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Implementation of a Research-oriented Model of Learning in the Subject Technique in Lower Secondary Education with a Focus on the Cognitive Domain

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Abstract

In this paper, attention is paid to the inquiry-oriented model of students' education in the subject Technique in lower secondary education. The proposed model reflects the long-term needs of students' education in the subject Technique, which, in spite of the updated content of the curriculum in the Educational Standard of the subject Technique, have not yet been fulfilled. These issues are addressed within the KEGA project No. 006UMB-4/2022 in the years 2022–2024. The project is funded by the Ministry of Education and Science of the Slovak Republic. In the article we present basic information about the background, objectives, about the research team and the planned outputs of the problem.

Keywords: elementary school, model of education, subject Technique, technical education, experiment

Introduction. Current state of the issues

One of the aims of education in primary and secondary schools is to prepare students for practical and real life so that every graduate has an equal opportunity to join the workforce in today's evolving information society, knowledge economy and globalisation. Currently, the still prevailing transmissive way of teaching and the assessment of students with a grade requires, due to the ongoing school reform from 2015 and the changes in the curriculum with a specific focus on the educational scope of Man and the World of Work, to implement elements of research-based learning and new assessment practices in the teaching process.

Based on the decision of the Ministry of Education, Science and Higher Education of the Slovak Republic, starting from the school year 2015/2016, the technical education began to be implemented from the 5th class of the primary school (PS) in line with the innovative State Educational Programme (iSEP) according to the innovative Educational Standard (iES) of the subject Technique. The subject Technique in lower secondary education has its firm, specific and irreplaceable place in the system of teaching subjects, which cannot be replaced by any other subject.

As stated in the iSEP, the subject Technique must be based not only on theoretical knowledge but above all on practical activities. Its content is targeted at skills and habits for students' employment and society further in life. It is based on students' creative participation and cooperation. It adds an important component to basic education by laying the foundations in technology that are essential for further study and for students' performance in real life. Students learn to plan, organise and evaluate work activities both independently and in groups. The content of the subject Technique continuously provides students with important information and helps them to make responsible decisions about their future career and life choices.

The objectives of the subject Technique formulated in the iSEP reflect the content of the subject in grades 5–9 of primary school. From the aspect of solving problems in the project, we are primarily interested in fulfilling the following objectives in the subject Technique:

- students experiment with ideas, materials, technologies and techniques,
- students distinguish and safely use natural and technical materials, instruments, equipment and tools,
- students apply creativity and their own ideas in work and experimental activities,
- students acquire the necessary knowledge and skills relevant to employment opportunities, the choice of their own professional direction and further professional and life orientation.

Innovative Educational Standard for the subject Technique in 5th–9th grades of PS within individual thematic units also includes so called Performance Standard, which formulates performances that determine what the student should know at the end of a given year within a given thematic unit should know and be able to perform.

Experience and our own knowledge from pedagogical practice, as well as the results of extensive research in the Slovak Republic (Ďuriš, Stadtrucker, Pandurović, 2019; Pavelka et al. 2020) lead us to a conclusion that the objectives of the subject Technique and the required performances formulated in the Performance Standard have not yet been met.

This state has not been significantly affected in a positive sense by the publication and commercial dispatch to PS (not to all PS in the Slovak Republic) of

the following methodological materials for the subject Technique (Workbook for 5th and 6th grades, 2015, Workbook for 7th, 8th and 9th grades, 2016 – from the publishing house Dr. Josef Raabe Slovensko, s.r.o. Workbook for 5th, 6th and 7th grades, 2017, Textbook for 5th and 6th grades – from the Taktik, s.r.o.).

Among the causes of this state, we can include mainly the unqualified teachers teaching the subject Technique, still prevailing transmissive method of teaching and evaluation of students with a grade, the absence of textbooks for the subject, insufficient material equipment for the subject and others.

In pedagogical practice, we most often encounter the application of summative assessment of students in the teaching process, which is usually associated with a classification. Students are often stressed by its application, they learn only for good grades, and they are often only passive objects of examination and evaluation. The aim of students' assessment cannot simply be to assess their performance at the moment, but should be directed towards formative assessment and self-assessment.

The essence of self-assessment is that students are responsible for their learning and are actively involved in the learning process. From a didactic point of view, self-assessment can be seen as a competence that promotes students' self-activity and independence from the teacher.

Self-assessment and self-control are the most important motivational means for the students. Formative assessment of students in the teaching process aims at obtaining feedback on the students' progress in learning, on shortcomings and mistakes, with the aim of their eliminating. As stated by several authors (Turek, 2014; Kalaš, 2013; Shute, Kim, 2014; Đuriš, Stadtrucker, Pandurović, 2019), formative assessment of students should be used more extensively because it improves the quality of students' knowledge and skills.

