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RESEARCH INTO THE INFLUENCE OF THEORETICAL KNOWLEDGE ON THE ACQUISITION OF PRACTICAL SKILLS OF STUDENTS IN A TECHNICAL EDUCATION

Introduction

The needs of the Slovak industry today require an excellent technical level and the willingness of employees to solve everyday technical problems in practice. The students should acquire basic and gradually advanced technical knowledge at the lower and upper levels of secondary education. Several authors have dealt with the issue of technical training in the past and present. They found that today's school system continues to marginalise technical education. The competent authorities often changed the content of technical education and the time allocation for teaching, especially in lower secondary education[1]. The ascertained state of the technical education also has a negative effect on the acquisition of theoretical and practical knowledge, which is necessary for successfully solving technical problems in practice. It is necessary to teach students to be aware of technical tasks and problems of the modern information society to establish a positive attitude to technology as part of vocational training. Technology as a subject is usually taught in school workshops. Lessons in school workshops are characterized by students learning to apply acquired theoretical knowledge in practical activities. Students get to know and get acquainted with technical materials, work equipment and tools. They investigate the properties of technical materials from which they manufacture consumer goods, gifts and products. Teamwork and creativity are important factors for successfully solving practical technical tasks. In particular, the

[1] J. Pavelka, *Why is There Continuing Disinterest of Basic School Pupils In Science*, Technology and The Study of Technology?, In: *Technika a vzdelávanie.* Banská Bystrica: FPV, 2019, p. 2-9.

factors of creativity must be developed in the students when solving practical technical problems it is necessary to teach students to quickly and easily make sketches of various technical utility and gift products. Students should be able to develop different solutions for the same problem. Prerequisite for successful solutions - not only of typical school tasks but also problematic technical assignments, using practical skills - is the ability of students to recognize problems, change the meaning and use of the product, develop solutions and design and manufacture intriguing products.

Knowledge and skills in technical education

Practical skills are very important in technical education. For a student to have the best practical skills in solving various practical tasks, they must first acquire high-quality theoretical knowledge. We can say that theoretical knowledge impacts the process of acquiring the right practical skills If the student acquires high-quality knowledge and practical skills at an appropriate level, orientation in solving demanding technical/practical problem tasks is easier[2]. The mastry of theory and practice and their connection also guarantees a possible successful solution to more arduous technical problems. Competencies in technology can be acquired through various forms of teaching, especially in handicrafts, construction and experimentation, etc. The acquired theoretical knowledge in practice is insufficient to a greater extent. For a good candidate in the labour market, it is necessary to know and check the relationship between theory and practice and its regularity. The subject of technology serves to develop the skills and abilities necessary for students' future professions. Practical learning is strengthened by the experience of the students. Work activities and their development are important not only for the future professions of students and their employment ability but also as a motivating factor (incentive) to learn and continue in their studies at secondary vocational school. Technical education provides the student with practical skills at various levels of learning. First, the student is mentally and physically ready to perform a certain activity[3]. Next is the repetition of the activities demonstrated by the teacher. The student independently performs mechanical activities according to the teacher's instructions. The student can perform less complex activities quickly and easily. The following level of learning consists of performing difficult automatic complex activities. And last but not least, there is an individual automatic execution of activities by students and the application of learned working methods in new, unknown and problematic situations. If a student has already mastered these levels of learning in primary school, we can say that they are ready for further education in the current school[4].

2 J. Bajtoš., Hodnotenie psychomotorických zručností žiakov v technických prácach. In: Príprava učiteľov - elementaristov na prahu, 2000.

3 J. Bajtoš, Psychomotorické zručnosti v technickej výchove - príspevok k hodnoteniu. *In: Pedagogická evaluace 06:* sborník příspěvků z konference s mezinárodní účastí konané ve dnech 21.-22.9.2006 v Malenovicích. Ostrava, 2006.

4 J. Bajtoś, Psychomotorická zložka osobnosti žiaka (formovanie, rozvoj a hodnotenie technických predmetoch). Equilibria, s.r.o., 2007, s. 113.

