COMPARING PUPILS' PERCEPTIONS OF TECHNOLOGY AND CHEMISTRY: INSIGHTS FROM SEMANTIC DIFFERENTIAL ANALYSIS

Kristína KOMÁROVÁ, Univerzita Konštantína Filozofa v Nitre, Slovenská republika
Gabriel BÁNESZ*, Univerzita Konštantína Filozofa v Nitre, Slovenská republika

Přijato: 23. 4. 2025 / Akceptováno: 16. 12. 2025
Typ článku: Teoretická studie
DOI: 10.5507/jtie.2025.015

Abstract: The research focuses on the analysis of the attitudes of primary school pupils (ISCED 2) in the Slovak Republic towards the subjects of Chemistry and Technology. These subjects are an important part of the education system and affect not only the knowledge of students, but also their future orientation in the field of natural and technical sciences. The objective of the research was to find out how pupils perceive both subjects and what characteristics they attribute to them, using the semantic differential method, which allows the assessment of subjective attitudes based on bipolar adjective scales. The research examined the attitudes of 105 pupils in the seventh to ninth grades of primary schools (ISCED 2). The results showed that the subject of Technology is perceived mostly positively – pupils consider it practical, innovative and organized. Chemistry is perceived as more demanding, abstract and theoretical, but pupils still rated it as interesting and active. Some aspects of Chemistry, such as laboratory experiments, can be interesting, but at the same time, the subject is often associated with the need to memorize a lot of facts and chemical formulas, which can be demotivating for some pupils.

Key words: semantic differential, subject chemistry, subject technology, attitude.

POROVNANIE VNÍMANIA TECHNIKY A CHÉMIE ŽIAKMI: POZNATKY Z ANALÝZY POMOCOU SÉMANTICKÉHO DIFERENCIÁLU

Abstrakt: Výskum sa zameriava na analýzu postojov žiakov základných škôl (ISCED 2) v Slovenskej republike v rámci vyučovacích predmetov chémia a technika. Tieto predmety sú dôležitou súčasťou vzdelávacieho system a ovplyvňujú nielen vedomosti žiakov, ale aj ich budúcu orientáciu v oblasti prírodných a technických vied. Cieľom výskumu bolo zistiť, ako žiaci vnímajú oba predmety a aké charakteristiky im pripisujú,

*Autor pro korespondenci: gbanesz@ukf.sk

pričom bola využitá metóda sémantického diferenciálu, ktorá umožňuje hodnotenie subjektívnych postojov na základe dvojpólových adjektívnych škál. V rámci výskumu sa skúmali postoje 105 žiakov siedmeho až deviateho ročníka základných škôl (ISCED 2). Výsledky ukázali, že predmet technika je vnímaný prevažne pozitívne – žiaci ho považujú za praktický, inovatívny a organizovaný. Chémia je vnímaná ako náročnejšia, abstraktnejšia a teoretickejšia, avšak stale ju žiaci hodnotili ako zaujímavú a aktívnu. Niektoré aspekty chémie, ako laboratórne experimenty, môžu vzbudzovať záujem, no zároveň sa predmet často spája s potrebou zapamätať si množstvo faktov a chemických vzorcov, čo môže byť pre niektorých žiakov demotivujúce.

Kľúčové slová: sémentický diferenciál, vyučovací predmet chémia, vyučovací predmet technika, postoj.

1 Introduction

The relationship and attitudes of pupils towards school subjects can vary. There are subjects that pupils mention as their favorites, and there is a group of subjects that are considered less popular, often due to their abstract nature. In our paper, we present the attitudes of pupils towards two subjects taught in primary schools (ISCED 2) in the Slovak Republic: Chemistry and Technology.

Chemistry, as a subject representing a natural science discipline, is often categorized as an abstract subject. Pupils learn about the composition of chemical elements and substances and gain initial information about chemical reactions, among other topics. Mastering the basics of Chemistry is a necessary prerequisite for successful study of the subject at higher levels of education, especially at grammar schools and secondary vocational schools focused on preparing professionals for the chemical industry. Chemistry teaching involves both theoretical elements and practical activities such as chemical experiments and laboratory work.

