for 5th – 8th grade of the basic school* (primary and lower secondary education, ISCED 1 - 2). In 1997 the elaboration of the *technical education* standard continued, in particular there was carried out verification of the standard for the core and alternative subject matter of *technical education* and its respective parts. Beside the standard, questionnaires for head teachers, teachers and pupils as well as didactic tests were elaborated.

The educational standard came into force on September 1st, 2000. The standard consisted of two relatively independent parts, content and performance standard. Each of them included three chapters according to the subject segmentation into the particular parts: *technical education, plant cultivation works* and *family education*. Subject matter of *technical education* was divided into the core and alternative subject matter. The educational standard for the alternative part of the subject matter in its technical part followed the requirements stated in the core

educational standard. The core educational standard consisted of 11 topical units:

1. A man and technology.
2. Technical materials. Raw materials, production, energy. Communication in technology.
3. Electric power, simple electric circuits. Electrical appliances.
4. Simple machines, force and motion transmission.
5. Operations and tools for technical materials processing.
6. Means of mechanization.
7. Elements of housing installation.
8. Electro-assembly operations. Electronic automation and control elements.
9. Housekeeping chores.
10. Technical electronics.
11. Technical, economical, ecological and aesthetical rateability of household investments.

In the content part of the particular topical units of the standard there were stated content components falling into the core subject matter of the respective topical units. These were parts of the subject matter, with which all pupils were to be acquainted. The performance part of the standard was entitled *Requirements on pupils´ knowledge and skills.* This part included the part of the subject matter which was to be learnt by all pupils but on different qualitative levels. Expected level of mastering the given topical unit was expressed through a percentage proportion of fruitfulness at each of them. A disadvantage of the performance standard was that it was not prepared for the particular grades but it was done to the topical units.

The last standard of technical education from this period, which conceptually elaborated the educational standard from the year 2000, came into force on September 1st, 2002. In this standard the previous one was eked with exemplificative tasks, which elaborated range and level of the requirements put on the pupils` knowledge and skills. The educational standard from the year 2002 was structured, alike the previous one, according to the topical units. It included the performance standard (already without the expected percentage fruitfulness of the respective topical units) complemented by exemplificative tasks and suggestions for practical activities. It also contained a brief recommendation how to use the standard. The role of the content standard was fulfilled by the subject curriculum.

The State educational program approved in 2008 was a result of the transformation process of the Slovak system of education. Content of education in basic schools was divided into eight educational areas according to the key competences. Technical education at the 2nd stage of the basic school was incorporated into the educational area *A man and the world of the work.* This area was characterized as follows:

- The area *A man and the world of the work* contains a broad range of working activities and technologies, leads pupils to acquire basic user skills in different areas of human activities, and helps to the develop pupils' personal life and professional orientation.
- Conception of the educational area *A man and the world of the work* follows specific life situations in which pupils come into a direct contact with human activity and technology in its diverse forms and wider contexts.
- The area *A man and the world of the work* is focused on adopting working practices and it ekes the whole basic education with an important component necessary for employing a man in future life and society. In this aspect the area differs from the other ones and in some way it represents a particular counterbalance to them. It is based on creative cooperation of pupils.

Objectives of the educational area were to be achieved by means of three school subjects - *manual training* taught at the 1st stage of the basic school and *world of the work* and *technology* taught at the 2nd stage of the basic school. Technical education of pupils started in 3rd grade of the basic school, one lesson of *manual training* per week, continued in 4th grade, as well one lesson per week, and then a pause from two to three years followed. Consequently, technical education was scheduled in 7th and 8th grade of the basic school, through the only school subject *technology* taught with the lesson allocation of 0.5 lesson per week devoted to topical units:

- Man and technology,
- Graphical communication,
- Materials and technologies,
- Electric power,
- Technology – household – safety.

In practice the subject was taught one lesson per week either in 7th or 8th grade. The cut of technical education at 2nd stage of the basic school led to underestimation of the *technology* subject importance by school managements, what led in practice to liquidation of classrooms (workrooms) specialized for teaching technology (technology education) and delegating *technology* teaching to teachers without qualification for this subject teaching (school leaders did not employ teachers with this specialization).

