Teachers' implicit pedagogical knowledge in the field of technical creativity

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Abstract

Technical creativity represents a critical competence for navigating the challenges of the 21st century; however, its systematic cultivation within primary education remains insufficiently addressed. Given their formative role in early learning environments, primary school teachers significantly influence pupils' creative engagement through their implicit pedagogical knowledge—tacit, experience-based understandings that inform instructional decision-making. This study examines how such implicit knowledge shapes teachers' conceptualizations of technical creativity and its integration into pedagogical practice. Employing a quantitative research design, data were collected via a rigorously validated questionnaire instrument. Descriptive and inferential statistical analyses, including non-parametric tests and Pearson correlation coefficients, were applied to identify relevant patterns and associations. The findings revealed two central thematic domains: teachers' perceived knowledge and their attitudinal orientation toward technical creativity. The study highlights the necessity of addressing both cognitive and affective dimensions within pre-service and in-service teacher education.

La creatività tecnica rappresenta una competenza fondamentale per affrontare le sfide del XXI secolo, ma la sua promozione sistematica nella scuola primaria rimane limitata. Gli insegnanti svolgono un ruolo chiave nello sviluppo del coinvolgimento creativo degli alunni attraverso le loro conoscenze pedagogiche implicite, ossia comprensioni tacite basate sull'esperienza che orientano le decisioni didattiche. Questo studio analizza come tali conoscenze influenzino le concezioni degli insegnanti sulla creatività tecnica e sulla sua integrazione nella pratica

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educativa. Attraverso un disegno di ricerca quantitativo, i dati sono stati raccolti mediante un questionario validato e analizzati tramite statistiche descrittive e inferenziali, inclusi test non parametrici e correlazioni di Pearson. I risultati hanno evidenziato due dimensioni principali: la conoscenza percepita e l'orientamento attitudinale verso la creatività tecnica. Lo studio sottolinea l'importanza di considerare sia la dimensione cognitiva sia quella affettiva nella formazione degli insegnanti.

Keywords: technical creativity; technical education; implicit knowledge; teachers; primary school

Parole chiave: creatività tecnica; educazione tecnica; conoscenze implicite; insegnanti; scuola primaria

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1. Introduction

In general, creativity is characterized as a key skill for the 21st century, bringing benefits to both the individual and society as a whole (Newton & Newton, 2014; UNESCO, 2006; DuPriest, 2017; Runco, 2023). There is a global social consensus on the particular need for flexibility and creative problem solving aiming to prepare children for dealing with changing social and environmental conditions. The importance of developing creativity and creative thinking is supported by the fact that PISA included the assessment of creativity and creative thinking as one of its areas of innovation in 2022 (OECD, 2022). Despite the fact that most educators are supportive of the development of creativity, it is not always appropriately applied and developed (Bahar et al., 2021; Maker, et al., 2022; Částková, 2022).

Technical creativity of pupils and its development in the younger school age period is very marginally addressed in professional circles. A sufficient number of empirically verified facts are, however, a precondition for creating a modern educational environment and improving the quality of the educational system, both in the field of professional training of teachers and education of pupils. We approach the topic of creativity within engineering science as a desirable innovation in education, targeting teachers as creators and initiators, whose views and experience influence the educational process both consciously and unconsciously.

2. Implicit pedagogical knowledge of teachers in a pedagogical-psychological context

Implicit knowledge refers to unconscious understanding and skills which individuals acquire and use, and which hence influence their thoughts, behaviour, and decision-making processes. Moreover, they are essential to various psychological processes, including learning, perception, and problem solving (Dienes & Perner, 1999). For the purposes of this article, we shall focus primarily on implicit learning, which can be defined as a process by which individuals unconsciously acquire knowledge without the intention to learn (Herbig & Müller, 2014). This mode of learning is fundamental to the development of complex skills such as language acquisition and social behaviour. Studies show that implicit learning can take place through repeated exposure to patterns and regularities in the environment without the learning individual being aware of it. For example, research by Jiménez and Méndez (1999) showed that participants can learn complex sequences of events without being aware of the rules which actually control these sequences.

