Evelopment of Key Competences of Pupils in the Subject of Technology, Technical education

Daniel Kučerka, Michal Mrázek, Čestmír Serafín, Pavlína Částková, Hana Bučková, Michal Sedláček

Abstract

The contribution is focused on key competences and on the de-velopment of key competences of primary school pupils in the subject of Tech-nology (work-based teaching) in the Czech Republic and Slovakia. In the first part, the authors describe the concept of key competences, competences in the work of a teacher, and then the authors reflect on the key competences that pupils should achieve in the subject of technology after finishing primary school and show some possibilities for achieving these competences.

In the second part of the article, the authors used the questionnaire method to investigate what competencies students acquire during lessons in the subject of Technology. The research sample consisted of 3516 pupils from the Czech Re-public and Slovakia. When comparing the results, it is shown that approximately the same results are achieved in the subject of Technology and they also show the students' preference for materials in their work.

The aim of this contribution is to point out the importance of developing the key competences of pupils in the subject Technology, Work-based teaching and in the empirical part to try to show what competences pupils will acquire in pri-mary school.

Keywords: Competences and their development, technique, questionnaire, research methods

Introduction

Each individual acquires the competences to obtain an education and thus to inte-grate into society. Our society is undergoing constant changes, and this also applies to education. Employers' requirements are also undergoing such changes, and thus the requirements and view of the student are also changing. Based on these changes, questions arise related to the competencies required by employers from employees. But what are these competencies? For employees, the required competencies are essentially unknown to potential employers. However, it is required that the students possess key competences such that they can apply their knowledge and skills in vari-ous contexts and constantly complexly changing situations, and

ISSN: 0067-3064

therefore find em-ployment as employees or even employers in the future. Once again, we come to the question of what kind of competence is actually necessary to build in pupils for their professional and life application, for their full application in society. However, this key question is still not satisfactorily answered.

These questions concern not only pupils, but understandably or even primarily teachers, as they are the first to be responsible for preparing the new generation for life and work in society. Teachers, when they want to prepare pupils with the required knowledge and skills for professional practice, must necessarily be educated and they too must acquire new competences, which they can then pass on to pupils.

1 Key competences

In the Slovak Republic, starting in 2023, the transition to the new ŠVP will gradual-ly take place, where actors will be able to co-create the content and form of educa-tion.

They will learn and improve together through their own activity [33]:

• The student will be the main actor co-responsible for his education.

• The teacher will actively accompany the student and create opportunities for ef-fective learning, but at the same time he will have sufficient space and support for his own development.

• The parent will be invited to actively participate in the creation of the school's culture and to actively support the form of the educational process.

The future is inherently unpredictable; but by being attuned to some of the trends sweeping the world now, we can learn—and help our children learn—to adapt to, thrive in, and even shape whatever the future holds. Students need support in devel-oping not only knowledge and skills, but also attitudes and values that can lead them to ethical and responsible behaviour. At the same time, they need opportunities to develop their creative ingenuity to help propel humanity toward a bright future [28].

In the 21st century, the focus of education is shifting from memorizing lessons and memorizing isolated facts to the systematic and deliberate development of versatile and functional literacy in accordance with the demands of society, which can be applied to everyday personal and social life and to the fulfillment of personal, educa-tional, cultural and social needs. The reason is that the breadth of acquired knowledge is no longer enough [33].

The currently valid Framework Educational Program for Basic Education (hereaf-ter referred to as RVP ZV) [27] requires teachers and schools to develop knowledge, skills and attitudes in mutual synergy in teaching. Therefore, having competence means that "the student is equipped with a whole complex set of knowledge, skills and attitudes, in which everything is connected so advantageously that thanks to this, a person can successfully handle the tasks and situations he gets into in his studies, at work, in his personal life. life. Having a certain competence means that we can ade-quately orient ourselves in a certain natural situation, perform appropriate activities, adopt a beneficial attitude" [3]. In this context, the concept of competence is quite succinctly expressed by the behavioral definition, that competence is behaviour (ac-tivity or a complex of activities) that characterizes excellent performance in a certain area of human activity [13].

The reference framework according to the EU Council for Key Competences es-tablishes eight key competences: (Recommendation 2018/C 189/01)

• literacy
• multilingualism
• mathematical knowledge and knowledge in the field of natural sciences and en-gineering
• digital competences and competences in the field of technology
• skills in the field of interpersonal relations and the ability to acquire new compe-tencies
• active citizenship
• entrepreneurial thinking
• cultural awareness and expression.

The concept of key competences has also been used in the State Education Pro-grams for Basic Education (SR) since 2008 and in the Framework Education Pro-grams for Basic Education (CR) since 2004.