On the other hand, the reform brought also some positive facts. One of them were so-called disposable lessons. These were lessons number of which was different for each grade and the school could decide about the subject teaching of which would be supported by these lessons. In this way schools were given a possibility to profile themselves according their own decision. The intention was to enable to schools to respond to pupils` interests, particularities of their region (district), material-technological facilities and teaching staff qualification composition. Some of the schools used the disposable lessons just to reinforce the *technology* subject teaching. Mostly they added in frame of the School education program one more lesson for teaching *technology*, but the content of the taught topics varied considerably.

The subject committee for the educational are *A man and the world of the work* of the National Institute for Education, academics, scientists, researchers, professionals and experts did not accept this state and called for continuity of technology education from 1st up to 9th grade of the basic school. The need or necessity to do something with technology education carried out at basic schools was proved at the secondary vocational school reform and dual system of vocational training introduction. Secondary schools pointed out to pupils` disinterest in technical study fields as well as to their low knowledge level and mainly insufficient level of skills with which the pupils came from the basic to secondary vocational schools (i.e. from lower level of secondary schools to upper level of secondary schools).

As the State educational program evoked a great criticism not only in relation to teaching *technology*, but also in relation to the other school subject teaching an innovated State educational program was prepared, which came into force on September 1, 2015.

Design of the innovated State educational program for the educational area *A man and the world of the work* followed preferentially requirements of practice, put on knowledge and practical skills of the basic school graduates. But at the same time it made provision for pupils` attitudes and their professional interests.

From the point of view of technical education carried out at basic schools the innovation of the State educational program from 2008 meant a return, coming back to the lesson allocation of one lesson per week continually from 3rd to 9th grade of the basic school. What is very important is the fact that one started to talk about the problems connected with technical education at schools, mainly about the problem of the material and technical equipment necessary to ensure its realization. Criticism of the lack of the relevant material and technical equipment at schools resulted in two national projects aimed at improvement of this

situation. Within these two projects, known as *Creative Workrooms I* and Creative *Workrooms II*, 226 schools were equipped with teaching aids and devices supporting natural science and technical subjects teaching at schools and at the same time teachers were trained to their use (ŠIOV, 2013 - 2015; ŠIOV 2015).

Increase of the lessons was accompanied by changes of the subject content. According to the innovated educational standard the subject *technology* is divided in two topical areas, which are *Technology* and *Household economy*. Both of them have declared their own content, but a greater emphasis should be on the topical area *Technology*.

According to State educational program from 2013 a duty to teach at least two thirds from the total number of lessons allocated for the subject *technology* from the topical area *Technology* in each school year. Content of the topical area *Technology* is as follows:

- A man and technology,
- A man and production in practice,
- Utility and gift items,
- Graphical communication in technology,
- Technical materials and operating procedures of their processing,
- Electric power, electric circuits,
- Simple machines and machineries,
- Machines and equipment for household,
- World of the work,
- Electrical appliances for household,
- Technical electronics,
- Technical creation,
- Housing installations,
- Machine processing of materials,
- Creative activity.

3 Research questions and methodology of the research

In 2018 the innovated State educational program was in the third year of its realization, what means that the subject *technology* had already been taught according to this program in grades 5th – 7th of the basic schools. The aim of the presented research was to assess knowledge level of pupils of 7th grade resulting from teaching *technology* according to the innovated version of the State educational program.

Following the goal of the research, two research questions were stated:

RQ1: What is the knowledge level of pupils in 7th grade of the basic school resulting from teaching *technology* according to the innovated State educational program?
RQ2: Are there any changes in pupils` knowledge in comparison with the previous period?

In frame of the research following null hypothesis was tested:

H0: Pupils` knowledge level resulting from teaching *technology* identified in 2018 is the same as the one identified in the previous period (2010).

The null hypothesis was tested on significance level $\alpha = 0.05$.

Research sample consisted of 102 pupils of 7th grade attending basic schools in the city Nitra. Selection of the schools was done on the basis of the previous co-operation with basic schools in Nitra, approachability of the schools and agreement of the school management to co-operate on the monitoring of pupils` learning achievements. Under the previous co-operation it is understood here a similar monitoring of pupils` learning achievements (in the subject *technology*) done at these schools in 2010.