Technology as a subject in primary schools is considered an integrative subject. Its content integrates various natural science disciplines such as physics, chemistry, biology, and of course, mathematics. The different areas of Technology make use of the foundations of natural science subjects. Technology in primary school is predominantly a practical subject. Successfully mastering the basic knowledge in the subject of Technology—such as technical drawing, technical materials, electronics, basics of automation, etc.—is a necessary prerequisite for further study at secondary vocational schools with a technical focus.

2 Theoretical background

The issue of comparing pupils' attitudes toward selected subjects has been addressed by several authors. From the research studies focusing on measuring students' attitudes, we present the following examples.

Within the framework of the theoretical background, we focused on the study by Osborne (2003), which examined pupils' attitudes toward science and the factors influencing these attitudes. The aim of the study was to understand the reasons behind the persistent decline in the number of pupils choosing to study science and to identify ways to increase their interest. Osborne examined what is meant by "attitudes toward science," the challenges associated with their measurement, and what is known about pupils' attitudes toward science. The study also analyzed the influence of various factors, such as gender, teachers, curricula, and cultural variables, emphasizing the importance of teaching quality and motivation in shaping pupils' attitudes. The research highlights the need for further investigation into aspects of science teaching that make school science engaging and interesting for pupils.

Furthermore, we were interested in the study conducted by Rusek, Chytrý, and Honskusová (2019), which focused on examining the impact of chemistry education on students' perception and understanding of the Nature of Chemistry (NoC), as well as their attitudes toward this school subject. The research involved 282 ninth-grade students at the end of their compulsory education. The respondents answered a set of open-ended questions concerning their understanding of the nature of chemistry, their perception of the importance of various chemistry topics, the topics they found interesting, and their overall evaluation of chemistry as a school subject. The collected responses were subsequently analyzed using the open coding method. The authors of the study conclude that most students do not have a fully developed understanding of the nature of chemistry as a scientific discipline. The evaluation of chemistry as a school subject among the majority of respondents was situated at the mid-point of a five-point Likert scale, indicating a generally neutral to slightly positive attitude. The findings of this study represent an important contribution to understanding the factors that influence students' perception and conceptualization of chemistry within the educational context (Rusek, Chystrý, Honskuová, 2019).

We also report on a study involving 223 first-year high school students from Slovak cities of various sizes, who evaluated science subjects and teaching in primary school using a 21-item questionnaire with a five-point scale. The aim was to assess students' interest in chemistry, its relevance for life and future careers, differences between genders, and the relationships between teaching methods and students' interest. The results indicated a moderate to low level of interest, with variations depending on gender and teaching approach, while more active and interactive methods were associated with higher interest. The study highlights the importance of a constructivist, student-centered approach that promotes independent thinking, discussion, discovery, and practical application of knowledge, which can enhance students' motivation and engagement in learning chemistry (Veselský, Hrubišková, 2009).

One of the studies that examined attitudes toward the subject of Chemistry was conducted by Kubiatko (2016), titled *The Semantic Differential as One of the Possibilities for Investigating Attitudes Toward Chemistry in Lower Secondary School Pupils*. The author used a questionnaire developed by Bauer (2008) as the research method, which defines four dimensions: interest, fear, difficulty, and emotional satisfaction. The author set the interval <1,6>, within which the subject of Chemistry is perceived as neutral, negative, or positive. If the score ranged between <3.5; 4.5>, Chemistry was considered perceived neutrally. A score above 4.5 indicated a positive perception, while a score below 3.5 indicated a negative perception of the subject. The research results showed that chemistry was perceived as a neutral subject, with a score of $x = 4.13$. Furthermore, the results revealed that students found Chemistry to be interesting, acceptable, understandable, and demanding. (Kubiatko, 2016)

Another study focusing on the issue of the semantic differential method was published in the article *Semantic Differential Method as a Pedagogical Diagnostics Tool in University Learning Process* (2018). The main objective was to examine the perception of the educational process in the subject of chemistry at the university level using the semantic differential method. It was found that Chemistry was perceived by university students as classical, unchanging, theoretical, and dull. (Mezentseva, Svidzinskaya, 2018)