In order for a pedagogical employee to become a teacher, to acquire another part of competences in addition to the knowledge acquired at the university, i.e. skills, experience, etc. the adaptation process is not enough. Some experts speak of three or five years, and some speak of up to eight years of professional teaching experience. The teaching staff say that the pupils have changed. This results from their possibili-ties, which our generation did not have, i.e. a number of publications, traveling and learning about the world from a different point of view, or working with information technologies. From this point of view, the teacher must also change his approach to teaching preparation, to the course and results of pedagogical practice, and to this point of view and the description of the teacher's competencies. According to Hupková and

Petlák (2004), a teacher's pedagogical competences develop gradually and can be divided into five levels.

2 Research of the key competences of pupils in the teaching of Technology

The stimulus and at the same time the subject of our research was the analysis of available research focused on key competences in the teaching of technically orient-ed subjects in primary schools. We focused primarily on research that was carried out during the 21st century, primarily in the Czech Republic (CZ) and Slovakia (SK), but also abroad. To what extent are competencies the dominant and unifying intersec-tion of knowledge, skills, attitudes, etc. see the definition in part 1, it is necessary to perceive research on competences in technical subjects from a partial perspective. More complex research in terms of the scope of the issue is rather an exception [18], [15], [31], [24]. Many authors focus their research on sub-categories, contents or constructs falling under the constitution of key competences. We can mention pro-fessional and research works [2], [6], [21], [7], [35].

It is therefore obvious which trend of competency research in technical subjects prevails. We do not deviate from the trend, yet we see the absence of a more com-prehensively understood research as the main research problem. Therefore, our goal for the following years is to carry out partially connected, international, research investigations, which, after combining the individual parts, we will be able to present as a comprehensive set of knowledge about the development of key competences in technical subjects in primary schools.

In this contribution, we aim at an empirically supported description of the devel-opment of key competences through the technical skills of primary school pupils in CZ and SK. The partial intention is to point out the differences between the skills of pupils in both countries. On the one hand, we will present the results from individual countries from the pupils' point of view on the implemented and preferred curriculum, on the other hand we will try to demonstrate statistical differences in the skills of pupils in both countries, but we will also offer suggestions for discussion based on the results and their placement in the field-didactic context.

2.1 Research problem, key research questions, hypotheses

The research problem stems from the lack of empirically based information and knowledge about the current level of technical skills of elementary school students. The theory and practice of branch didactics lacks up-to-date answers to many key questions. Let's list selected questions. What technical skills do students acquire and at what level? What technical materials did the students learn to work with in class? Which technical materials are students interested in in class? In what conditions do students learn technical skills? We wanted to respond empirically to these selected questions. However, the scope of the research investigation is so extensive that we cannot fit it into one professional output. For this reason, we allow ourselves to narrow down our presented results. We determined 3 main research questions (MQ), which are also related to partial sub-questions (PQ).

Research questions

MQ1 What technical materials did the students learn to work with in the lesson?

PQ1.1 What materials did pupils in CZ learn to work with?

PQ1.2 What materials did pupils in SK learn to work with?

PQ1.3 The level of skills to work with technical materials among pupils in CZ and SK differs.

MQ2 Which technical materials would students prefer in class?

PQ2.1 What materials do pupils prefer in CZ?

PQ2.2 What materials do pupils prefer in SK?

PQ2.3 Are the preferences of technical materials different among CZ and SK pupils?

MQ3 Is there a discrepancy between the implemented and preferred curriculum?

From the mentioned research questions, it is evident that some can be answered using descriptive methods, others (PQ1.3; PQ2.3; MQ3) have the potential for confirmatory statistical verification of differences, requiring the determination of substantive hypotheses.

Hypotheses

H1.3 - The level of skills to work with technical SE materials among pupils in CZ and SK differs.

H2.3 - Do the preferences of technical materials differ among CZ and SK pupils?

H3 - There is a discrepancy between the implemented and preferred curriculum.

Note on H3: The implemented curriculum means the materials with which the students learned to work. Preferred curriculum means technical materials that students would welcome in the classroom.