The acquisition of implicit knowledge is closely related to the way people process information. Specifically, it is connected with what is called experiential cognition which leads to the acquisition of implicit knowledge through intuitive, emotionally charged, and automatic processing of information from direct experience. This process subsequently leads to the automation of skills and behaviours with minimal conscious control. Experiential cognition is holistic and involves perceiving situations as wholes. This holistic approach allows for the effective integration of implicit knowledge as individuals often unconsciously perceive and learn complex patterns and connections. The opposite is reflective cognition, which refers to a conscious, analytical and often slower way of processing information and involves analytical thinking and intentional learning

Research shows that implicit knowledge often results from experiential cognition. For example, Epstein (1994) described that people tend to use experiential thinking in situations which require quick and intuitive decision making. In addition, Lieberman (2000) identified specific brain regions, such as the limbic system, which are active during experiential cognition, thus suggesting a link to implicit information processing.

Our intention to identify implicit pedagogical knowledge is based on the epistemological perspective of constructivism, which is characterized by the complex perception and construction of knowledge, and by the interpretation of the latter based on individual experience. Knowledge is approached as a construct influenced by

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both the individual's personal dispositions and the environment with which it is associated. Thus, each individual constructs a subjective model of the world based on his or her unique experience and socio-cultural environment, constructivism being the genuine framework for understanding how knowledge is constructed and interpreted. In line with Vygotsky (1978), we assume that all knowledge is social to some degree and has an implicit origin. Therefore, it is culturally conditioned and cannot be studied without considering the explicit part of the knowledge base (McAdam et al., 2007). However, in addition to socio-cultural implicit knowledge, semantic implicit knowledge can be singled out (Castillo, 2002, pp. 48-52) which can be referred to when trying to capture teachers' implicit pedagogical knowledge.

For the purpose of identifying and segmenting implicit pedagogical knowledge, we consider it necessary to first define its core areas. Shulman (1987, p. 8) identifies seven categories of pedagogical knowledge: content knowledge, general pedagogical knowledge, curriculum knowledge, pedagogical content knowledge, knowledge of learners and their characteristics, knowledge of educational context, and knowledge of educational ends, purposes and values (Whitty, 1996; Torff & Sessions, 2005; Švec, 2005; Elliott et al., 2011).

Implicit pedagogical knowledge can be conceptualised as intuitive concepts having significant influence on the ways in which teachers behave and act in certain situations. This knowledge is also referred to as tacit knowledge, mental representations, practical know-how or tacit dimensions of knowledge (Šíp & Švec, 2013) (tacit knowledge, implicit knowledge, knowledge in action, craft knowledge) and represents the teacher's understanding of what is happening in the classroom without the teacher being fully aware of the above mentioned happening or being able to describe, explain or communicate it (Polanyi, 1958, 1966; Eraut, 2000; Sternberg & Grigorenko, 2001; Shim & Roth, 2008; VanPatten & Rothman, 2015). While explicit pedagogical knowledge is acquired through a deliberate and systematic process, implicit pedagogical knowledge is embedded in relationships and ways of thinking, and emerges spontaneously, in authentic situations, without conscious control, based on observation, imitation and experience of the teacher (Haldin-Herrgard, 2000; McAdam et al., 2007; Pavlicek, 2009; Stuchlíková, 2005). Implicit knowledge is acquired through both deliberate explicit learning and pedagogical practice. Consequently, it can be said that implicit and explicit knowledge are interrelated and influence each other.

Eraut (2000) distinguishes three types of implicit knowledge, namely understanding the situation (tacit understanding of people and situations), routine procedures (tacit routinized actions), and rules (tacit rules). The aforementioned are intertwined provided that there is a routine activity interrupted by situations requiring quick intuitive decision making. Situational learning actually leads to greater individual variability as teachers go through pedagogical situations in different contexts.

Besides others, the formation and development of implicit knowledge is related to the teacher's inner potential, as the former includes both cognitive and affective components represented by individual interests, preferences and needs. The overall content and structure of the teacher's knowledge is then referred to as a theory representing an intuitive explanation of the events, behaviour and actions of the individual and his/her environment (Sternberg, 1985). In the Czech Republic, the notion of teachers' subjective theories has been elaborated in more detail by Švec (2003, 2005) and Janík (2005). Although they may not be consciously formulated, teachers` subjective theories represent assumptions which have both positive and negative effects on reactions in complex or emotional situations (Poudel, 2017). Teachers naturally prefer their own conceptions and perceptions, and they consequently base their behaviour and actions on these subjective theories (Koubek, 2021).