A further study using the semantic differential method to determine students' motivation toward the subject of Chemistry was conducted by the Saint-Petersburg University of State Fire Service of EMERCOM in Russia. The findings showed that students at the mentioned university lacked motivation to acquire knowledge in Chemistry and largely perceived it as uninteresting. (Svidzinskaya et al., 2019)

Similarly to the subject of Chemistry, research has also been conducted on the attitudes toward technical subjects. Uhlířová's study (2018) focused on identifying teachers' attitudes toward using educational technologies in teaching natural sciences. A total of 172 teachers expressed their attitudes toward computer technology and its use in science lessons. The research results indicated the lowest attitude score related to the computer itself and to obtaining new information through computers. The highest variation in attitudes among respondents was found in relation to the use of computers and acquiring new information through them (standard deviation was 1.28). The author concludes that teachers are still not convinced of the value of implementing educational technologies in the teaching process at primary schools.

Another study by Bertea (2009) dealt with attitudes in the context of technology. The main objective was to analyze students' attitudes toward e-learning in Romania. The research focused on analyzing the following areas: the need for advanced technical experience, attitudes toward e-learning, and time management. The results showed a correlation between technical skills and students' approach to e-learning. They also indicated that attitude was influenced by the time spent using a computer and the need for advanced technical skills.

The final study mentioned is by Kahveci (2015), which aimed to explore high school students' attitudes toward Chemistry education, focusing on both intellectual and emotional perceptions of the subject. For this purpose, a shortened version of the ASCIv2 questionnaire (Attitude toward the Subject of Chemistry Inventory version 2) was used. After translation and cultural adaptation, the questionnaire was administered to 503 students from four public high schools in Turkey. A subsequent factor analysis confirmed the tool's two-factor structure—distinguishing between intellectual and emotional attitudes—and demonstrated its reliability in a different cultural context. The results showed that students had on average neutral to slightly positive intellectual attitudes (M = 3.60; SD = 1.47) and slightly positive emotional attitudes (M = 3.93; SD = 1.75) toward Chemistry. The analysis also revealed that previous success in Chemistry and overall performance in primary school significantly influenced these attitudes. The findings confirm the assumption that students' attitudes toward Chemistry are closely related to their academic achievements and also point to the suitability of using the ASCIv2 tool to measure students' attitudes toward Chemistry across different cultural settings.

3 The research design and objectives

The main objective of our research was to determine the attitudes of pupils toward the subjects of Technology and Chemistry as taught in grades 7, 8, and 9 of lower secondary education, using the semantic differential method. These two subjects were selected because their content and performance standards significantly influence each other and complement each other effectively.

As partial objectives of the research, we defined the following:

- To compare how primary school pupils understand the subject Technology in comparison to the subject Chemistry.
- To determine whether there is a relationship between the perception of Technology as active–passive and energetic–tiring.
- To examine whether there is a relationship between the perception of Technology as interesting–mundane and Chemistry as difficult–simple.

Based on the main objective and the partial objectives, we formulated the following research questions:
RQ 1: Do primary school pupils perceive the subject Technology as valuable?
RQ 2: Do primary school pupils perceive the subject Technology as organized?

To compare pupils' attitudes toward the selected subjects, the research method of semantic differential was used. According to Chráska and Chrásková (2016), it is considered one of the most frequently used research methods, providing information about respondents' attitudes in the field of education. The semantic differential is a method that requires respondents to express their attitude toward the subject of research by selecting from a rating scale. It often utilizes the principle of a seven-point Likert scale, in which numerical values are replaced by verbal descriptors (Kuhn, 2023).

The concept (term) used in the semantic differential plays a significant role in terms of its placement within semantic space, which is most commonly constructed from three dimensions: the evaluation dimension, the strength dimension, and the activity dimension.

The evaluation dimension (factor), considered the most important, identifies what impression the formulated concept leaves on the respondent in relation to the research subject (positive/negative). The strength dimension expresses whe-

2/2025, Volume 17, Issue 2
ISSN 1803-537X

ther the concept appears to be strong/dominant or weak. The activity dimension is most often defined in terms of its relation to movement and change (active/passive) (Divilová, 2016).

