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TECHNICAL SKILLS OF PRIMARY SCHOOL PUPILS IN SLOVAKIA

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Abstract: Technical skills are part of elementary education in most primary schools worldwide, including the Slovak Republic. In Slovakia, the development of these skills begins in pre-primary education and continues in primary schools. Mastery of the technical skills necessary for further education, personal life, and professional life is dependent on the material and technical equipment of schools. In the years 2013–2015, two national projects were implemented in Slovakia, providing equipment to 226 schools for teaching the subject of Technology. This article examines whether these schools utilize the provided equipment for practical education of students. The aim of the research was to assess the level of practical skills among 7th-grade students through observation, which was conducted on a sample of 83 students. It was found that all respondents achieved a 70% level of skills in all observed areas. The article further provides a detailed analysis of the students' skills.

Key words: Technical skills, material and technical equipment of schools, analysis.

TECHNICKÉ ZRUČNOSTI ŽIAKOV ZÁKLADNÝCH ŠKÔL NA SLOVENSKU

Abstrakt: Technické zručnosti sú súčasťou základného vzdelávania na väčšine základných škôl vo svete aj v Slovenskej republike. Na Slovensku sa s ich budovaním začína už v predprimárnom vzdelávaní a pokračuje sa na základných školách. Zvládnutie technických zručností potrebných pre ďalšie vzdelávanie, súkromný i profesijný život je naviazané na materiálno – technické vybavenie škôl. V rokoch 2013–2015 boli na Slovensku riešené dva národné projekty, ktoré zabezpečili vybavenie 226 škôl pre výučbu predmetu technika. Článok sa zaoberá skúmaním, či tieto školy využívajú poskytnuté vybavenie na praktickú výučbu žiakov. Cieľom výskumu bolo zistiť úroveň praktických zručností žiakov 7. ročníka prostredníctvom pozorovania, ktoré bolo zrealizované na

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vzorke 83 žiakov. Bolo zistené, že všetci respondenti dosiahli 70 %-nú úroveň zručností vo všetkých sledovaných oblastiach. Článok sa ďalej venuje podrobnej analýze zručností žiakov.

Kľúčové slová: technické zručnosti, materiálno-technické vybavenie škol, analýzy

1 Introduction

Technical and technological skills are an integral part of broader human activity and are essential for the survival of humanity (Autio, Hansen, 2002, Kozík, T., 2005). The basic dimensions of technical thinking were defined by Dyrenfurth (1990) and Layton (1994) in their works as follows: the first dimension is the cognitive domain. The second dimension of technical thinking is skill or "competence." Psychologists often refer to these skills as psychomotor skills and they are an important component of technical thinking. Skills include tactile or kinesthetic abilities and practical intelligence. The third dimension is the attitudinal aspect – technological will or the ability to "be active and enterprising."

The development of the foundations of technical skills begins in the preprimary stage of education and continues in primary schools, where it is implemented in subjects with various names, such as Technology, Skills, Technologies, etc. The development of students' technical skills is linked to the material and technical equipment of schools, which may not be the same in every school. For this reason, several experts are interested in the material and technical provision of subjects of a technical nature in primary schools, as well as the level of students' skills and other factors that influence the level of students' skills.

Results of research on the psychomotor skills of Finnish students indicate that technical abilities of students significantly improve even with minimal practice in the psychomotor domain (motor competence). Researchers (Ossi Autio, Ron Hansen, 2002) assessed the skills of students in each grade and found an increasing trend in the test of skills among students. They also discovered that a broader range of students' experiences with various materials and projects can be an important factor for good motor skills.

The research conducted by Kandlhofer and Steinbauer (2016) presents the results of an empirical study examining the impact of educational robotics on technical skills, social skills, as well as attitudes and interests of students related

to science. The research findings revealed significant intervention effects for one of the main categories – technical skills.

However, the majority of primary school teachers, even those with substantial experience in teaching technical subjects, lack sufficient knowledge about the technical abilities of their students. As a result, teachers have doubts about the quality of their support for the optimal development of these skills in students (Moreland, Jones, 2000).

A longitudinal study conducted in Slovakia on the teaching of Technical education at the primary level (9–10 year-old students) revealed significant and recurring deficiencies caused by the non-systematic approach to technical education. Third and fourth-grade students in primary school have achieved lower levels of technical skills in recent years compared to the years 2015, 2016, and 2017 (Huľová, Kožuchová, 2021).