Outline of problematic practical tasks for secondary school students in technology

In the past, several respected teachers have recommended a teaching process in which the student is more active than the teacher5. Today's schools (primary and secondary) implement newer teaching concepts. We assign students various practical problem tasks in technical and professional subjects. According to Niemierko's taxonomy6 of educational goals, these tasks are geared towards non-specific transfer. We present our proposed practical problem tasks for the subject of technology solved by students of the 7th grade of the primary school. The data obtained were evaluated as part of educational research.

Problem task 1:

The metal hanger is intended for wall mounting and will be used to hang up jackets. First, create a technical sketch or technical drawing of the hanger. A 2 mm thick steel sheet is used to make the hanger. The basic operations required to create this product include measuring and contouring, drilling, cutting, sawing and bending.

Output of problem task 1:

According to Niemierko's taxonomy of goals, we identify problem situation 1 as a task that requires a non-specific transfer. This situation requires the application of the knowledge acquired to solve a practical problem task. We know the teacher explained and presented theoretical information on manual machining of metallic materials to the students. Similarly, we proposed four more problem tasks, which we described in detail and implemented the outputs.

Pedagogical research

The pedagogical research aims to find out how 7th grade students can apply the theoretical knowledge they have acquired to solve practical problems or how knowledge affects the performance of students in psychomotor education.

Definition of the research problem

We specify our research problem as a relational research problem: What influence does theoretical knowledge have on solving technical problem tasks for lower-secondary school students? With this formulated research question, we want to determine the relationship between the phenomena examined (acquired theoretical knowledge in the subject of technology) and their influence on the efficient solution of technical problem tasks. We explain the connection between cognitive processes and psychomotor skills when solving problem tasks at the level of learning, specific and non-specific transfer according to Niemierko's taxonomy of educational goals. From a methodological point of view, we focus

[5] R. Čapek, Moderní didaktika. Praha: Grada Publishing. 2015, s. 604.
[6] B. Niemierko, Taxonómia celów wychowania. *In: Kwartalnik pedagogiczny 1979,* roč. 24, č. 2, s. 117-132.

on conducting quantitative research, in which we determine the relationship between the phenomena through research methods and tools.

Aim, tasks and hypotheses of the research

The main goal of the research was to identify the performance that students achieve in solving practical problems in individual regions of the Slovak Republic after acquiring theoretical knowledge. Another sub-goal was to identify whether there are differences in the performance of students in solving practical problems within four regions of the Slovak Republic. The subject of the research focused on the skills and performance of students in psychomotor education depending on previous knowledge from primary schools in selected regions of the Slovak Republic. The research was carried out between September 2019 and June 2020. Based on the formulated research problem and the research goal, we have defined the main hypotheses. We tested the defined hypotheses at the level of significance $\alpha = 0.05$ (95%).

H_1: We assume that students who achieve a certain score in the knowledge didactic test will achieve the same score when solving practical problem tasks. There will be no statistically significant difference between the achieved score of students in the knowledge didactic test and the achieved score in the practical test[7].

H_2: We assume that the results of the students from the Žilina, Prešov, Banská Bystrica and Nitra regions are the same in solving practical problems.

To operationalize the variables in the main hypotheses and their subsequent confirmation or rejection, we set the following working hypotheses:

$H_{2.1}$: The students from the Žilina region will perform better in solving practical problems compared to the students from the Prešov region.

$H_{2.2}$: The students from the Žilina region will perform better in solving practical problems compared to the students from the Banská Bystrica region.

$H_{2.3}$: The students from the Žilina region will perform better in solving practical problems compared to the students from the Nitra region.

$H_{2.4}$: The students from the Banská Bystrica region will perform better in solving practical problems compared to the students from the Prešov region.

$H_{2.5}$: The students from the Banská Bystrica region will perform better in solving practical problems compared to the students from the Nitra region.