Our semantic differential and the selection of adjectives used within it were primarily based on the content and terminology of the semantic differential developed by Osgood (1957).

The choice of this method was made because it is most frequently used for:

- investigating attitudes towards subjects, teachers, or teaching methods,
- examining the perception of concepts across different age groups,
- comparing opinions among various social groups.

In the Slovak context, this method was applied by Kubiatko (2016), who examined students' attitudes toward science subjects. He found that students consider chemistry to be an interesting yet challenging subject, which corresponds with several international findings. Similarly, Svidzinskaya et al. (2019) and Mezentseva & Svidzinskaya (2018) used the semantic differential method to explore university students' attitudes toward chemistry, highlighting its perception as a theoretical and less attractive subject. These studies demonstrate that the semantic differential method is suitable for capturing subtle semantic differences in students' and pupils' attitudes.

In the subject *Technology*, the following adjectives were selected for the activity dimension: energetic – tiring, active – passive, organized – chaotic, practical – theoretical, dynamic – static. For the evaluation dimension in the subject of Technology, we chose the adjectives: pleasant – forbidding, valuable – inferior, favourite- unfavourite, clean – dirty, innovative – classical. For the strength dimension in Technology, the following adjectives were used: dominant – secondary, strong – weak, difficult – simple, colorful – transparent, interesting – mundane.

In the subject *Chemistry*, the following adjectives were selected for the activity dimension: energetic – tiring, active – passive, organized – chaotic, dynamic – static, hot – cold. For the evaluation dimension, we chose: pleasant – forbidding, valuable – inferior, beautiful – ugly, clean – dirty, and sweet – bitter. The strength dimension reflected attitudes through the following adjectives: deep – shallow, intense – bland, difficult – simple, colorful – transparent, interesting – mundane.

The adjectives representing a positive attitude toward the school subject are listed first in each pair in Table 1, in the column "Dimension (Technology)" and

"Dimension (Chemistry)." The adjectives representing a negative attitude are listed second in each pair in the same columns of Table 1.

The shared adjective pairs in the semantic differentials for the subjects of Technology and Chemistry are: energetic – tiring, pleasant – forbidding, active – passive, valuable – inferior, difficult – simple, colorful – transparent, clean – dirty, interesting – mundane.

The main reason why not all adjectives match in the given semantic differentials is the so-called different representations of the subjects. Chemistry and Technology are subjects with different connotations and may evoke various emotions and associations among pupils. When evaluating the subject of Chemistry, pupils may think more about laboratory experiments, formulas, abstract concepts, or chemical reactions. In contrast, when thinking about Technology, pupils are likely to associate it with practical applications, technologies, manual skills, and the functioning of machines and various devices.

While constructing the semantic differential, several shared adjective pairs were selected for both subjects (Technology and Chemistry); however, some differed due to the specific characteristics of the individual subjects. For example, in the subject of Technology, the pair practical – theoretical was used to reflect the emphasis on manual and practical activities typical of technical instruction, while in Chemistry the pair intense – bland was included, focusing on the emotional intensity of experiencing experiments and explanations.

The pair dominant – secondary was included in Technology to capture perceptions of the subject's importance within the curriculum, whereas in Chemistry it was replaced with deep – shallow, expressing the need for analytical and abstract thinking. The pair strong – weak appeared in Technology, referring to stability, precision, and confidence associated with technical activities, while in Chemistry the visually and aesthetically oriented pair beautiful – ugly was preferred, linked to the attractiveness of chemical reactions.

While in Technology the emotional connection of pupils to the subject was explored using the scale favourite – unfavourite, in Chemistry the pair hot – cold was used, metaphorically expressing the intensity of experience and perceived "elemental" characteristics of the subject. Additionally, Technology included the pair difficult – simple to assess the difficulty of practical tasks, while Chemistry used the pair sweet – bitter, reflecting the emotional attitude of the student toward instruction.