Another research team, led by Žáčok (Žáčok et al., 2020), arrived at different results while examining the influence of students' theoretical knowledge on practical skills in technical subjects at the lower secondary level of education in the Slovak Republic. The conducted pedagogical research on a sample of 120 students indicated that 7th-grade students achieved above-average performance in solving practical tasks, with no statistically significant differences observed among different regions. The students achieved very good results in solving tasks in the psychomotor domain because they had a solid grasp of theoretical knowledge in technology.

Several authors have conducted research focused on improving students' psychomotor skills. The study by Sumarni et al. (2016) discusses the application of project-based education to enhance students' psychomotor skills and understanding of concepts, as well as how project-based teaching contributes to improving students' psychomotor skills in learning chemistry. Based on the results of the action research conducted by the authors, it can be concluded that project-based learning through hands-on work with real laboratory tools is necessary and beneficial for students in all three learning domains (cognitive, affective, and psychomotor). Working procedures play an important role in creating connections with everyday life, enabling students to comprehend the subject matter, embody learned knowledge, and develop their psychomotor skills (Pekbay, Kaptan, 2014). Of course, the need for working with real tools is inherent in the psychomotor domain of learning.

The study by Huang et al. (2020) analyzed the effects of creative thinking, psychomotor skills, and creative self-efficacy (CSE) on the creativity of engineering design in 208 eighth-grade students (14-year-olds). The main conclusions of the study were as follows: creative performance exhibited low to moderate correlation with creative thinking, psychomotor skills, and CSE. Among the examined factors, psychomotor skills had the strongest impact on design creativity, while creative thinking had the weakest direct influence.

From these studies, we can see that psychomotor skills are a crucial component in building students' knowledge in the field of technology and enhancing their creativity.

Technical education in Slovakia at the lower secondary level is implemented through the subject of Technology. The situation in technical education at primary schools in Slovakia was significantly changed in 2015 when the educational content was innovated. Two national projects also contributed to improving education by enhancing the material and technical resources for the subject of Technology. Prior to that year, the situation was much worse, as the time allocation for the subject of Technology was practically zero, and thus the content was negligible.

The aim of this contribution is to determine the level of practical skills of students following the 2015 reforms. For this purpose, a methodology for assessing students' psychomotor skills was developed. This assessment methodology involves the structured observation of students. An observation sheet, the content of which is provided below, was designed for recording observations.

2 Research Objectives and Methodology

In general, the fundamental goal of education in primary schools is to teach students basic knowledge, skills, and habits. However, this goal cannot be understood in absolute terms, as the educational process also involves the development of critical thinking, problem-solving skills, and understanding the connections between academic knowledge and real-life situations. Education in the field of technology is implemented as part of general education in Slovakia within the educational domain of "Human and the World of Work," specifically in the subject of technology.

The content of the technology subject leads students to understand the connections between theoretical natural science subjects such as physics, mathematics, chemistry, and biology, which are applied in technology. The technology subject

is distinct from other subjects in its structure, as it focuses not only on knowledge and habits but also on acquiring necessary skills in working with technical materials, handling electrical circuits, electronics, and the basics of automation and robotics.

The aim of our research was to determine whether the skills acquired by students in the subject of Technology at elementary schools are at an appropriate level. We defined an appropriate level of acquired skills as a success rate of at least 70% based on observation sheets we established.

The reason we decided to examine students' skills is that in 2015, two significant projects were implemented in Slovakia, which resulted in positive changes in the subject of Technology. These projects were the national projects "Creative Workshops 1: Supporting vocational orientation of primary school students towards vocational education and training through the development of polytechnic education focused on the development of practical skills and talent work" (abbreviated as Creative Workshops 1) and "Support of polytechnic education in primary schools" (Creative Workshops 2). These projects helped many schools to improve their material and technical resources for teaching Technology, Chemistry, and Biology. Both national projects implemented at elementary schools allowed for the enhancement and improved quality of teaching in the areas focused on polytechnic education. They provided selected schools with material and technical equipment for equipping their technology classrooms, thus contributing to the development of students' practical skills in the subject of Technology.