2.2 Methodology

For the solution of the research, we chose the quantitative design of pedagogical research, which is commonly used in research into pedagogical reality with the aim of obtaining generalizable answers to research questions [16]. The target group was elementary school students in the 8th and 9th grade (age 13-14). The key quantita-tive method was a constructed questionnaire that contained 3 demographic items and 14 main items with sub-questions. In total, the questionnaire contained 29 items. The typology of items is mixed. Included are scale items, closed items with a choice of multiple answers, closed items with the option of open answers, items with an open answer. The scale items contained a scale of 1-5 expressing the opinion or the degree of agreement of the respondent with the content of the question. The construction of the questionnaire was divided into 3 phases: 1. creation of the questionnaire; 2. comments by experts from practice (teachers); 3. modification of the question-naire. When constructing the questionnaire, internal and external validity were taken into account in connection with the considered validity of the research and the inter-pretation of the results. Furthermore, adjustments to the items were conditional on content and construct validity. Subsequently, two verifications of the questionnaire took place on a smaller sample of respondents (April-June 2023). First in SK [23] and then in CZ [26]. As part of the verification, the reliability of the questionnaire was determined according to McDonald's ω and Cronbach's α, see tab. No. 2. The selec-tion of respondents was stratified random, for the reason that we first chose a com-pletely random selection of schools and distribution of questionnaires using online methods within both countries.Unfortunately, the cooperation of the schools and thus the return was very unfavourable. That's why we proceeded to stratify schools based on availability with the possibility of personal distribution (the criterion was driving distance). Stratification was carried out with the knowledge of reducing the representativeness of the research sample. After that, schools were randomly ap-proached within the set radius of the available reach. The same procedure was ap-plied in the research itself. Out of the total number of 5754 schools in CZ and SK, 1525 schools (26.5%) were selected in a stratified manner according to the propor-tional share for both countries. The data were obtained from official, national statis-tical offices, where the number of pupils in schools was also determined to calculate the ratio coefficient. On the basis of a successful power analysis, an estimate of the minimum sample size was determined with the expected power of the tests ("power" = 0.9), a low effect size (ES = 0.2) and a sample ratio coefficient of 2.178 [34], [20]. The expected confirmatory tests were determined by the parametric T-test and the non-parametric Mann-Whitney U-test. The minimum range of the entire research sample was calculated to be N= 2200.

Table 1 Number of respondents, return of questionnaires and reliability in research

Verification and research	Slovakia	Czech Republic
Number of verification respondents N (return rate)	376 (96 %)	313 (93,7 %)
Verification reliability ω (α)	0,844 (0,881)	0,823 (0,871)
Number of research respondents N (return rate)	1190 (96,7 %)	2435 (94,8 %)
Research of reliability ω (α)	0,897 (0,885)	0,878 (0,863)
Overall research reliability ω (α)	0,893 (0,880)	

2.3 Analyzed questionnaire items

To answer the set research questions in this contribution, 2 scale items of the ques-tionnaire with seven sub-questions were analyzed. Pupils chose on a scale of 1 = defi-nitely yes; 2 = rather yes, 3 = 50-50, 4 = rather no, 5 = definitely not. The five-point scale was deliberately chosen, because it was worked with the assumption that stu-dents in both countries are evaluated on a 5-point scale (grade) in schools, and it will therefore be more natural for them to express a degree of agreement or an evaluative opinion in this range.

Questionnaire items:

1. Do you think you have learned to work with materials? (a1-paper, b1-textile, c1-plastic, d1 modelling materials, e-1wood and natural materials, f1-metals, g1-glass) – each material had its own scale.
2. Which materials did you work with the most? (a2-paper, b2-textile, c2-plastic, d2 modelling materials, e2-wood and natural materials, f2-metals, g2-glass) – each material had its own scale.

2.4 Results of the research investigation

We chose two approaches to data evaluation. A descriptive approach was applied in an attempt to answer research questions MQ1; PQ1.1; PQ1.2; MQ2; PQ2.1; PQ2.2. As the main method, we chose the analysis of the descriptive characteristics of the data set, especially the comparison of average values. A confirmatory approach was chosen when evaluating hypotheses that are linked to research questions PQ1.3; PQ2.3; MQ1. As part of the evaluation of the hypotheses, two-tailed statistical hy-potheses were formulated. Null hypotheses were formulated in accordance with the hypothesis verification methodology [16], [8], i.e. the formulation of null hypotheses expressed the absence of differences between the compared groups of respondents. The Wilcoxon paired test and the two-sample Mann-Whitney U Test were applied to test the hypotheses [5]. The use of the parametric T-test was not possible due to fail-ure to meet the requirements of normality and homogeneity of variances. The verifi-cation of these requirements was solved using Fisher's, Levene's and Lilliefor's tests in the software Statistica, 2024. Most of the tests gave results of $p < 0.01\alpha$, therefore, normality or equality of variances was not proven. Post hoc power analysis for the application of Mann Whitney's tests was performed for a two-sample sample of respondents. Power of tests was detected (by G*Power) at power ($1-\beta$) range = 0.901~0.998 and Effect Size d range = 0.09~0.47 [10].

Table 2. Average values of responses to the item: Do you think you have learned to work with

Variable	Average CZ	Average SK	Diff. Averages	Average Total	Mean Total
a1) Paper	2,216	2,474	-0,258	2,301	2
b1) Textile	3,268	3,443	-0,175	3,325	3
c1) Plastic	3,214	3,545	-0,331	3,322	3
d1) Modelling mass	3,208	3,462	-0,254	3,291	3
e1) Wood	2,101	2,570	-0,469	2,255	2
f1) Metal	3,248	3,676	-0,428	3,389	3
g1) Glass	4,004	4,113	-0,109	4,040	5

Table 3. Average values of the answers to the item: With which materials did the work interest you the most?