These differences in the choice of adjectives reflect the specific characteristics of each subject and also provide a deeper insight into how they are perceived by the target group of pupils.

The subject Technology is included in Slovak primary schools from the fifth grade (11-year-old pupils) to the ninth grade (15-year-old pupils). Its aim is to guide pupils in acquiring basic user skills in various areas of human activity (Standard, 2014). The subject is practically oriented, focusing on acquiring necessary skills in the field of technology. The content of the Technology subject integrates knowledge from various science subjects. One such key subject is undoubtedly Chemistry. Chemistry is taught from the seventh grade (13-year-old pupils) to the ninth grade. For this reason, the research sample consisted of pupils from the 7th, 8th, and 9th grades.

The selection of the research sample was based on the requirement that both subjects be present in the mentioned grades. Since there is a considerable problem in Slovakia with the specialized teaching of the subject Technology due to a lack of qualified teachers, we sought a fully organized school where both subjects were taught by qualified teachers of chemistry and technology, each with at least ten years of teaching experience, so that we could be present during the administration of the questionnaires.

The research was conducted from March 2022 to September 2022. The total research sample consisted of 105 primary school pupils (ISCED 2) across the Slovak Republic. For the subject Technology, 54 respondents participated, of whom 32 were female (59.26%) and 22 were male (40.74%). For the subject Chemistry, there were 51 respondents in total, with 29 females (56.86%) and 22 males (43.14%).

Using a questionnaire, pupils were asked to express their attitudes toward both subjects. The questionnaire consisted of 15 items. Each item included an adjective characterizing a positive pupil attitude toward the subject and adjectives characterizing a negative attitude toward the subject. For example, pleasant – forbidding, active – passive, etc. Between these adjectives, numbers (descriptors) from 1 to 7 were given, where number 1 corresponded to the adjective expressing a positive attitude, and number 7 corresponded to the adjective expressing a negative attitude of the respondent. There was no time limit for completing the questionnaire to ensure that pupils had enough time to thoughtfully consider their attitudes.

4 The course and results of problem solving

A detailed analysis and evaluation of the results of the semantic differential research method for the subjects Chemistry and Technology were conducted through graphical analysis. The graphical analysis is presented in Table no.1. The individual parts of the table were divided into the dimensions of the semantic differential according to the official format: the activity dimension, the strength dimension, and the evaluation dimension, each accompanied by a legend.

From the collected data on the attitudes of all respondents, the arithmetic mean was calculated, the value of which is shown in the respective Table no. 1. Based on the results of the respondents' attitudes, we can conclude the following.

The subject Technology is perceived by pupils in the 7th, 8th, and 9th grades as organized, practical, colorful, active, and innovative. We consider the organization of the subject as one of the attributes that primarily arises through the teacher's role in direct pedagogical activity. According to the author Rastogi (2022), the practical importance of technology lies mainly in the fact that pupils acquire practical skills, develop fine motor skills, and, last but not least, connect theory with practice within the educational process. The colorfulness of the Technology subject can be explained in terms of the use of methods, techniques, materials, and activities within the teaching process. Additionally, Technology is perceived as an active subject that leads pupils to activity and motivation, as well as innovative, bringing progress, new trends, and connections with modern information and communication technologies into the educational process.

On the other hand, the subject Technology appears to be secondary compared to other subjects. This finding may stem from the fact that Technology is taught in Slovakia with a time allocation of only one lesson per week for all mentioned grades. Pupils do not perceive the subject as core compared to, for example, Mathematics or the native language, which are usually allotted more teaching hours. The graphical analysis also showed that the subject is perceived as simple.