However, not all elementary schools participated in these projects, and therefore, not all schools obtained material and technical equipment. Such schools have to provide the necessary spaces (school workshops), equipment (planers, locksmith tables), as well as devices, tools, and aids from their own resources, which is economically demanding for schools. As a result, many of these schools choose an easier path and provide the subject's curriculum only in a theoretical manner or in a significantly limited form in terms of students' practical skills.

Schools that were involved in national projects have acquired many useful and effective teaching aids, school workshop equipment, as well as the necessary tools and devices for working with various materials. However, the question remains whether these schools actually utilize these resources.

Therefore, in our research, we focused on comparing the skill levels of students from those primary schools that were involved in the projects. The sample consisted of 7th-grade students, who were expected to have acquired basic skills

2/2024, Volume 16, Issue 2
ISSN 1803-537X

necessary for working with technical materials over the course of nearly three years. According to the technology curriculum standards, students encounter technical materials and processing techniques in lower secondary education (5th to 9th grade) as follows: In the 5th grade (11 years old), students familiarize themselves with work tools and equipment. They also learn to distinguish between raw materials, materials, and semi-finished products. In the 6th grade (12 years old), students learn to recognize the structure and properties of wood, metals, and plastics when working with technical materials. They learn various working procedures such as measuring and outlining dimensions, cutting, filing, sawing, grinding, drilling, gluing, joining with nails and screws, cutting, notching, bending, and punching. In the 7th grade (13 years old), students work with materials such as wood, metals, plastics, ceramics, glass, rubber, and textiles. They should also master more demanding working procedures such as carving, drilling, and riveting (Curriculum Guidelines, 2019).

We decided to assess students' psychomotor skills through structured observation during the practical task solving. The task designed for students was intended to correspond to the skills defined in the performance standards of the technology subject. In order to successfully complete the task, students had to be able to read a simple technical drawing, trace and cut wood, select the appropriate tools, join materials using nails and glue, and perform surface finishing. We also included skills that are conditioned by theoretical knowledge among the observed skills. These were mainly related to reading technical drawings. This knowledge is essential for students' practical activities.

The task for students included a technical drawing of a square, which is commonly used for marking a right angle (Figure 1).

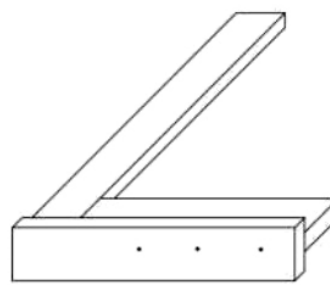

Fig. 1: Square (Angle Measuring Tool) – Task for Pupils.

Since it was not possible to create a research sample of students through random selection, we proceeded according to the following criteria:

1. We selected students from fully organized primary schools where the subject of technology is taught according to the valid curriculum by qualified teachers.
2. The research sample consisted of 7th-grade students from schools that were provided with teaching aids from national projects.

The total number of students involved in the research was 83. These included students from two state schools (classes B, C, D, E, F, G) and students from a religious primary school (class A). The main research method employed was observation conducted using observation sheets (Pavelka, 2016). The observation sheet included an assessment scale for the following categories: Student's knowledge (ability to use and implement) of: **materials and tools, work procedure, material cutting, carving, adhesive bonding, nail bonding**. The observer had the opportunity to mark the possibilities for each category as: correct, partially correct, partially incorrect, incorrect. Scale ratings were assigned point values as follows: correct (+2 points), partially correct (+1 point), partially incorrect (-1 point), incorrect (-2 points).

Points were allocated as follows:

- If a student correctly selected the tool and correctly performed the procedure on the first attempt, they received +2 points.
- If a student correctly selected the tool and correctly performed the procedure after multiple attempts, they received +1 point.
- If a student correctly selected the tool but incorrectly performed the procedure after multiple attempts, they received -1 point.
- If a student did not correctly select the tool and incorrectly performed the procedure after multiple attempts, they received -2 points.

Similarly, students' measurement and material tracing were observed, where the observer could record the following options: measurement on three sides of the material (+2 points), two sides (+1 point), one side (-1 point), none (-2 points). For the surface treatment of the completed product, the observer could indicate the evaluation as excellent (+2 points), praiseworthy (+1 point), good (0 points), satisfactory (-1 point), or unsatisfactory (-2 points). The observer marked the

2/2024, Volume 16, Issue 2
ISSN 1803-537X

corresponding level of completion for the observed categories in the observation sheet by circling the evaluation level (number of points).