Variable	Average CZ	Average SK	Diff. Averages	Average Total	Mean Total
a2) Paper	2,931	2,906	0,026	2,923	3
b2) Textile	3,357	3,363	-0,006	3,359	3
c2) Plastic	3,435	3,625	-0,190	3,497	3
d2) Modelling mass	3,156	3,157	-0,001	3,156	3
e2) Wood	2,239	2,516	-0,277	2,330	2
f2) Metal	3,239	3,461	-0,221	3,312	3
g2) Glass	3,785	3,843	-0,058	3,804	4

Based on the results shown in Tab. 3 and Tab. 4 we can descriptively answer selected research questions.

MQ1 – Within the collective evaluation Tab. 3, pupils in both countries learned to work with wood and natural materials the most. The second, most mentioned material was paper. On the contrary, the students learned to work with glass the hardest. In the case of a separate evaluation of both nationality groups, the results are similar, although individual partial differences can be observed.

PQ1.1 – In the Czech Republic, the order of materials does not differ from the collective evaluation. We can therefore formulate the answer to the research question in the same way as for MQ1.

PQ1.2 – In Slovakia, the order of materials differs from the collective evaluation. Pupils can work best with paper and slightly worse with wood. The pupils learned to work with glass the least. For other materials, the ranking differs, however, based on slight differences between the average values.

In comparison, however, we observe that students in CZ learned to work with all materials slightly better than students in SK

MQ2 – Within the collective evaluation Tab. 4 pupils were most interested in work, or rather they would prefer work with wood and natural objects. Then with paper. The least interesting and preferred material is glass.

PQ2.1 – In the Czech Republic, the order of materials does not differ compared to the collective evaluation. We can therefore formulate the answer to the research question in the same way as for MQ2.

PQ2.2 – In Slovakia, the order of materials does not differ from the collective evaluation. Again, we can formulate the answer to the research question in the same way as for MQ2.

Looking at the individual preferences, it is clear that students in the CZ would prefer materials such as wood, metal, plastic, or glass more. Working with textiles and modelling materials is practically the same preference of students from both countries. Pupils in Slovakia would prefer slightly more work with paper. The most significant difference in the negative increase in the value of preferences compared to the value of learning to work with the material is clear in the case of paper, especially in the case of CZ pupils.

We will prove whether the mentioned differences in research questions are relevant and significant in the following text.

Verification of hypotheses

A 5% level of significance (α = 0.05) was established when testing the hypotheses.

H1.3 - The level of skills to work with technical materials differs among pupils in CZ and SK.

Table 4. Mann Whitney tests of differences in students' skills to work with individual materials

Variable	Mann-Whitneyův U Test (Data_complet) By variable. Nationality Marked tests are significant at the level of p<.05000								
	Rank sum. CZ	Rank sum. SK	U	Z	p-value	Z	p-value	Valid N CZ	Valid N SK
a1) Paper	4263911	2308214	1298081	-5,09439	0,000000	-5,29439	0,000000	2435	1190
b1) Textile	4297883	2274242	1332053	-3,94630	0,000079	-4,04704	0,000052	2435	1190
c1) Plastic	4204527	2367599	1238697	-7,10130	0,000000	-7,27684	0,000000	2435	1190
d1) Modelling mass	4264154	2307971	1298324	-5,08618	0,000000	-5,21464	0,000000	2435	1190
e1) Wood	4137697	2434429	1171867	-9,35982	0,000000	-9,76486	0,000000	2435	1190
f1) Metal	4156777	2415348	1190947	-8,71500	0,000000	-8,95443	0,000000	2435	1190
g1) Glass	4315759	2256367	1349929	-3,34220	0,000831	-3,64499	0,000267	2435	1190

All values of calculated significances in Tab. 4 are $p < 0.05$ and even meet the more strictly established level ($\alpha = 0.01$). We can therefore state that we accept the alternative hypothesis about the difference in the level of pupils' skills to work with individual materials in CZ and SK. The results of the differences are statistically significant, while from Tab. 3 it can be seen that, in comparison of the average values, pupils in CZ are better at it than pupils in SK for all the surveyed materials. Differences become min. values |0.109| and max. values |0.469|. From the point of view of significance for practice, we consider values of differences Xdiff< 0.3 to be less significant, in other words harder to be identified by the teacher in practice. These differences could become significant in hypothetical cases, e.g. if the difference arises for an individual when deciding on a grade, when the student's skills are really on the border of the difference between two grades. Difference values of Xdiff> 0.3 are considered to be moderately to completely significant for practice. The teacher should already be able to identify such partial differences between pupils and further use them to optimize teaching, also with regard to the individual needs of the pupil. Moderately significant differences in favour of CZ pupils were identified for the materials wood, metal and plastic. Differences in average values of Xdiff> 0.6 do not occur in the results, however, we would consider these differences to be crucial for practice, because with such a difference, the teacher should already be able to clearly determine at what level the student fulfills the expected learning outcomes.

H2.3 - Do the preferences of technical materials differ among CZ and SK pupils?