2/2025, Volume 17, Issue 2
ISSN 1803-537X

Dimension (Technology)	Acquired values	Dimension (Chemistry)	Acquired values
Energetic-tiring	3,50	Energetic-tiring	2,94
Active-passive	2,80	Active-passive	2,41
Organized-chaotic	2,50	Organized-chaotic	2,50
Practical-theoretical	2,20	Dynamic-static	2,75
Dynamic-static	2,50	Hot-cold	3,41
Pleasant-forbidding	3,04	Pleasant-forbidding	2,94
Valuable-inferior	3,30	Valuable-inferior	2,41
Favourite-unfavourite	3,70	Beautiful-ugly	2,78
Clean-dirty	3,74	Clean-dirty	2,57
Innovative-classical	3,54	Sweet-bitter	2,94
Dominant-secondary	4,13	Deep-shallow	2,96
Strong-weak	3,15	Intense-bland	2,45
Difficult-simple	4,65	Difficult-simple	3,04
Colorful-translucent	3,35	Colorful-translucent	2,80
Interesting-mundane	2,83	Interesting-mundane	2,12

Table no. 1: Average values in the individual dimensions for the subject of Technology and the subject of Chemistry (see in Komárová, 2023)

Based on the average results from the graphical analysis of Table no.1 of the semantic differential for the subject Chemistry, we found the following facts.The subject Chemistry is perceived by the research sample of pupils from 7th, 8th, and 9th grades mostly in a positive sense. Pupils see it as pleasant, active, organized, intense, and interesting. The activity of the subject may stem from the use of modern educational strategies that the teacher applies within the educational process. These include strategies such as inquiry-based learning, project work, use of information technologies, and last but not least, experimentation and observation, which form an essential part of teaching. However, it is necessary to consider the material-technical equipment of schools, the presence of school laboratories, and related safety and health protection at work.

Another interesting finding is that Chemistry is perceived by the research sample as an organized subject. From the graphical analysis, it also appears that on the other hand, the subject is understood as somewhat cold. This finding can be explained by the teacher's approach and relationship toward the pupils.

	energetic--tiring CH	energetic--tiring T	active-passive CH	active-passive T	organized-chaoticCH	organized-chaotic T	dynamic-static CH	dynamic-static T
energetic-tiring CH	1							
energetic-tiring T	0,0664	1						
active-passive CH	**0,5423 (3,8)**	0,0011	1					
active-passive T	-0,1410	**0,6014 (4,0)**	-0,0232	1				
organized-chaotic CH	**0,5587 (3,9)**	-0,0941	0,2490	-0,1865	1			
organized-chaotic T	0,1208	**0,6208 (4,3)**	0,0545	0,4780	-0,0824	1		
dynamic-static CH	0,5804 (4,0)	-0,0068	0,3440	-0,1517	0,2851	-0,0618	1	
dynamic-static T	-0,1728	0,4355	-0,1719	**0,6295 (4,4)**	-0,1991	0,3277	-0,0639	1

Table no. 2: Correlation coefficients in the individual dimensions for the subjects Technology and Chemistry (see in Komárová, 2023)

Correlation coefficients for the activity dimension in Table no. 2 were examined only for areas that matched across the questionnaires for the individual subjects. In our case, the Pearson correlation coefficient was used to determine the relationship between pupils' attitudes toward the subjects Technology and Chemistry across the individual evaluation dimensions.

Although individual data obtained from measurements on a Likert scale are primarily ordinal in nature, when evaluating individual scales we use arithmetic means calculated from the scores of all items belonging to the given scale, which, according to Boone and Boone (2012), can be considered interval variables.

A correlation coefficient is a number expressing the strength and direction of the linear relationship between two variables. Correlation coefficient values typically range from -1 to +1. A value of 1 indicates a strong positive relationship, -1 indicates a strong negative relationship, and 0 indicates no linear relationship.

The correlation coefficients can be interpreted as follows: 0.90 to 1.00 indicates a very high correlation; 0.70 to 0.90 a high correlation; 0.50 to 0.70 a moderate correlation; 0.30 to 0.50 a low correlation; and 0.00 to 0.30 a very low or no correlation.

2/2025, Volume 17, Issue 2
ISSN 1803-537X

From the correlation coefficients in the activity dimension, no high correlation was observed among the variables studied. Correlations with values above 0.5 (highlighted in bold in the table) were also tested using Student's t-test (Holčík et al., 2015), according to the formula, $t = r.\sqrt{\frac{n-2}{1-r}}$ at a significance level of α = 0.05. If $t_T < t$, the null hypothesis (H_0) is rejected, indicating that there is no relationship between the compared correlation values. In our case, the tabular value was $t_T = 2$.