The task of the students was to be able to read a technical drawing, correctly name the assigned material, choose the appropriate work procedure, select suitable tools for material processing, and accurately construct a protractor based on their proposed work procedure.

To achieve the research objective, the following hypotheses were established:

H1: 7th-grade students from primary schools reach a minimum threshold of approximately 70% proficiency in selected categories.

H2: There are no differences in technical skills among the individual groups of students (classes).

3 Research Results

Hypothesis H1 was tested by evaluating the observation sheets, with the average values of the total points reaching the threshold of 70%. This threshold is recommended by Turek (1995, p. 56) for arbitrary assessment of fundamental knowledge. The results are summarized in Graph (figure 2).

As evident from the presented graph, students achieved the desired level of 70% in all observed criteria. Hypothesis H1 has been confirmed.

The second hypothesis was tested using the number of points obtained in each evaluative criterion from the observation sheet: material and tools, work procedure, measurement and tracing, cutting, material removal, adhesive bonding, nail bonding, surface treatment.

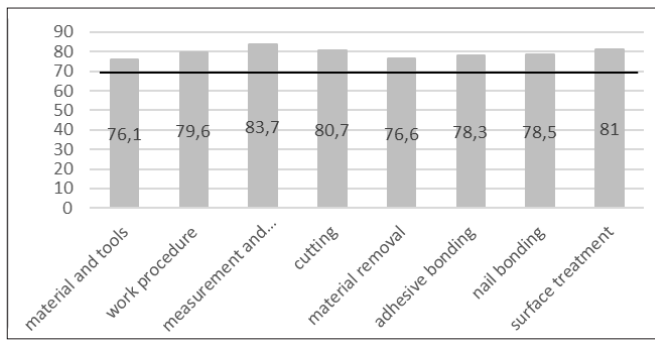

Fig. 1: Percentage Success Rate of Students' Individual Skills.

2/2024, Volume 16, Issue 2
ISSN 1803-537X

Through statistical methods for testing the established hypotheses, we investigated whether there were differences in the results of practical skill tests among the different groups. When testing the means of multiple groups, we employ analysis of variance. Several conditions must be met for conducting an analysis of variance. One minimum requirement is the assumption that the variances of the individual groups are equal. This is verified by the condition: $\frac{\max s_i}{\min s_i} \leq 3$. Since the difference between the arithmetic mean of 13.92 points and the median of 13.6 points is less than 10%, the distribution of the data set can be considered normal (Kasal, Hladikova, 1995).

We investigated the conditions for conducting an analysis of variance. The variances of the individual groups (classes) are listed in Table 1, along with the ratio of the maximum and minimum variances.

	Variances
class A	120,16
class B	113
class C	116
class D	140,16
class E	97,6
class F	108,33
class G	131,42
$\frac{\max s_i}{\min s_i}$	1,43

Table 1: Variances of Individual Groups (Classes).

Since 1,43 is less than 3, we were able to use analysis of variance for testing. The null hypothesis tested was: The means of all classes are equal. Against it, the alternative hypothesis was formulated: The means of all classes are not equal. The testing was conducted at a significance level of $\alpha = 0.05$. The results of the analysis of variance are presented in Table 2.

ANOVA Variations	SS	df	MS	F	P- value	F critical
Between groups	810,29	6	135,04	1,14	0,35	2,22
Within groups	9009,78	76	118,54			
Together	9820,07	82				

Table 2: Analysis of variance.

The probability value p = 0.348061 is not smaller than 0.05, and therefore we cannot reject the null hypothesis. There is no statistically significant difference between the means of the individual groups (classes) included in the study. Through the analysis of variance, we have demonstrated that there are no differences in the skills of students in the different classes. Based on these results, we can conclude that the investigated skills of 7th-grade students in elementary schools (13-year-old students) are at the required level (70%), and there are no statistically significant differences between the individual groups (classes) (Felixová, E., 2022).