Table 5. Mann Whitney tests of differences in pupils' preferences for working with individual materials

Variable	Mann-Whitneyův U Test (Data_complet) By variable. Nationality Marked tests are significant at the level of p<.05000							
	Rank sum. CZ	Rank sum. SK	U	Z	p-value	Z	p-value	Valid N CZ	Valid N SK
a2) Paper	4431911	2140214	1431569	0,58315	0,559792	0,59613	0,551089	2435	1190
b2) Textile	4411154	2160972	1445324	-0,11832	0,905817	-0,12165	0,903175	2435	1190
c2) Plastic	4292052	2280073	1326222	-4,14336	0,000034	-4,27768	0,000019	2435	1190
d2) Modelling mass	4413381	2158745	1447551	-0,04305	0,965658	-0,04416	0,964780	2435	1190
e2) Wood	4257070	2315056	1291240	-5,32560	0,000000	-5,54433	0,000000	2435	1190
f2) Metal	4286494	2285632	1320664	-4,33121	0,000015	-4,45431	0,000008	2435	1190
g2) Glass	4370170	2201955	1404340	-1,50336	0,132748	-1,59447	0,110833	2435	1190

All values of calculated significances in Tab. 5 are not significant $p < 0.05$ at the selected level of significance. We can therefore state that we cannot reject the null hypothesis about the difference in pupils' preferences for working with materials in CZ and SK. The results of the differences are statistically significant only for variables c2, e2, f2, while from Tab. 4, it can be seen that the average values of preference for materials such as wood, metal and plastic are higher among students in CZ than among students in SK. The mentioned differences Xdiff< 0.3 are, however, less significant in terms of significance for practice. For teachers, these differences in teaching preferences are increasingly difficult to recognize and hardly grasp. On the contrary, pupils in both countries prefer working with paper, textiles, modelling materials or glass.

H3 - There is a mismatch between the implemented and preferred curriculum.

The hypothesis was verified for each nationality separately, because a summary comparison would be meaningless due to the difference in the national (planned) curriculum. In this case, the summary verification of differences would correspond significantly less with the pedagogical reality in individual countries. Therefore, Wilcoxon's tests were processed to verify the differences between the implemented and preferred curriculum in CZ and SK separately.

Table 6. Wilcoxon's pair tests differences between the implemented and preferred curriculum in CZ

A pair of variables	Nationality=1 (CZ) Wilcoxon's pair test (Data_complete) Marked tests are significant at the level p <,05000				
	Platný	T	Z	p-values	Correlation "r"
a1 & a2	1431	151553,5	23,07296	0,000000	0,509857
b1 & b2	1239	335726,0	3,83922	0,000123	0,630584
c1 & c2	1229	265397,5	9,04123	0,000000	0,624245
d1 & d2	1198	332246,0	2,24208	0,024957	0,634686
e1 & e2	1121	254235,0	5,55300	0,000000	0,622345
f1 & f2	1146	320872,0	0,69098	0,489577	0,675953
g1 & g2	968	151113,0	9,58361	0,000000	0,615006

Differences in Tab. 6 were not statistically confirmed at the 5% significance level for only one pair of variables (metals). Pupils expressed the harmony between the implemented and preferred curriculum for working with metals. In other words, the students learned to work with metals as much as they are interested in working with metals, or rather how they prefer this work. For other pairs of variables, statistically significant differences were identified, as the detected significance was $p < 0.05$. On the one hand, we can state that relatively in the dominant majority of pairs of variables, students see a discrepancy between the implemented and preferred curriculum. On the other hand, we cannot unequivocally accept the hypothesis about

 ISSN: 0067-3064

the difference between the implemented and preferred curriculum due to the confirmation of the agreement of one pair of variables.

However, as we can further in Tab. 6 can be seen, there is a relatively consistent relational tendency between the evaluation of students' own skills and their interest, that is, the preference for working with specific materials. Although we have demonstrated statistical differences between the implemented and preferred curriculum, they are not practical according to the analysis of the average values from Tab. 3 and Tab. 4 (the differences are not shown in the tables; they were calculated from the 1st column – Average CZ) these differences are clearly understandable (most XDiff_aver values < 0.3), except for the difference between the implemented and planned curriculum when working with paper, when the difference reached a value of 0.715, which also explains the lower value of the correlation coefficient "r" = 0.509 compared to the others. Thus, it is possible to support the evaluation of PQ1.1, that the students consistently express (even with a certain structural relational agreement between the variables) that they have learned to work with wood the most and at the same time they like these activities the most.