To test knowledge level of the pupils a didactic test of our own design was constructed. The test consisted of 11 tasks, following subject matter included in curriculum of *technology* for 7th grade of the basic school. A principal requirement was that the relevant subject matter had already to be taught (before the monitoring). Each of the test tasks of the test was consistent with the content and performance standards of the subject. In this way the content validity of the test was ensured. At the same time great attention was paid to the content of the created task also from the aspect of the content of the tasks used in previous monitoring, i.e. content of the created tasks had to be relevant to the content of the tasks used in the monitoring done in 2010. From the 11 tasks of the newly created test 6 tasks were based on choice of answers, 3 tasks were of matching questions character and 1 task was of an open-ended character.

Description of the particular test tasks

T1 – Purpose of the test item T1 was to find out whether the pupils know some Slovak inventors. The task of the pupils was to write correctly at least one name of a Slovak inventor. It was not necessary to write what s/he invented.
T2 – Purpose of the test item T2 was to find out whether the pupils know the phases of a product creation and whether they are able to put the particular stages into the correct order. The answer was correct if all phases were assigned to the numbers in the correct order.
T3 – The test item T3 was focused on the pupils` ability to read information and data from a simple technical drawing. The task of the pupils was to find dimensions included in a technical drawing. There were two dimensions in the given picture and the pupils were expected to encircle both of them.
T4 – The test item T4 was focused on wood structure in its cross-section. The task of the pupils was to write into the given picture numbers connected with terms (notions) identifying the particular parts of the wood. The answer was correct only if all parts were assigned correctly.
T5 – Purpose of the test item T5 was to find out whether the pupils understand content of the term *ecological.*
T6 – Purpose of the test item T6 was to find out whether the pupils know what are the right clothing and shoes to be worn into the workrooms.
T7 – The test item T7 was aimed at metals harmful to human health. The pupils were expected to choose from the given ones those that are harmful.
T8 – The test item T8 dealt with the pupils` understanding of the term *thermoplastics.*
T9 – Purpose of the test item T9 was to find out pupils` knowledge related to the area of the use of different technical materials, in particular expanded (sponge) polystyrene.
T10 – The test item T10 was focused on the pupils` knowledge of technical material characteristics. The task of the pupils was to order four kinds of materials according their hardness. The answer was correct only in case that all four materials were ordered correctly, independently on the fact whether it was done in an ascending or descending way.
T11 – The test item T11 was aimed at the pupils` knowledge of electrotechnic symbols. The task of the pupils was to identify symbol of a bulb within a given picture.

For each correct answer the pupils were given one point.

4 Research results

Results of the monitoring of the pupils` knowledge level regarding teaching the subject *technology* are summarized and compared in a graphical form in Figure 1.

As Figure 1 shows, with exception of the test task T4 and T6 pupils achieved better results at all tasks in the current monitoring (2018) than in the previous one (2010). To confirm the working hypothesis

H0: Pupils` knowledge level resulting from teaching *technology* identified in 2018 is the same as the one identified in the previous period (2010).

t-test for sets of data with the same variance. Before that, to find out whether the variance of the sets are really the same, F-test was used. Results of F-test (Table 1) proves that there is no significant difference between the set variances (p = 0.09). Consequently, based on the results of t-test (Table 2) the null hypothesis was rejected (p = 0.00005) on the significance level α = 0.05.

Table 1: F-test results

	2010	2018
Mean	5.92	7.41
Variance	4.38	6.01
Observations	60	102
df	59	101
F		1.37
P(F<=f) one-tail		0.09
F Critical one-tail		1.48

Table 2: t-test results

	2010	2018
Mean	5.92	7.41
Variance	4.38	6.01
Observations	60	102
Pooled Variance		5.41
Hypothesized Mean Diff.		0
df		160
t Stat		3.95
P(T<=t) one-tail		0.00005
t Critical one-tail		1.65
P(T<=t) two-tail		0.00
t Critical two-tail		1.97

Rejection of the null hypothesis H0 means, that there has been proved that there is a statistically significant difference between the results achieved by pupils in 2018 and 2010. The difference is in benefit of the pupils in 2018, what confirms also the means of the achieved score (average number of points achieved by the pupils in the respective years: in 2010 – only 5.92, in 2010 – increase to 7.41).