Since implicit knowledge is based on subjective theory, sharing it is difficult and time consuming, the first step to it being awareness and identification (Hislop, 2009; Mládková, 2012). A significant amount of information becomes implicit through personal interactions, informal conversations, presentations, micro-performances,

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sitting in on classes, internships and teaching situations (Nonaka & Nishiguchi, 2001; Orzea, 2009; Yu & Zhou, 2015). In selected cases, implicit knowledge may become explicit (transformed) (Collins, 1978) and, subsequently, realized, observed and reflected upon.

In the field of technical education, implicit knowledge and its influence on the educational process have been only marginally investigated. For example, The STEMCrAfT. project (Fraser et al., 2019) has focused on identifying and potential sharing of teachers' implicit knowledge in STEM fields. The preconceptions and individual conceptions of the teaching of technology education by teachers and student teachers in the Czech Republic have been explored by Roučová (2007a, 2007b, 2013).

3. Technical creativity as an innovation and a requirement of practice

In line with theoretical foundations in the fields of pedagogy and psychology, we perceive creativity as a widely researched concept which overlaps into most areas of human activity. In professional literature, this versatile phenomenon is conceptualized from cognitive, neurological, and personality perspectives. In the context of humanistic pedagogical discourse, we focus specifically on the personality aspect of creativity. In compliance with the theoretical grounds, we understand creativity as a basic human ability and need, the degree of which varies significantly from person to person.

Furthermore, in this paper we discuss technical creativity (technical creativity, technological creativity, engineering creativity) as one particular type of creativity (Torrance, 1968; Jyotsna, 2022; Sánchez-Dorado, 2023). The latter involves cognitive processes which allow the creation of new original theories, technologies or technical objects having practical applications and benefits for society. This ability represents a key prerequisite for the development of society in the field of science and engineering (Částková et al., 2024). In the Czech Republic, technical education is implemented from as early as preschool education and generally aims at the acquisition of technical literacy in children, including the development of skills, technical thinking, knowledge, and technical creativity. During primary education, technical creativity is developed through technology focused, handicraft-oriented subjects such as Craft education, Practical activities, Hands on learning activities, Technical education, etc. (Částková et al., 2024).

Due to and along with intensive technological development, the goals of education and the requirements for human competences are naturally changing. In this process, not only the continuous updating of knowledge is crucial, but above all, the transformation of the ways of education with an emphasis on the development of personal qualities of the pupil, the ability to solve problems, cooperation, communication, independence, and creativity. In order to achieve these goals, it is, however, necessary not only to actively support the development of children's technical creativity, but also to understand the process of creative development (Potters et al., 2023).

Considering the specifics of teaching in primary school, we perceive teachers as a key source of information referring to the educational process, and an important determinant in the development of pupils' technical creativity. In pedagogical practice, different approaches of teachers to both pedagogical processes and educational content are being identified (for example Honzíková, 2008; Craft & Hall, 2009; Hong et al., 2009; Honzíková & Sojková, 2014).

Given the continuous development in theory and practice, the empirical approach to implicit theories provides the necessary principle of timelessness and flexibility. Implicit knowledge research represents a potential development for the undergraduate preparation of future lower primary schools` teachers as well as the practising teachers. Understanding the level of students' implicit knowledge shall enable systematic development of the latter in content, structure and process.

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4. Research design and methodology

At present, the existence of implicit knowledge is supported with both theoretical knowledge and empirical evidence. Nevertheless, no uniform procedures for how to effectively reflect it in the conditions of teaching aimed at the development of technical creativity have been determined up to now. It is therefore crucial to find the answers to several questions, including but not limited to: *Which sub-categories are dominant or, on the contrary, marginal for creating?*, *How is implicit knowledge structured and what are its interrelationships?*, and *Does it follow generally applicable rules or is it a purely individual matter?*.

As a follow-up to the identification of the structural arrangement of the categories, discerning the internal connections between them is to be considered. The demonstration and clarification of the above issues may lead to the categorization of teachers' implicit knowledge, the description and understanding of which shall provide a deeper, diversified view of teachers' work in relation to the development of pupils' technical creativity.