$H_{2.6}$: The students from the Prešov region will perform better in solving practical problems compared to the students from the Nitra region.

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[7] J. Chajdiak, Štatistika jednoducho. Bratislava: Statis, 2003, s. 194.

Research Methods

The research method is the collective name for a number of methods used to obtain data in the field. In our case, we used the knowledge didactic test to collect the data needed to test the hypotheses. We designed the didactic test in a non-standardized way, according to Turek[7]. We also suggested practical problem tasks and recorded their solution by the students on observation sheets, where we assigned the required number of points to each correct answer. When processing the data obtained and interpreting them, we have chosen the methods of mathematical statistics. We verified the hypotheses made by calculating test statistics and calculating the p-value. If the calculated p-value is below the significance level (in our case 95%), the null hypothesis is rejected. The difference identified in the research sample is statistically significant. If the p-value is equal to or greater than the specified significance level, the null hypothesis is not rejected. To statistically check established hypotheses, we used basic descriptive statistics, measurement of statistical dependency and a non-parametric test (Kruskal-Wallis test). The correlation coefficient measures the statistical linear dependence between the values of the X and Y variables. In our case, we measure the statistical dependence between knowledge and skills. Positive values of the correlation coefficient indicate a direct dependency, and negative values indicate an indirect dependency.

Selection and characteristics of the research sample

The research was carried out in 10 primary schools in the Slovak Republic during the 2019/2020 school year. Two primary schools were from the Žilina region, three primary schools from the Banská Bystrica region, three primary schools from the Prešov region, and two primary schools from the Nitra region. The selection of the research sample was made consciously. Based on the available possibilities and with regard to the efficiency and economy of the research, we selected 7th grade students of primary schools. Chráska[8] (2007) states that the extent of the respondent selection can be empirically estimated by determining its minimum and maximum value according to the relationships:

$$n_{min} = 0{,}1\sqrt{n} \quad \text{and} \quad n_{max} = \sqrt{n}$$

where n is the total number of elements in the base set. In our case, according to the statistical yearbook as of September 15, 2018, the basic set had the range of n = 41,046 students of the 7th grade of primary school. According to the above relationships, the interval of our sample should be in the range of 20 to 203 students. The sample in our research consisted of n = 120 students of the 7th grade of primary school. The Žilina and Nitra regions collectively added 60 students to the research sample (30 students each) and the Banská Bystrica and Prešov regions added 60 students (30 each), too.

[8] M. Chráska, sen. Metody pedagogického výzkumu: Základy kvantitativního výzkumu. 2 akt. vyd. Praha: Grada, 2016.

Research results

Table 1 Comparison of students' performance in the cognitive and psychomotor area

Variables	Theory	Practice
Valid data	120	120
Missing data	0	0
Sum	1,950	1,939
Mean	16.25	16.158333
Variance	6.054622	4.537745
Standard deviation	2.460614	2.130198
Variance coefficient	0.151422	0.131833
Standard error of mean	0.224622	0.19446
Upper 95% CL of mean	16.694775	16.543383
Lower 95% CL of mean	15.805225	15.773284
Geometric mean	16.05497	16.005857
Skewness	-0.256164	-0.742019
Kurtosis	2.751176	3.107922
Maximum	22	19
Upper quartile	18	18
Median	16	16
Lower quartile	14	15
Interquartile range	4	3
Minimum	10	10
Range	12	9
Centile 95	20	19
Centile 5	12	12

The basic statistics shows (Table 1, Figure 1) that the student performance in the cognitive area (knowledge didactic test) and the psychomotor area (solving practical problem tasks) were at approximately the same level. When solving practical problems, not a single student achieved a maximum score of 19 points. Regression correlation analysis was used to examine whether there was a statistical relationship between knowledge and skills.