The most interesting findings are the moderate correlations with values above 0.5 (highlighted in bold in the table). A moderate correlation (0.54) was found between the pairs active–passive (Chemistry) and energetic–tiring (Chemistry). A correlation coefficient of 0.6 was found between active–passive (Technology) and energetic–tiring (Technology). Furthermore, an appealing level of correlation was observed for the semantic pairs organized–chaotic (Chemistry) and energetic–tiring (Chemistry), where the correlation coefficient reached a value of 0.56. A value of 0.62 was observed between organized–chaotic (Technology) and energetic–tiring (Technology). A moderate correlation of 0.58 occurred between dynamic–static (Chemistry) and energetic–tiring (Chemistry). Lastly, a moderate correlation of 0.63 was found between dynamic–static (Technology) and active–passive (Technology).

Surprisingly, there was little to no correlation between the subjects themselves, and if any, it was very weak to negligible. Of the lowest correlations, the correlation coefficient of 0.12 was found between the semantic pairs organized–chaotic (Technology) and energetic–tiring (Chemistry).

5 Discussion and conclusion

The results of our study provided interesting insights into how pupils in grades 7 to 9 perceive the subjects Technology and Chemistry. The subject Technology was evaluated predominantly positively. Pupils perceived it as practical, organized, active, and valuable, yet they also considered it simpler and less important compared to other subjects. These findings are consistent with the research of Uhlírová (2018) and Bertea (2009), who emphasize the influence of practical application and pupil motivation on shaping attitudes toward technical subjects. It appears that Technology has the potential to be an attractive subject, although its significance needs to be better communicated and pedagogically developed.

The results mainly indicate that attitudes toward Technology may have been influenced by the subject's practical focus.

Chemistry, however, was perceived differently. Pupils described it as organized, intense, and interesting, but also as difficult, less pleasant, and "cold." These findings align with those of Kubiatko (2016) and Kahveci (2015), who reported that pupils recognize chemistry as valuable but perceive it as challenging and less emotionally engaging. Similarly, Svidzinskaya et al. (2019) and Mezentseva & Svidzinskaya (2018) highlighted low student motivation toward chemistry, which is often seen as a theoretical and more difficult subject.

An interesting finding was the correlation between the evaluation of Technology and Chemistry (r = 0.29), which indicates a low, yet noticeable, relationship between the attractiveness of Technology and the perceived complexity of Chemistry. This relationship opens up opportunities for pedagogical innovations, such as integrating practical activities from Technology with chemistry content. A similar difference in perception was observed in the research by Tokárová et al. (2023), which emphasized the importance of emotional engagement and motivation in education. Improving this relationship could also be addressed by incorporating activities in both subjects using a STEM-based approach.

Overall, it can be concluded that Technology is perceived by pupils as a positive and practically oriented subject, whereas Chemistry is regarded as interesting but challenging and less pleasant. Differences in the perception of these subjects may relate to the structure of teaching, the level of abstraction, or the degree of practical engagement. Our findings highlight the need to employ didactic strategies that increase the attractiveness of Chemistry and strengthen the significance of Technology in the school environment.

We acknowledge that our results are not representative due to the small sample size. However, we are convinced that they indicate potential ways to enhance the attractiveness of both subjects, particularly through the selection of teaching methods that allow pupils to better apply knowledge from both subjects.

For this reason, we plan the following steps in the future, focusing on two areas:
1. Providing teachers with appropriate suggestions to make instruction in the subjects more engaging.
2. After a certain period, we plan to repeat our study with a much larger sample, utilizing the insights and experience gained so far.

From a practical standpoint, our results can inform the development of teaching methodologies that address both positive and negative pupil attitudes, thereby increasing their motivation in learning Technology and Chemistry. Based on these insights, teachers can adapt instruction to foster positive pupil attitudes—for example, by emphasizing practical and fun elements in Technology or by including activities that improve the emotional impact of Chemistry. Attention should also be given to teaching methods that can be modified to address specific negatively perceived aspects (such as the coldness and difficulty of Chemistry). Teachers might implement interactive and engaging methods to reduce the sense of difficulty and enhance the learning experience.