The brief outline of the elaboration of pedagogical theory based on teachers' subjective theories of technical creativity which we mentioned above requires extensive research activity, built on a partial incremental approach of scientific inquiry, using relevant methods of pedagogical research. For this reason, we opted for quantitative-qualitative research design, otherwise also referred to as a mixed methods research design (Creswell & Creswell, 2023).

In this study, we shall focus on the initial part of the established design – that is to say, the implementation of quantitative research based on the design, validation, and application of a research instrument, which is a self-reflective questionnaire for teachers. It aims to identify and validate key categories of subjective knowledge and the structural relationships between the particular categories. Considering the scope of the research, we have focused on the following sub-objectives in this paper:

- Identify teachers' views on the importance of the knowledge component for the implementation of technical creativity in the educational process at primary school.
- Determine the way primary school teachers perceive technical creativity.
- Analyse possible links between the selected key categories.

We formulated the research problems in the form of the questions as follows:

Q1: What is the internal structure of the categories focusing on the perception and the knowledge of the topic of technical creativity?

Q2: Which aspect is dominant for the category of the perception of the topic of technical creativity?

Q3: Which aspect is dominant for the category of the knowledge of the topic of technical creativity?

Q4: What are the structural links between the category of the perception and the category of the knowledge of technical creativity?

4.1 Research instrument

The process of developing the research instrument was based on theoretical assumptions describing implicit knowledge as internal structures of the individual occurring without conscious control, which can be identified through specific social situations and, subsequently, used to describe the mechanisms and unconscious motivations leading to specific behaviours and actions (Goffin & Koners, 2011; Šíp & Švec, 2013).

Self-reflective techniques were used to capture the personal perspectives of primary school teachers on technical creativity, its application and development in the primary school environment (Švec, 2005; Janík, 2005). In an effort to capture a large amount of data from the respondents, we chose a self-reflective questionnaire consisting of a total of 51 items divided into 7 subcategories based on the teacher's perception of teaching (Mareš, 1996),

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2 of them being test ones (Chráska, 2016). The mentioned categories included topic perception (Roučová, 2007a, 2007b, 2013), creative self-concept (Karwowski & Lebuda, 2017), topic knowledge (Eraut, 2000; Janík, 2005), experience, motivation, conditions and implementation (process) (Nonaka & Nishiguchi, 2001; Ivona, 2009; Yu & Zhou, 2015). Each of the categories contained 7 aspects in the form of statements about specific knowledge, preferences, attitudes, experience, and other facts influencing teachers' choice of educational strategies in the implementation of technical subjects. The individual statements in the study were measured by means of a 7-point Likert scale with the response anchors as follows: 1 = strongly disagree, 2 = rather disagree, 3 = disagree, 4 = neutral, 5 = rather agree, 6 = agree, 7 = strongly agree. Due to possible differences in respondents' interpretation of the term technical creativity, a unifying definition was integrated into the questionnaire, too. The validation of the questionnaire was implemented in three phases. Content validity, construct validity, and Cronbach's alpha reliability were monitored (Cohen et al., 2017), where the validity of the questionnaire was mainly addressed in Phase 1 and Phase 2 of the validation. Based on the results of construct validity, we increased the number of the questionnaire items in order to ensure a more detailed and relevant item representation for each category. The sub-characteristics of the validation are presented in Table 1 below.

Table 1

Validation characteristics

Phase	Number of items	Number of respondents (N)	Cronbach`s α
1	7 x 5	20	0.72
2	7 x 7 + 2	35	0.84
3	7 x 7 + 2	74	0.95

Reliability was monitored in Phase 1 and Phase 2 of the validation on an indicative basis, taking into account the results of the individual items and, in particular, the size of the respondents` sample. The key reliability value of Cronbach`s α was determined in the last stage of validation, considering the association between the Cronbach`s α reliability value and sample size (Kennedy, 2022).

In the following subsection, we present the partial results of the research investigation focusing on the categories of pedagogical knowledge and perceptions of the topic of technical creativity.

In evaluating the research questions, standard descriptive statistics methods were used to characterize the results. It was essential to identify the characteristic values of the data set and, further to that, to systematically disaggregate and compare them. For this purpose, we established a semantic differential rating scale; see Table 2, which was used to categorize the results according to their significance.