Table 2 Simple linear regression

Equation: Practice = 0.526371 Theory + 7.604811
Standard Error of slope = 0,063272
95% CI for population value of slope = 0,401074 to 0,651667
Correlation coefficient (r) = 0,608016 (r_2 = 0,369684)
95% CI for r (Fisher's z transformed) = 0,481219 to 0,709892
t with 118 DF = 8,319108
Two sided **P < 0,0001**
Power (for 5% significance) > 99.99%
Correlation coefficient is significantly different from zero

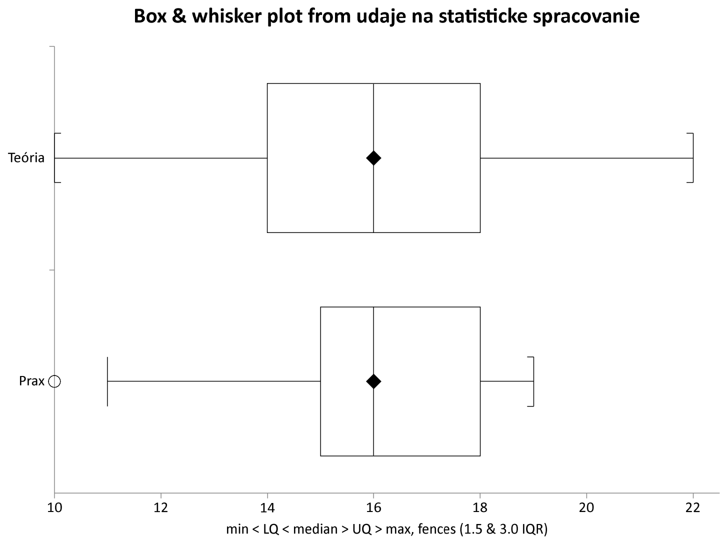

Figure 1 Comparison between theoretical knowledge and skills

We used regression correlation analysis to test the dependency between the results in the knowledge didactic test and practical problem tasks. The students could achieve a maximum of 22 points in the knowledge didactic test and in solving practical problems. From Table 2, we can see that the correlation coefficient was calculated to be 0.608, which is the mean positive dependency between the results of elementary school students on the knowledge test and the solution of practical problem tasks. Positive means that a higher number of points from the knowledge didactic test corresponds to a higher number of points when solving practical problem tasks. Based on a p-value of 0.0001, we consider the correlation coefficient at the significance level of 0.05 (95%) to be statistically significant.

We reject hypothesis H_1. We can say that in 60.8% of the cases, the performance of the students in the cognitive education area is positively affected by the performance of the students in the psychomotor education area, and therefore the theoretical knowledge of he students correlates with their practical skills. We proved there is a statistically significant linear dependency between the results of primary school students in the knowledge didactic test and practical problem tasks. The students who obtained good results in the theoretical test also obtained good results in solving practical problem tasks. We were also interested in performances that the students achieve in solving practical problem tasks in the subject of technology in selected regions of Slovakia. We verified hypothesis H_1. By correctly solving practical problems, the student could achieve a maximum of 22 gross points (gp) while solving 22 practical subtasks. The descriptive statistics (Table 3) show that the students have an above-average command of the curriculum. The calculated arithmetic mean and standard deviation of pupils from the Žilina, Prešov, Banská Bystrica and Nitra regions were calculated on the confidence interval: lower limit -95%, upper limit + 95%. From the average of the measured research sample, we identify that the calculated arithmetic average from measurement confidence interval is 15.74-17.40 for students from the Žilina region, 14.99-16.74 for students from the Prešov region, 15.19-16.75 for students from the Banská Bystrica region and 15.38-16.75 for students from the Nitra region. We can say that the students solved the practical problem tasks at about the same level. Students from the Žilina region achieved the best average. The range of variation for students in the Žilina region is determined by a minimum value of 10 and a maximum of 19, for students in the Prešov region by a minimum value of 10 and a maximum of 18, for students in the Banská Bystrica region by a minimum value of 11 and a maximum of 19 and for students in the Nitra region by a minimum value of 12 and a maximum of 19.