Moreover, pupils' attitudes toward subjects in primary schools often influence their interest in further studies in the field. Strengthening positive perceptions of Chemistry and Technology can contribute to greater interest in STEM fields at secondary and higher education levels, supporting an increase in graduates in technical and scientific disciplines.

6 Bibliography

Boone, H. N. J. & Boone, D. A. (2012). Analyzing Likert data. Journal of Extension, 50(2).

Divilová, S. (2016). Semantic differential as one of the research tools suitable for establishing the attitudes of pupils to old age and seniors. *Universal Journal of Educational Research, 4*(8), 1858–1862. https://doi.org/10.13189/ujer.2016.040815

Gavora, P., a kol. (2010). *Elektronická učebnica pedagogického výskumu*. Univerzita Komenského. http://www.e-metodologia.fedu.uniba.sk/

Holčík, J., & Komenda, M. (2015) *Matematická biologie: e-learningová učebnice* 1. vydání. Brno: Masarykova univerzita. https://portal.matematickabiologie.cz/

Chráska, M., &Chrásková, M. (2016). Semantic differential and its risks in the measurement of students' attitudes. *Procedia – Social and BehavioralSciences, 217*, 820–829. https://doi.org/10.1016/j.sbspro.2016.02.155

Kahveci, A. (2015). Assessing high school students' attitudes toward chemistry with a shortened semantic differential. *Chemistry Education Research and Practice*, *16*(2), 283–292. https://doi.org/10.1039/C4RP00186A

Komárová, K. (2023). *Medzipredmetové vzťahy techniky a chémie* [Diplomová práca].

Kubiatko, M. (2016). Sémantický diferenciál jako jedna z možností zkoumání postojů k chemii u žáků druhého stupně základních škol. *Scientia in educatione, 7*(1), 2–15. https://www.researchgate.net/publication/336742570_Semanticky_diferencial_jako_jedna_z_moznosti_zkoumani_postoju_k_chemii_u_zaku_druheho_stupne_zakladnich_skol

Kuhn, G. (2023). *Explaining semantic differential scales*. Drive Research. https://www.driveresearch.com/market-research-company-blog/what-is-a-semantic-differential-scale/

Mezentseva, M. E., &Svidzinskaya, G. B. (2018). Semantic differential method as a pedagogical diagnostics tool in university learning process. *European Proceedings of Social and Behavioural Sciences.* https://doi.org/10.15405/epsbs.2018.12.02.57

Osborne,J. ,Simon S. & Collins, S. (2003) Attitudes towards science: A review of the literature and its implications, International Journal of Science Education, 25:9, 1049–1079. https://doi.org/10.1080/0950069032000032199
Osgood, C. E., Suci, G. J., &Tannenbaum, P. H. (1957). *The measurement of meaning*. University of Illinois Press.
Rusek, M., Chytrý, V., & Honskusová, L. (2019). The effect of lower-secondary chemistry education: Students' understanding to the nature of chemistry and their attitudes. Journal of Baltic Science Education, 18(2), 286–299. https://doi.org/10.33225/jbse/19.18.286
Rastogi, S. (2022). *Practical teaching – Approach for teachers*. Teachmint. https://www.teachmint.com/online-teaching-software
Svidzinskaya, G. B., Baskin, Y. G., & Mezentseva, M. E. (2019). Using the semantic differential method to assess the learning motivation and attitude of first-year student's towards chemistry in University of EMERCOM of Russia. *International Journal of Education and Practice, 7*(2), 88–100. https://doi.org/10.18488/journal.61.2019.72.88.100
Štátny pedagogický ústav. (2004). *Vzdelávací štandard Technika – nižšie stredné vzdelávanie*.https://www.statpedu.sk/files/articles/dokumenty/inovovany-statny-vzdelavaci-program/technika_nsv_2014.pdf
Veselský, M., & Hrubišková, H. (2009). Zájem žáků o učební předmět chemie. Pedagogická orientace, 19(3), 45–64. https://journals.muni.cz/pedor/article/view/1259/951