Table 2

Semantic differential rating scale

<1.2)	<2.3)	<3.5>	(5.6>	(6.7>
Extremely negative	Negative	Neutral	Positive	Extremely positive
obstructive, impeding	unnecessary, insignificant	having no effect	necessary, significant	essential, indispensable

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The determination of dominant aspects in each category was implemented by means of confirmatory hypothesis testing with respect to the difference of the mean values of the variables. Simple hypotheses were validated by means of the t-test for independent variables, and the normality of the data was checked using Q-Q plots. In this study, we deliberately do not provide a detailed description or formulation of the hypotheses, by contrast, we only point out the results which confirm the difference at the $\alpha = 0.05$ (0.01) significance level, including the presentation of the effect size calculated post hoc.
Correlation coefficient analysis, which is used to determine the correlation tightness between the variables, was selected to identify the structural relationships of particular aspects.

4.2 Characteristics of the research sample

For the purpose of the research investigation, a deliberate multiple sampling of the research population, determined by categorising relevant characteristics, was applied. The research domain was the entire Czech Republic, from which four regions - South Moravia Region, Pardubice Region, Plzeň Region, and Central Bohemia Region - were randomly selected for the sake of the representativeness of the sample. In the selected regions, a comprehensive sampling of towns and neighbourhoods was implemented, followed by a proportional stratified sampling of schools, and a survey sampling of primary school teachers. The invitation to participate in the survey was also shared within social groups focusing on primary schools. For this reason, teachers from all regions of the country are represented in the research sample. All participants gave their informed consent for inclusion before they participated in the study.
In order to generalise the findings to the primary school sector, the research investigation was conducted in different types of primary schools in terms of organisation. Schools from various agglomerations and of different organizational management are represented in the research sample. However, within the framework of data analysis, the specificities of each category of schools are not perceived and reported as a contrast between the types of school in comparison with the results of the whole.
The research sample comprised both primary and secondary school teachers, lecturers and tutors parallelly teaching a subject focused on technical activities at a primary school. In terms of gender, both females and males were represented; no other gender was mentioned among the respondents. Due to the over-representation of women among Czech primary school teachers, women were predominant among the respondents, accounting for 97%. The representation of respondents in terms of age and length of experience is presented in Figure 1 and 2.

Figure 1
Representation of respondents in terms of age

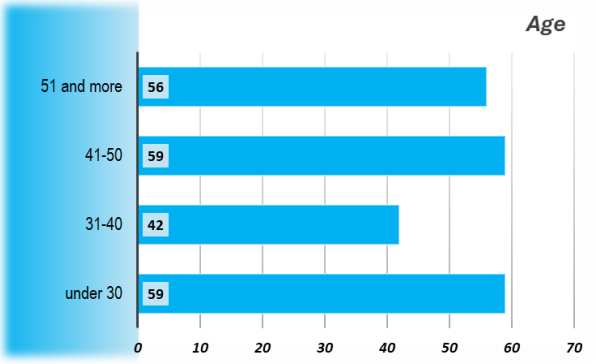

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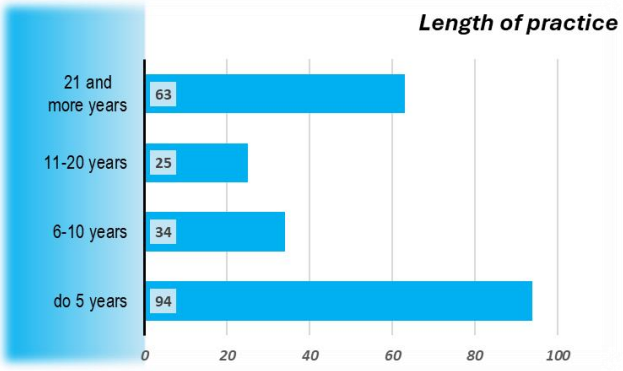
Figure 2

Representation of respondents in terms of length of teaching experience



4.3 Partial results of the research investigation

We hereby present partial results with respect to the determined research questions. In the Tables below (3, 4) we introduce the categories studied and their individual aspects. The specific values found are presented with descriptive statistics data and are further supplemented with graphs. Confirmatory and exploratory statistical analyses are also performed in accordance with the research questions.