The test task T4, in which pupils in 2010 achieved in average a higher point score than pupils in 2018, was focused on knowledge of technical materials, in particular wood. Solving of the task bears relation to the lowest level on Niemierko`s taxonomy (Niemierko, 1979), as well as the task T6, at solving of which the pupils were more successful in 2010 (the task focused on the right clothing and shoes in the workrooms, difference between the means achieved by pupils at this task in 2010 and 2018 was minimal 0.87 vs. 0.83 respectively).

The biggest difference of the results was recorded at the test task T5 (0.32 vs. 0.80), which tested the pupils` understanding of the content of the term *ecological*. As this term has been used in common and pupils can meet it also in other subjects teaching (e.g. in biology), this results is quite surprising.

4 Discussion of the results

The research results proved that the innovation of the State educational program of *technology* education has brought improvement of pupils` quality education. But it should be under investigation whether also the pupils` skills have been improved proportionally to the knowledge increase, so as the secondary vocational schools require it. However, pupils` skills strongly depend on material-technological equipment of schools and investigation of different researches show that *technology* teaching supporting equipment of schools is very poor (Hašková, Bánesz, 2015).

As to the scope and content of technical subjects taught at basic schools, after 10 years of basic school reformation we have come back nearly to the level as we had before the reform. Almost, because five years of the reform was enough for basic schools to disappear the classrooms specialized for technical subjects teaching (workrooms) and with them also the appropriate equipment, devices, tools, teaching aids and materials necessary for pupils` practical training activities.

Due to the national projects *Creative Workrooms I* and *Creative Workrooms II* a 226 of the basic schools obtained material-technological equipment appropriate to ensure *technology* teaching, from the total number of 1400 schools in Slovakia it has been only a very small part (ŠIOV 2013 - 2015; ŠIOV 2015).

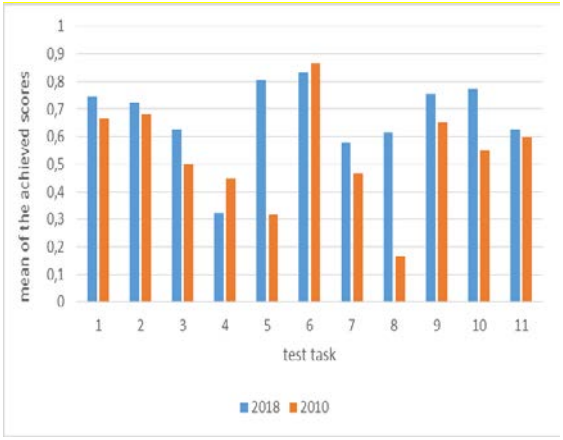

Figure 1: Comparison of the pupils` results achieved at the particular test tasks in 2018 with results from 2018

It is necessary to mention that based on an intervention of the respective section of the Ministry of education, science, research and sport of the Slovak Republic, into the innovated educational standard there was introduced an additional part topically focused on household economy. This was done at interest of 33 lessons per year, previously allocated to *technology* teaching. Under a direction of the Ministry it was recommended to schools to teach at the most 11 lessons per academic year in grades 5th - 9th. Professionals assess this step as a very inappropriate, enabling to schools not to fulfil in the whole range requirements put on them through the valid innovated educational standard of *technology* (Pavelka, Kuzma, 2017).

5 Conclusion

Current state of teaching *technology* at basic schools offers a hope that due to the introduction of the innovated educational standard for *technology* there will be created in successive steps appropriate conditions for technical education development and support. Otherwise, one can hardly expect that in the forthcoming years pupils` interested in studying technical branches will be increased.

On the other hand, not only the professionals point to a need of further updating of the innovated State educational program to adapt it to the current requirements of practice and society. In current form the innovated State educational program is only at the half of its way to be a decisive document determining content of education, and its further innovation is necessary (Papuga, 2015).

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