The median for the students in the Žilina region was calculated to be 18, in the Prešov region 16, in the Banská Bystrica region 16 and in the Nitra region 16. Half of the students in the Žilina region achieved ≤18 points in solving practical problem tasks (PPTs) and the other half of the students achieved ≥18 points in solving practical problem tasks (PPTs). Similarly, half of the students from the Prešov, Banská Bystrica and Nitra regions achieved ≤16 points in solving practical problem tasks (PPTs) and the other half of the students achieved ≥16 points in solving PPTs. From descriptive statistics, we can also conclude that the peak coefficient is not equal to zero; therefore, we state that the distribution of the values is more acute (asymmetrical) than the normal distribution of the values. Figure 2 also shows that the results of the students from all four regions differ. Figure 2 shows that the mean of the sample for students in the Žilina region is 18, for students in the Prešov region 16, and for students in the Banská Bystrica and Nitra regions 16. The median is the mean value that divides the respective value series into two approximately equal halves. With a symmetrical distribution of values, the median is equal to the mean. In our case, we found that the calculated arithmetic mean and median are not the same We measured very low deviations of the median from the mean for all students from all regions. The quartile range represents the range of the middle 50% of the values of the variables, i.e. from 13 to 19 for students from the Žilina region, from 10 to 18 for students from the Prešov region, from

12 to 19 for students from the Banská Bystrica region and from 13 to 18 for students from the Nitra region. The quartile margin represents the difference between the third and first quartiles (75th and 25th percentile). The quartile margin is important in determining the outliers. In our case, we found that, apart from the group of students from the Žilina and Prešov regions, in other research groups, there are few deviating values outside the interval (quartile range).

Table 3 Descriptive (basic) statistics

Variables	ZA	PO	BB	NR
Valid data	30	30	30	30
Missing data	0	0	0	0
Sum	497	476	479	482
Mean	16.57	15.87	15.97	16.07
Variance	4.94	5.50	4.38	3.37
Standard deviation	2.22	2.34	2.09	1.84
Variance coefficient	0.13	0.15	0.13	0.11
Standard error of mean	0.41	0.43	0.38	0.34
Upper 95% CL of mean	17.40	16.74	16.75	16.75
Lower 95% CL of mean	15.74	14.99	15.19	15.38
Geometric mean	16.40	15.68	15.83	15.96
Skewness	-1.05	-1.01	-0.30	-0.24
Kurtosis	3.49	3.42	2.47	2.06
Maximum	19	18	19	19
Upper quartile	18	18	18	18
Median	18	16	16	16
Lower quartile	15	15	15	15
Interquartile range	3	3	3	3
Minimum	10	10	11	12
Range	9	8	8	7
Centile 95	19	18	19	18
Centile 5	13	10	12	13

Table 4 Kruskal-Wallis test and Table 5 Kruskal-Wallis test: all comparisons

Variables: ZA, PO, BB, NR
Groups = 4 df = 3 Total observations = 120
T = 2.077314 P = 0.5565
Adjusted for ties: T = 2.225042 P = 0.527

Critical q (range) = 3.63316	
ZA vs PO	not significant
(|-1.95048| > 3.63316)	P = 0.5124
ZA vs. BB	not significant
(|-1.506391| > 3.63316)	P = 0.7108
ZA vs. NR	not significant
(|-1.725646| > 3.63316)	P = 0.614
PO vs. BB	not significant
(|0.085939| > 3.63316)	P > 0.9999
PO vs. NR	not significant
(|0.108066| > 3.63316)	P = 0.614
BB vs. NR	not significant
(|0.107133| > 3.63316)	P = 0.9998