Table 3

Overview of aspects in the category of topic perception

Item	Name of aspect perception	Average	SD
Item 1	The topic of technical creativity is up-to-date	5.763	1.514
Item 2	The topic of technical creativity is necessary	6.185	1.379
Item 3	The topic of technical creativity is attractive	5.699	1.484
Item 4	The topic of technical creativity is not demanding on the teacher's knowledge and skills	3.546	1.743
Item 5	I am convinced that technical creativity may be developed in every human and in every age	5.986	1.598
Item 6	The development of pupils' technical creativity is not limited to art lessons	6.310	1.558
Item 7	The acquisition of basic skills and knowledge and the support of technical creativity are of equal importance at lower primary school	6.083	1.422
	Total average of category	**5.653**	

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Table 4

Overview of aspects in the category of topic knowledge

Item	Name of aspect knowledge	Average	SD
Item 15	I understand the topic of technical creativity	5.125	1.497
Item 16	I know how pupils' technical creativity gradually develops and manifests itself over the course of primary school	4.764	1.493
Item 17	I know what type of activities to choose so that they encourage the development of pupils' technical creativity	4.806	1.404
Item 18	I know how to eliminate barriers to creative thinking in teaching	4.412	1.398
Item 19	I know the aids, instruments and tools applicable for the sake of developing pupils' technical creativity	4.935	1.403
Item 20	I know how to individualize the teaching to develop technical creativity in all pupils regardless of their skill level	4.435	1.413
Item 21	I know different technical materials which can be used to develop pupils' technical creativity	4.935	1.468
	Total average of category	**4.773**	

4.3.1 Internal organization of the category focused on the perception of technical creativity

The perception of technical creativity by practicing teachers takes on a positive meaning as expressed by the quantitative mean value avg = 5.653 in the significance interval from 5 to 7 (Table 3). This implies that teachers consider perception of technical creativity as important when it is incorporated into teaching.

A more detailed analysis of the results of the individual aspects forming the perception category (Figure 3) shows at first sight a relatively uniform and positively biased category ordering with a rare abnormality for Item 4 (avg. = 3.55). This abnormality denotes the neutral (null) importance of the easiness (unpretentiousness) of the technical creativity topic in the context of the teacher's knowledge and skills within the overall perception of the issue. The difference of Item 4 to all other items in the category in question was verified at a significance level of $p < 0.01$. The effect size was identified as $d > 0.85$ in all calculations. Item 4 differences are thus statistically and factually significant with respect to all the other items.

At the same time, the neutral mean value of Item 4 lowers the overall median of the perception category. Removing the abnormality would increase the overall mean value (avg. 5.653 => 6.004), and perception of the topic of technical creativity would then be considered indispensable by teachers. On the other hand, when interpreting the results, the variability (Standard Deviation - SD) of the results of each aspect has to be taken into consideration.

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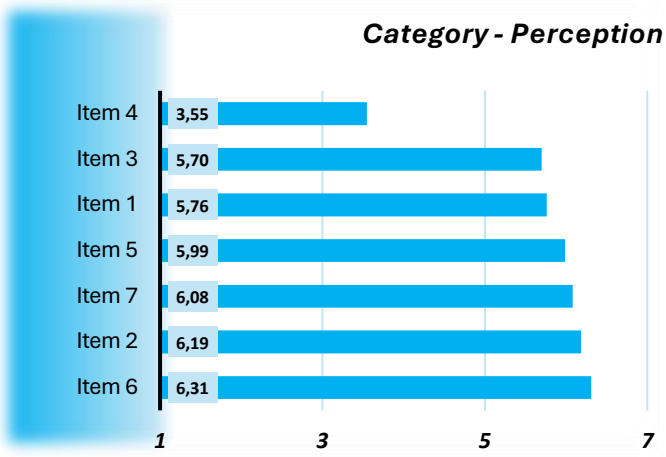
Figure 3