Since the existing models of education in the subject of technology fail to meet the stated objectives of the subject, it is necessary to perform the teaching process not only in a demonstrative and age-appropriate way, but especially experientially with the application of creative thought participation and cooperation of students. This requires the need for active participation of students in the teaching process, which can be achieved, for example, by means of research-oriented teaching. Another need is to carry out activities of an experimental nature with use of available and unexpensive tools. We also propose to methodically process the proposed activities of an experimental nature with the application of formative assessment of students (self-assessment sheets for students) with a focus on comprehension and specific transfer of learning in the cognitive domain.

The subject matter of the study. Project focus and description

The project focuses on the design and implementation of students' experimental activities using formative assessment and students' self-assessment within a research-oriented model of learning in the subject Technique in lower secondary

education. The proposed experimental activities and their implementation will serve to improve and consolidate students' knowledge and skills (fixation phase) and application in practical tasks and life situations (application phase), thus emphasizing the integration of students' learning and self-evaluation. It also implies a "shift" from simply verifying the students' state of knowledge towards activating their higher cognitive abilities in solving tasks requiring creative thinking.

In the learning process of a student, feedback on what he/she has learned is very important for him/her. This information enables to regulate his/her own learning and, if obtained by the student him/herself, has a significant impact on his/her level of self-assessment and self-awareness. The implementation of a research-based model of learning in the subject Technique represents an innovation in the formal assessment of the student in the teaching process. On the one hand, the student applies his/her knowledge and skills from the exposure phase of teaching in practical situations, which is required of the student in the field of technical education and, on the other hand, the student receives immediate feedback on the success or failure of his/her learning. In this way, students' learning outcomes can be improved in synergy with the application of experiential learning. At the same time, students' experimental activities are aimed at promoting their key competences and 21st century skills (creativity and innovation, creative and critical thinking, problem solving, etc.).

The experimental activities will be focused on the thematic unit Technical materials and working procedures of their processing, which is included in the updated Educational Standard for the subject Technique in the 6th and 7th grade of PS. Emphasis will be placed primarily on the Performance Standard in which the performances are formulated in a given thematic unit, determining what the student should know and be able to do at the end of a given school year in a given thematic unit. Part of the formulated performances is also the implementation of simple experiments that should significantly influence the acquisition of knowledge and skills of students in the higher levels of the taxonomy of educational objectives, which are necessary for further education and life in the 21st century.

As this is applied research, the aim of its implementation within the project will be to verify the effectiveness and efficiency of the proposed research-oriented model of education, the proposed experimental-oriented practical activities and activities of students with the application of formative assessment of students, in selected fully organized urban and rural primary schools through the main research method - natural pedagogical experiment. The research will be carried out through partial research activities of the members of the research team.

Research methodologies, tools and research Team

The solution of the given problems in the project and the gradual fulfilment of the set objectives should also be applied in the undergraduate training of fu-

ture teachers of the subject Technique at the FE CFU in Nitra. Another reason is the implementation of the verification of the proposed research-oriented model of education in the subject Technique also in primary schools in the regions, for which the FE CFU in Nitra prepares their teachers for the subject Technique.

All members of the research team have recently published not only university textbooks, but also important scientific works (scientific monographs in domestic and foreign publishing houses), scientific studies at home and abroad in renowned journals, as well as in journals included in the scientific databases Web of Knowledge or Scopus. Numerous published outputs have been acclaimed at the national and international level.

The project team consists of teaching staff, experts in the field of didactics with a focus on didactics of scientific technical subjects (prof. PaedDr. M. Ďuriš, CSc., doc. PaedDr. J. Stebila, PhD., doc. PaedDr. V. Tomková, PhD., doc. PaedDr. J. Depesova, PhD.) and focusing on the field of scientific technical subjects (prof. Ing. A. Očkajová, PhD., Ing. P. Kvasnová, PhD., Ing. M. Kučerka, PhD.) from two departments (Department of Technology of the Faculty of Natural Sciences of Matej Bel University in BanskáBystrica, Department of Technique and Information Technologies of the Faculty of Education of Constantine the Philosopher University in Nitra). The need to involve the collaborating department (FE CFU in Nitra) into the research team results mainly from the fact that this department prepares students in the accredited study programmes Teacher of Technique (Bachelor and Master studies) for the position of teacher for teaching the subject Technique in lower secondary education.

Since the members of the research team have achieved excellent results in the KEGA and VEGA projects in recent years, there is a presumption that they are a guarantee of high expertise and quality of the project outputs and also, to achieve the set project objectives in the research area of Educational Sciences.

Within the framework of international cooperation, the research team will collaborate with foreign partners:

1. Prof. PaedDr. Jarmila Honzíkova, Ph.D. (University of West Bohemia in Pilsen, Czech Republic).

Participation and assessment of research activity proposals including the application of formative assessment of students focusing on comprehension and specific transfer of learning in the cognitive domain, which will be included in the publication Workbook for the subject Technique with exemplification tasks. Expertise and assessment of the proposed scientific monograph aimed at defining the theoretical basis of experimental activities in the selected content of the curriculum and at interpreting the results of the experimental validation of the research-oriented model of education in the subject Technique.