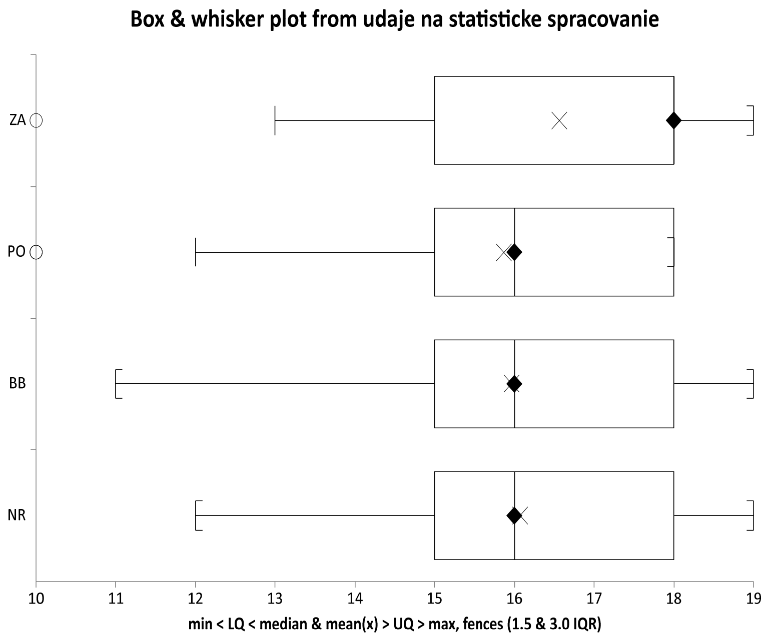

Figure 2 Median, quartile and range of variation of variables *from solving practical problems for 7th grade students*

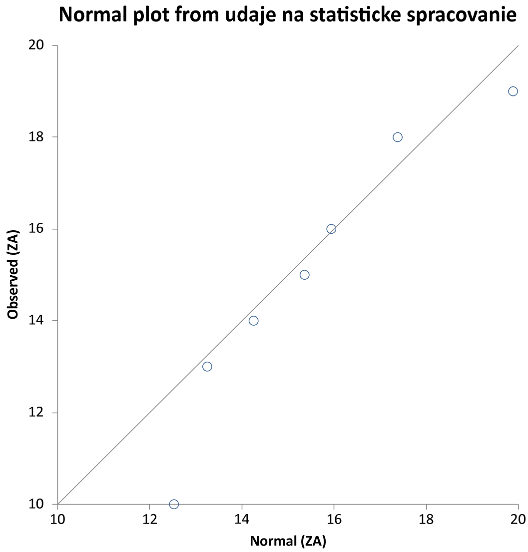

Figure 3 Assessment of the normality of random errors - graph of the normality of residuals in the research group (ZA region)

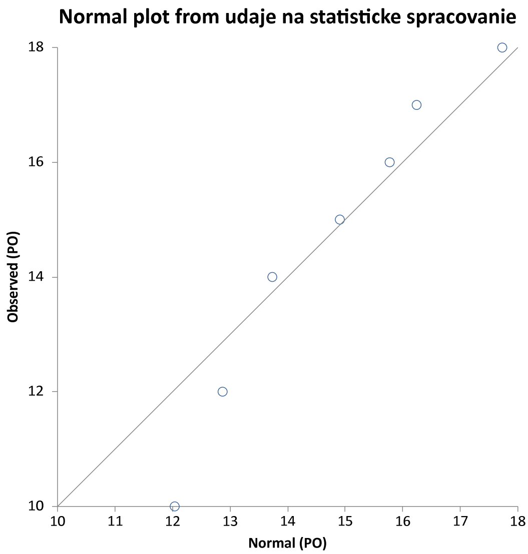

Figure 4 Assessment of the normality of random errors - graph of the normality of residuals in the research group (PO region)

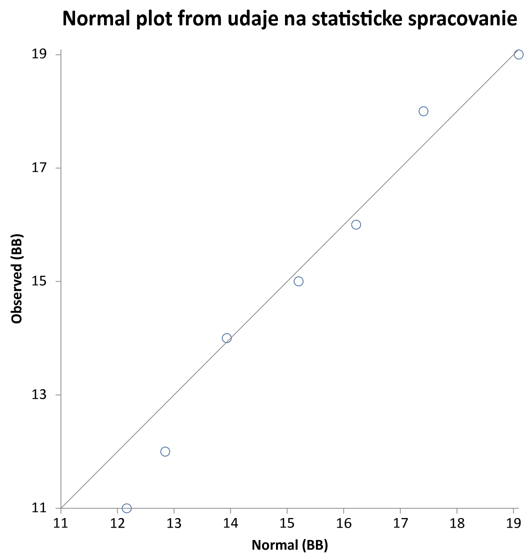

Figure 5 Assessment of the normality of random errors - graph of the normality of residuals in the research group (BB region)