4 Discussion

From the given results, it can be inferred that students in the observed groups achieved similar results in the areas under study. Based on the information provided, it can be concluded that their attained skills are at the required level of at least 70%. The highest percentage of success was achieved in measuring and sketching the necessary dimensions (83.7%) and material division by cutting (80.7%). Regarding the first mentioned area, it can be stated that students not only correctly marked the material dimensions but were also able to read them from technical drawings. This finding is interesting because reading technical documentation often poses challenges for students. Similarly, students paid attention to the overall appearance of the products, as their success rate in this criterion reached 81%. A common problem is that students struggle to estimate the appropriate amount of adhesive when gluing products, which then affects the overall appearance. However, the observed students did not encounter such problems.

The biggest challenges were encountered in correctly identifying the appropriate materials and, especially, tools (success rate of 76.1%). Students often reached for the wrong tools, which they had to replace with the correct ones and adjust their working procedure accordingly.

Our results are reflected in the findings of other authors as well. For instance, Ažaltovičová et al. (2021) state that insufficient practical skills become evident when students transition to vocational secondary schools, where up to 50% of secondary school teachers rate the skills of primary school students as inadequate. They evaluate "students' knowledge in general technical awareness and their manual skills in working with materials and tools as insufficient" (2021, p. 36).

The development of research skills was also addressed by Čipková et al., who focused on inquiry-based learning with an emphasis on the development of practical manual skills in their research. They used a test as a research tool. The results of their research indicate that students primarily had difficulties with skills requiring verbal expression (formulating conclusions, responses) and with analyzing their own work.

Authors Valentová and Brečka (2017) also engaged in the observation and analysis of students' work. Their research was conducted with 10-year-old primary school students to determine the level of their practical skills. The results of their evaluation of student products revealed that students had difficulties using tools. Nevertheless, they found that students showed an increased interest in independent creative work and were eager to practice manual skills with tools. Our research results indicate that students' skills have improved—they are now able to use tools appropriately, although they initially struggle to select the correct tool for a technological operation. We hypothesize that this improvement is related to better material and technical equipment in the schools involved in the research, as well as the qualifications of the teachers who teach the subject of Technology.

Based on these findings, it can be stated that the educational aids, equipment, and tools provided to schools through the Creative Workshops 1 and Creative Workshops 2 projects have contributed to improving the material and technical resources of the subject of Technology in primary schools in the Slovak Republic.

Our results are influenced by the sample size. Not every school in the Slovak Republic participated in the "Creative Workshops 1" and "Creative Workshops 2" projects. The study only reflects the local state of students' skills in the participating schools within the given region. The small sample size was also affected by the proposed methodology for assessing students' skills (observation). In the future, it would definitely be necessary to apply our proposed methodology to assess students' skill levels on a larger and more representative sample.

2/2024, Volume 16, Issue 2
ISSN 1803-537X

5 Conclusion

Several studies indicate that students have a better understanding of the subject matter and their knowledge is more effectively acquired when they engage not only their minds but also their bodies in the learning process. Manipulative skills encompass the ability to manipulate materials and instruments within the context of scientific research. Insufficient exposure of students to "practical" activities in primary school leads to inadequate manipulative skills, which can persist into secondary school. (Mohd Fadzil, H., Mohd Saat, R., 2013).

In the subject of Technology, learning takes place through reflection at each stage of the technological process of producing a student product. However, does current pedagogical research acknowledge and investigate this connection? Educators, students, and their parents understand that technology, technologies, and the associated development of students' skills must be part of basic education because technology and technologies are driven by human needs. It is both possible and necessary to reconcile technological and social development of individuals.

Every generation must understand that technological culture and social development of individuals are interconnected. There are many technical knowledge and skills necessary for meaningful societal progress, and therefore, they must be part of the curriculum in primary schools. The cognitive and psychomotor goals of technical subjects must be balanced so that students have enough time to acquire not only knowledge but also skills. Our research has shown that in the 7th grade of Slovak primary schools, students have the required skills acquired at the desired level. Although the sample of students was relatively small, it is likely that students from other schools involved in national projects also possess these skills, as these schools have the necessary material and technical infrastructure for teaching the subject of technology, as well as qualified teachers. However, the question of material and technical provision of the subject of technology is not completely resolved in other Slovak schools. Schools that were not involved in the projects may have difficulties with the material and technical provision of the subject. This discrepancy between the planned state curriculum and the material provision of teaching needs to be addressed as soon as possible so that students have the opportunity to acquire the necessary technical skills for their future professional growth, life, and joy of creation.

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