2. Doc. PhDr. PaedDr. Jiří Dostál, Ph.D. (Palacký University in Olomouc, Czech Republic).

Participation and assessment of research activity proposals including the application of formative assessment of students focusing on comprehension and specific transfer of learning in the cognitive domain, which will be included in the publication Workbook for the subject Technique with exemplification tasks. Expertise and assessment of the proposed scientific monograph aimed at defining the theoretical basis of experimental activities in the selected content of the curriculum and at interpreting the results of the experimental validation of the research-oriented model of education in the subject Technique. Collaboration in publishing the results of the problem solving in the international journal JTIE – Journal of Technology and Information Education.

3. Dr hab. prof. Wojciech Walat (University of Rzeszów, Faculty of Mathematics and Natural Sciences, Department of Modern Educational Technologies, Rzeszów, PL).

The aim of the cooperation, apart from the mutual exchange of information on the latest developments in the field of didactics of technology focused on research activities in Polish primary and higher education institutions, will be the presentation of the achieved results at an international conference entitled *Education – Technology – Computer Science. Main Problems of Technology and Professional Education. Rzeszów*. Part of the cooperation will include the publication of outputs from the solution of the given problem in the international journal Education – Technology – Computer Science.

Analysis of research results. Objectives of the project

The main objective of the project is to design and validate experimental activities that will be part of a research-oriented model of students' education in the subject Technique in lower secondary education. Other important objectives of the project are the development of the methodology of the proposed exploratory activities with the application of formative assessment of students (students' self-assessment sheets) focusing on the understanding and specific transfer of the selected content of the curriculum in the cognitive domain. The experimental activities will involve the development of strategies for solving practical learning tasks that are aimed at promoting and developing key competences and skills of 21st century students (creativity and innovation, creative and critical thinking, problem solving, etc.).

Intangible objectives of the project

1. Development of theoretical basis for the design of research activities in the selected content of the subject Technique with emphasis on the development of competencies and skills of students in solving application and problem-solving tasks.

2. Creation and incorporation of selected chapters from didactics of technique focused on innovations in the assessment of students in the teaching process into the study in accredited study programs Teaching Technique, preparing future teachers of the subject Technique.

3. Creation of conditions in the undergraduate training of future teachers of subject Technique and for selected groups of teachers in the framework of life-long learning also in the form of conferences, methodological days, or professional seminars and workshops.

Tangible objectives of the project

1. Creation of a set of experimental activities, experiments focused on the selected content of the curriculum (thematic unit Technical materials and working procedures of their processing) in the subject Technique in lower secondary education with the application of formative assessment of students – Workbook for the subject Technique with exemplification tasks.

2. Creation of an information sheet for a compulsory elective course focusing on activities of an experimental nature for the field of technology and materials processing, which will form a part of the future accredited study programme Teaching Technique. The compulsory elective subject will complement the compulsory subject in its content.

3. Creation of a scientific monograph aimed at defining the theoretical foundations of experimental activities in the selected content of the curriculum in the subject Technique and the analysis and interpretation of the results of the experimental validation of the research-oriented model of education in the subject Technique.

Conclusions. Planned application of outputs

The application of the project outputs in practice is in the form of a publication entitled Workbook for subject technique with exemplification tasks. The publication will contain designed and methodically processed students' exploratory activities, experiments in the selected content of the curriculum with the application of formative assessment of students with a focus on understanding and specific transfer in the cognitive domain.

Another output will be the design and production of an information sheet for a compulsory elective course focusing on experimental activities for the field of technology and materials processing (wood, metal, plastics). The information sheet will form part of the future accredited study programme Teaching Technique.

The final output of the project will be the publication of a scientific monograph aimed at defining the theoretical foundations of research activities in the selected content of the curriculum in the subject Technique and at presenting the results of research aimed at experimental verification of the proposed research-oriented model of education in the subject Technique.

The publications produced will respect:

– requirements that are aimed at promoting and developing key competences and skills for 21st century learners (creativity and innovation, creative and critical thinking, problem solving, etc.),

- based on these requirements, didactic resources and teaching materials will include new modern teaching elements (formative assessment, problem tasks, PISA tasks, experimental support for teaching, etc.),
- the requirements of the guarantors of individual study programmes focused on the teaching of subject Technique and the current requirements of individual departments (FNSof Matej Bel University in Banská Bystrica, FHNS of University in Prešov, FEof Constantin the Philosopher University in Nitra),
- publications will take into account the impact of the school reforms of regional and higher education that have taken place in Slovakia in recent years.

The created publications will be used not only in the undergraduate training of future teachers of the subject Technique, but also in the framework of lifelong learning of teachers teaching the subject Technique, also in connection with the introduction of new content of the curriculum according to the updated Educational Standard of the subject Technique in lower secondary education.

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