Table 7. Wilcoxon's pair tests of differences between implemented and preferred curriculum in SK

A pair of variables	Nationality =2 (SK) Wilcoxon's pair test (Data_ complete) Marked tests are significant at the level p <,05000				
	Valid	T	Z	p-values	Correlation "r"
a1 & a2	714	74390,0	9,65617	0,000000	r < 0,5
b1 & b2	668	100830,0	2,18316	0,029025	r < 0,5
c1 & c2	636	92903,0	1,80774	0,070647	r < 0,5
d1 & d2	653	71298,0	7,35450	0,000000	0,548679
e1 & e2	658	102824,5	1,14411	0,252577	0,532694
f1 & f2	611	66250,0	6,23866	0,000000	0,60238
g1 & g2	546	47521,5	7,36003	0,000000	r < 0,5

For pupils in SK according to Tab. 7, there were no statistically proven differences at the 5 % significance level for two pairs of variables (wood and plastics). The compliance between the implemented and preferred curriculum was expressed by the students in the skills to work with plastics and wood or natural materials. For other pairs of variables, statistically significant differences were identified, as the detected significance was $p < 0.05$. It is therefore obvious that even pupils in SK tend to express a discrepancy between the implemented and preferred curriculum. Nevertheless, we cannot unequivocally accept the hypothesis about the difference between the implemented and preferred curriculum due to the confirmation of the agreement of the two pairs of variables.

Although we did not verify the relative difference between the correlation coefficients, simply by comparing Tab. 7 and 8 we find the following. Among pupils in SK, the consistent relational tendency is lower than among pupils in CZ between the assessment of pupils' own skills and their interest, i.e. preference for working with specific materials. Only for the variable working with metals do we see a relational tendency value of "r" > 0.6 between the implemented and preferred curriculum.

Therefore, although we have demonstrated statistical differences between the implemented and preferred curriculum for five pairs of variables, according to the analysis of the average values from Tab. 3 and Tab. 4 (the differences are not shown in the tables; they were calculated from the 2nd column – Average SK) these differences are clearly perceptible (most XDiff_aver values < 0.3), except for the differences between the implemented and planned curriculum when working with paper and modelling materials, when the differences reached values of 0.432 and 0.305. The support of results by relational consistency is not as obvious as in the results of students in CZ.

3 Discussion of results and conclusion

Comparing our results with previous research on the regional scale of both coun-tries concerned is practically impossible. We could present here a comparison with students' qualification works or other research findings, but with a focus on a differ-ent level of schools, but we perceive such a procedure as scientifically incorrect. Therefore, with the comparison, we turn to the theoretical level, establishing optimal or ideal conditions for determining the planned curriculum. Here, authors from the pedagogic or didactic community agree that the development of skills when working with technical materials is ideal to be implemented multi-materially using traditional materials such as paper and cardboard [22], [11], as well as wood, plastics, metals [7], [17], [4] or textiles [12]. Technical materials such as glass [30] or modelling mate-rials [32] are mentioned very sporadically by the authors. From a comparative per-spective, our research showed a certain agreement with the theory. In their answers, the students mostly declared that they learned to work with all the mentioned materi-als at different levels. MQ1: Whether it is pupils in CZ or SK, in the subjects. Work activities (CZ) and Technology (SK) are dominated by work with wood, respectively, the students learned to work with this material the most. The secondary material is paper and cardboard. The pupils learned to work with glass the least. The more fre-quent inclusion of technical activities with wood, paper and cardboard is common in primary schools. The advantages of these materials include relatively good availabil-ity and, above all, their less demanding processing compared to e.g. metals or glass. MQ2: The preference for technical materials, or interest in working with them, is simi-lar in both countries. Wood dominates again, followed by paper and cardboard. The least preferred material is glass. The popularity of working with wood among pupils in the Czech Republic was documented by a partial survey [17]. As the sample of re-spondents in the said survey was small, it fairly reliably represents a long-term trend in the context of the results we found. Currently, it will be interesting to see whether the trends will change, for example, in favor of a greater emphasis on the use of plas-tics in teaching due to the incorporation of modern technologies into educational concepts such as 3D printers [25], [1]. MQ3:Inconsistency between the implemented and preferred curriculum was not clearly demonstrated in individual countries for all examined materials. Although most of the examined technical materials were statis-tically different. However, the discussion gains importance from the point of view of practical significance. When performing the tests, the test power $(1-\beta) > 0.901$ was found, but in almost all tests the ES $d < 0.4$. From this we can conclude that the per-formed tests were accurate, but the significance for pedagogical practice is low (comp. [19]). The differences of the average values XDiff_aver< 0.3 for most pairs of variables also correspond to this. For teachers in practice, these differences are very difficult to grasp and apply. However, it can be helpful for practice in schools in the Czech Republic to find that pupils show a relatively consistent relational tendency between what they learn and what they are interested in.

We are aware of the limits of the reporting values of the results of our research, mainly due to the forced execution of a randomly stratified selection of the research sample. Therefore, we assume that the results themselves may deviate slightly from the base set (the studied population). Despite this, we believe that we have taken all scientifically necessary steps to achieve sufficient representativeness of the research and the relevance of the results, which reflect the current conditions of pedagogical practice. We do not currently consider the research results to be revolutionary, but rather unique in a way, as they are empirically based. Thus, scientifically relevant and beneficial for field theory in terms of documentation of the current conditions for the development of technical skills in the context of key competences in CZ and SK.