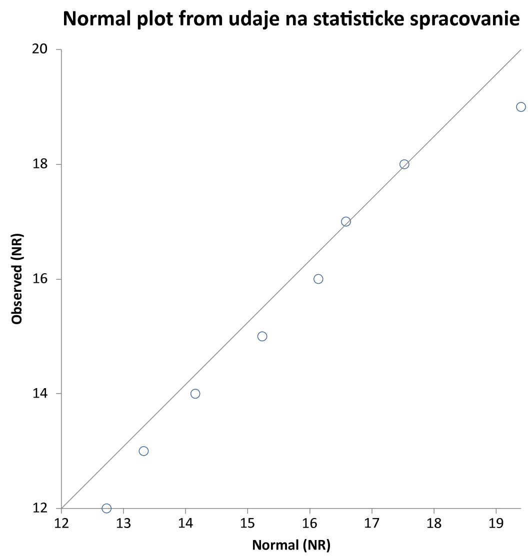

Figure 6 Assessment of the normality of random errors - graph of the normality of residuals in the research group (NR region)

Residual is the difference between the actual and the estimated value. In our case, the residuals have a normal distribution (Figure 3 to Figure 6) since the graph of the normality of the residuals is a line (the appearance of normal probability graphs is acceptable). We decided to use a non-parametric test also based on the requirement met (the variances between the research files are not the same). Based on the results, we decided to use the non-parametric Kruskal-Wallis test (Tables 4, 5). We reject hypothesis H_2, if $H \geq \chi^2_{1-\alpha\,(k-1)}$. For significance level $\alpha = 0.05$, the rejection area is determined by the quantile value $\chi^2_{1-\alpha\,(k-1)} = \chi^2_{0.95(1)}$ = 3.63316. This means that the value of the test statistic is not in the range of rejecting hypothesis H_2. We found that the calculated p-value is too high, i.e. hypothesis H_2 was confirmed at the significance level $\alpha = 0.05$ (95 %). We also examined whether there are statistically significant differences between regions in the Slovak Republic. The conclusion is that the performance of the students from the individual regions statistically does not differ. The calculated p-value is too high and therefore we not only confirm the hypothesis H_2, but can also conclude that the hypotheses $H_{2.1}$ and $H_{2.6}$ were not confirmed. Our research shows that differences between students from individual regions differ by descriptive statistics, but further research shows there are no statistically significant differences in the performance of students from individual regions.

Discussion and recommendations

Through pedagogical research, we have identified that the 7th-grade primary school students in the individual self-governing regions have acquired approximately the same theoretical knowledge but show only minor deficiencies in solving technical problems. We suggest placing more emphasis on assigning and solving technical problem tasks directly in the educational process in the subject of technology in the lower secondary education. This attention must be paid earlier in the technical education of children and students in preschool and primary education. The subject of skill acquisition among students in the psychomotor area has been addressed by several experts. Professor Ján Bajtoš has published several scientific studies in this area. He not only developed the taxonomy of educational goals in the psychomotor area but also prepared and analysed in detail the criteria for evaluating student performance in the psychomotor area. This research area in vocational didactics is important. The development and shaping of psychomotor skills is part of general education. Flitner[9] and Hurrelmann[10] dealt with the topic abroad. Psychomotor skills can be acquired in various forms of teaching. In the subject of technology, these include manual processing of technical materials, experimental activities (investigation of basic properties of technical materials), etc. The subject of technology serves to develop the skills and abilities necessary in later life for students' future professions or for different activities. Theoretical knowledge plays an important role because of its large influence on the performance of the students

[9] A. Flitner, Schulreform und praktisches Lernen. Neue Sammlung, 30, Jahrgang. 1990, č.3.