The research results show that the most popular material for pupils in the Slovak Republic and the Czech Republic is wood. The level of competence among pupils is different. This state depends on the teachers' approach to the subject of technology, technical education, but also on the students' approach and interest. The most im-portant factor is the motivation of the students by the subject teacher and the use of the principle of combining school with practice, i.e. theory with practice.

4 Acknowledgment

The contribution was supported by the project GDF_PdF_2023_03 - Development of key competences through the use of didactic means of technical education - teacher 21

5 References

[1] Abu Khurma, O., Ali, N. and Swe Khine, M. (2023) “Exploring the impact of 3D printing integration on STEM attitudes in elementary schools,” Contemporary Educational Technolo-gy, 15(4), p. ep458. Available at: https://doi.org/10.30935/cedtech/13568.

[2] Andersson, I.-M. et al. (2014) “Knowledge and Experiences of Risks among Pupils in Vo-cational Education,” Safety and Health at Work, 5(3), pp. 140–146. Available at: https://doi.org/10.1016/j.shaw.2014.06.002.

[3] Bělecký, Zdeněk et al. (2007) “Klíčové kompetence v základním vzdělávání.“ Praha: Výzkumný ústav pedagogický. ISBN 978-80-87000-07-6

[4] Björkholm, E., Andrée and M., Carlgren, I. (2016) “Exploring technical knowledge in the primary technology classroom.“ Australasian Journal of Technology Education, 1. Available at: https://ajte.org/index.php/AJTE/article/view/23/17

[5] Bürkner, P.-C., Doebler, P. and Holling, H. (2017) “Optimal design of the Wilcoxon–Mann–Whitney-test,” Biometrical Journal, 59(1), pp. 25–40. Available at: https://doi.org/10.1002/bimj.201600022.

[6] Částková, P. and Kropáč, J. (2015) “Pupil’s Self-Concept in Inquiry-based Technical Educa-tion,” Procedia - Social and Behavioral Sciences, 186, pp. 776–784. Available at: https://doi.org/https://doi.org/10.1016/j.sbspro.2015.04.046.

[7] Dostál, J. (2023) Comparison of the National Curriculum from the STEM Perspective with Focus on Technologies and Engineering in the Czech Republic, Poland and Slovakia. TEM Journal. 12(1), pp. 566-577. Available at: https://doi.org/10.18421/TEM121-67

[8] Emmert-Streib, F. and Dehmer, M. (2019) “Understanding Statistical Hypothesis Testing: The Logic of Statistical Inference,” Machine Learning and Knowledge Extraction, 1(3), pp. 945–961. Available at: https://doi.org/10.3390/make1030054.

[9] Glăveanu, V.P. (2018) “Educating which creativity?,” Thinking Skills and Creativity, 27, pp. 25–32. Available at: https://doi.org/https://doi.org/10.1016/j.tsc.2017.11.006.

[10] Happ, M., Bathke, A.C. and Brunner, E. (2019) “Optimal sample size planning for the Wil-coxon-Mann-Whitney test,” Statistics in Medicine, 38(3), pp. 363–375. Available at: https://doi.org/https://doi.org/10.1002/sim.7983.

[11] Honzíková, J. (2015). “Psychomotorické dovednosti jako součást polytechnické výchovy.“ Trends in Education, 8(1), 132-136. Available at: https://tvv-journal.upol.cz/artkey/tvv-201501-0031

[12] Honzíková, J. (2022). “Natural textile fibres in education for the future. “Technika a vzde-lávanie, 11(2). pp. 21-29. Available at: https://www.fpv.umb.sk/app/cmsFile.php?disposition=i&ID=21330

[13] Hrmo. R., Turek, I., (2023) Návrhsystémukľúčovýchkompetencií. [online] 2024. [cit. 21. 1. 2024]. Dostupné na internete: https://www.mtf.stuba.sk/buxus/docs/internetovy_casopis/2003/2/hrmo2.pdf

[14] Hupková, M., Petlák, E., (2004) “Sebareflexia a kompetencie v práciučiteľa.“ Vvyda-vateľstvo IRIS? 2004.135s. ISBN 80-89018-77-7

[15] Hrmo, R., Škrabánková, J., Kučerka, D. A Kmec, J. (2016) “Kľúčové kompetencie v tech-nických a prírodovednýchpredmetov.“ Monografia. 1. vyd. Varšava: WyzszaSko-laMenedzerska w Warszwie. ISBN 978-83-7520-204-5

[16] Chraska, M. (2016) Metody pedagogického výzkumu: základy kvantitativního výzkumu. 2nd edn. Praha: Grada.

[17] Janu, M. and Podlahová, L. (2016) “Case study realization of workshop of working educa-tion at primary school in Dub nad Moravou.” Trends in Education, 9(1), pp. 115–119. Available at: https://doi.org/10.5507/tvv.2016.016.

[18] Juhasova, J. (2014) “Development of key competencies of pupils technical vocational educa-tion.” Journal of Technology and Information Education, 6(2), pp. 79–84. Available at: https://doi.org/10.5507/jtie.2014.021.

[19] Kacmaz, G. and Dubé, A.K. (2022) “Examining pedagogical approaches and types of math-ematics knowledge in educational games: A meta-analysis and critical review,” Educational Research Review, 35, p. 100428. Available at: https://doi.org/10.1016/j.edurev.2021.100428.

[20] Kang, H. and Huh, S. (2021) “Sample size determination and power analysis using the G*Power software,” jeehp, 18(0), p. 17. Available at: https://doi.org/10.3352/jeehp.2021.18.17.

[21] Kokko, S. and Räisänen, R. (2019) 'Craft education in sustaining and developing craft tradi-tions: Reflections from Finnish craft teacher education', Techne Series: Research in Sloyd Education and Craft Science A, 26(1), pp. 27–43. Available at: https://journals.hioa.no/index.php/techneA/article/view/2911

[22] Kropáč, J. (2004). “To the problem of an integrated concept of education of general technical subjects.“ e-Pedagogium, 4(1), 60-71. Available at: https://e-pedagogium.upol.cz/artkey/epd-200401-0007

[23] Kucerka, D. et al. (2024) “Development of key competences of students in the subject of technology in primary schools,” R&E-SOURCE, 1(1), pp. 117–130. Available at: https://doi.org/10.53349/resource.2024.is1.a1248. Source: open online journal for research and education. ISSN:2313-1640

[24] Martínez-Borreguero, G., Naranjo-Correa, F.L. and Mateos-Núñez, M. (2022) “Cognitive and Emotional Development of STEM Skills in Primary School Teacher Training through Practical Work,” Education Sciences, 12(7). Available at: https://doi.org/10.3390/educsci12070470.

[25] Moc, P. (2021). Statut quo technical education by computer – controled machines at primary schools and secondary schools. Journal of Technology and Information Education, 13(1), pp. 1-22. Available at: https://doi.org/10.5507/jtie.2021.002

[26] Mrazek, M. and Kucerka, D. (2024) “Development of key competencies of students in the subject of technolgy in primary schools in Czech republic” Journal of Technology and In-formation Education, [in print].

[27] MŠMT ČR. Rámcový vzdělávací program pro základní vzdělávání [online]. Praha: MŠMT ČR, 2023. [cit. 2024-01-01]. Dostupný z: https://www.msmt.cz/vzdelavani/zakladni-vzdelavani/ucebni-dokumenty

[28] OECD Learning Compass 2030. [online] 2024. [cit. 20. 3. 2024]. Dostupné na internete: https://www.oecd.org/education/2030-project/teaching-and-learning/learning/megatrends/#d.en.533690

[29] Odporúčanie 2018/C 189/01. ODPORÚČANIE RADY z 22. mája 2018 o kľúčových kompetenciách pre celoživotné vzdelávanie.[online] 2024. [cit. 20. 3. 2024]. Dostupné na internete: https://eur-lex.europa.eu/legal-content/SK/TXT/PDF/?uri=CELEX:32018H0604(01)&from=en

[30] Pecina, P. (2017) Fenomén odborného technického vzdělávání na středních školách. 1st edn. Brno: Masarykova univerzita.

[31] Soltes, J. (2016) “Key responsibilities in the process of pupils’ independent work in the sub-ject of technology.” Journal of Technology and Information Education, 8(2), pp. 117–133. Available at: https://doi.org/10.5507/jtie.2016.031.

[32] Simbartl, P. (2017) “Modelling Materials on the Primary School as the Element for an Im-provement of Fine Motor Skills and a Support of Creativity,” Edukacja – Technika – In-formatyka, 21(3), pp. 82–86. Available at: https://doi.org/10.15584/eti.2017.3.10.

[33] Štátny vzdelávací program 2023 (ŠVP, 2023). [cit. 2024-01-01]. Dostupný z: https://vzdelavanie21.sk/digitalny-statny-vzdelavaci-program/

[34] Thorlund, K. and Mills, E.J. (2012) “Sample size and power considerations in network me-ta-analysis,” Systematic Reviews, 1(1), p. 41. Available at: https://doi.org/10.1186/2046-4053-1-41.

[35] Zacok Lubomir et al. (2024) Research on the degree of correlation between knowledge and skills to solve problem taska in technical education. Trends in education, 16(1), pp. 29–39. Available at: https://doi.org/10.5507/tvv.2023.006.

6 Authors

Daniel Kučerka (email: daniel.kucerka@upol.cz).

Michal Mrázek (email: michal.mrazek@upol.cz).

Čestmír Serafín (email: cestmir.serafin@upol.cz).

Pavlína Částková (email: pavlina.castkova@upol.cz).

Hana Bučková (email: hana.buckova@upol.cz).

Michal Sedláček (email: michal.sedlacek@upol.cz).