[10] K. Hurrelmann, Schulische Lernarbeit im Jugendalter. Zeitrschrift főr Pädagogik. 34, 1998, č.6.nového tisícročia. Prešov, PdF PU 2000.

in the psychomotor area. Educators should have a positive effect on the performance of the students. Helping students acquire knowledge and skills through independent search, research and experimentation. It is important to focus more on the level of skill acquisition and applying theoretical knowledge in practical activities and work skills. The teacher must ensure that the student can apply the theoretical knowledge acquired in practice and pay attention to the level of professional skills so that their occupational skill is competitive in the labour market. It is therefore important that the teacher correctly assesses and controls the student's willingness to learn, the quality and range of intellectual abilities and habits, motor skills, acquired knowledge and skills, activity and theoretical knowledge. The teacher should focus on ensuring that students are informed about what is expected of them during class, otherwise their learning initiative will be reduced. When evaluating psychomotor skills depending on the characteristics of the teaching process, it is necessary to take into account the appropriate choice of taxonomy level. Problem tasks should be focused on all levels of psychomotor education. In today's schools, assignments geared towards higher levels of learning according to the Simpson Taxonomy of Educational Goals are of great importance. Learning levels, the adaptation of activities, and creative activity are important. From the identified and processed data in the context of solving the given problem, we recommend:

- To design and create high-quality teaching texts in a way they have the greatest impact on achieving accomplishment in the psychomotor field of education, in solving typical and problematic school tasks.
- To transfer the activity to the students in solving practical tasks. The teacher should act as a helper and consultant.
- To apply as many activating methods as possible to the educational process, which would help students develop technical thinking and creativity.

We do not consider the discussed issue to be closed. There is a room for an in-depth study of the relationship between knowledge and skills in teaching vocational subjects.

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Badania wpływu wiedzy teoretycznej na nabywanie umiejętności praktycznych przez studentów w kształceniu technicznym

Praca naukowa koncentruje się na rozwiązaniu badań dotyczących korelacji wiedzy teoretycznej i umiejętności psychomotorycznych w rozwiązywaniu zadań problemów technicznych w gimnazjum. Przedmioty techniczne w szkole podstawowej dają uczniom nie tylko informacje teoretyczne, ale nacisk kładziony jest głównie na nabywanie umiejętności w obszarze psychomotorycznym. Badanie naukowe ma na celu scharakteryzowanie umiejętności psychomotorycznych. W drugiej części opracowania przedstawiamy schemat praktycznych zadań problemowych dla uczniów klas 7 gimnazjum. Następnie przeprowadziliśmy badania pedagogiczne mające na celu określenie poziomu umiejętności nabytych przez pedagogów w zakresie edukacji poznawczej i psychomotorycznej oraz wpływu wiedzy teoretycznej na nabywanie umiejętności praktycznych przez uczniów 7 klasy szkoły podstawowej.
Słowa kluczowe: technika, uczeń, podstawowy kurs spawania, egzekwowanie.

Research into the influence of theoretical knowledge on the acquisition of practical skills of students in a technical education

The scientific study focuses on solving the research on the correlation of theoretical knowledge and psychomotor skills in solving technical problem tasks in lower secondary education. Technical subjects at primary school give students not only theoretical information, but the emphasis is mainly on the acquisition of skills in the psychomotor area. The scientific study aims to characterize psychomotor skills. In the second part of the study, we present a scheme for practical problem tasks for 7th grade students in lower secondary education. Subsequently, we conducted pedagogical research to identify the level of skills acquired by educators in cognitive and psychomotor education and the influence of theoretical knowledge on the acquisition of practical skills in 7th-grade primary school students.
Keywords: technology, skills, student, knowledge, primary school.

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