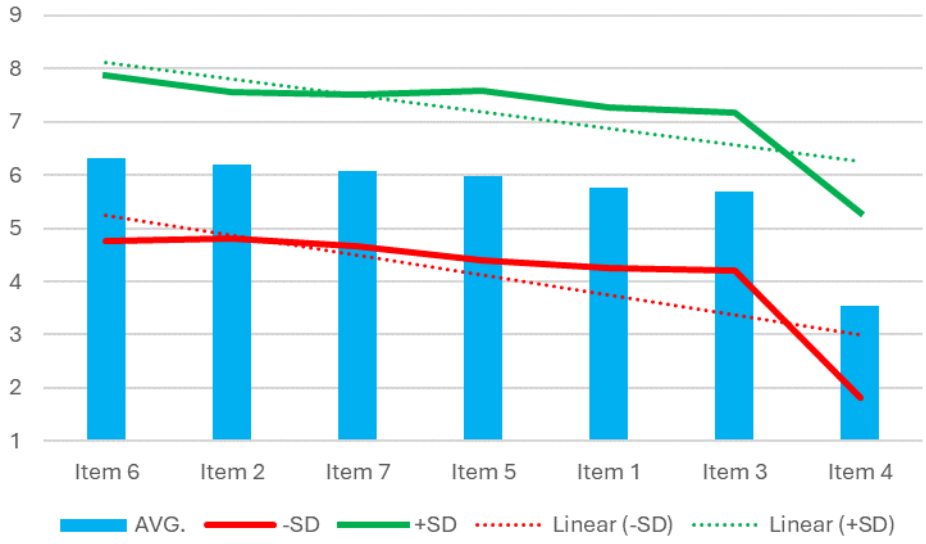
Results of Category - Perception



The standard deviations for the individual aspects range from 1.379 to 1.743, the teachers deviating from each other in their answers by more than 1 degree. However, with a certain degree of tolerance involved, we view SD < 1.5 as relatively consistent. Nevertheless, this threshold cannot be considered a strict rule. Indeed, in Figure 3, we can observe a steady trend of standard deviations between the different aspects, which means the teachers' opinions are rather uniform. The crucial finding is the highest variability of responses for Item 4 (SD = 1.743), which indicates less agreement in teachers' opinions; the diversity in teachers' opinions on this aspect being further supported by other descriptive values (mode = 2; median = 3.5). Consequently, we can assume that the structure of the perception category is most influenced by Item 4 focusing on the unpretentiousness of the topic of technical creativity in the context of teacher`s knowledge and skills.

Figure 4

Consistency of means and SD in Category - Perception



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The dominant aspects of the category focusing on the perception of technical creativity are Item 6, Item2, and Item 7, which scored the highest mean values. The differences in mean values were not demonstrated by T-test at the level of significance $p > 0.05$ as follows:

- Item 6 vs. Item 2, Item 7
- Item 2 vs. Item 7, Item 5
- Item 7 vs. Item 5,

For the other combinations of validation of the 3 items mentioned, the difference was demonstrated, though (ES = 0.2~2).

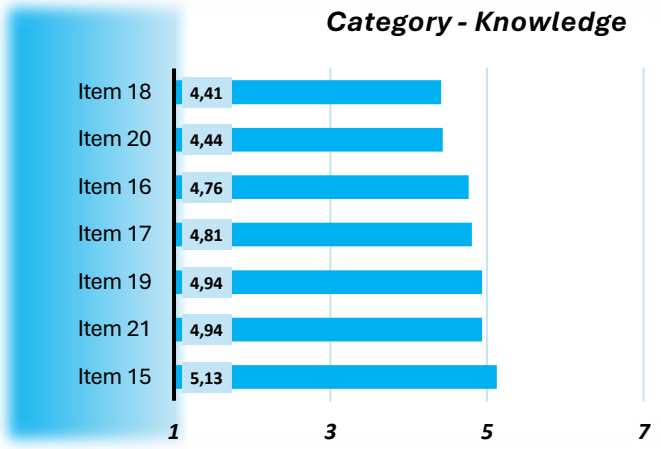
Teachers' overall perception of technical creativity is mainly based on the need to develop the latter, which should thus not be only a part of art lessons; on the contrary, its importance shows itself as equivalent to the development of basic knowledge and skills.

4.3.2 Internal organisation of the category focused on the knowledge of technical creativity

The category of technical creativity knowledge is conceptualised neutrally by practitioner teachers. In the extreme, we could even say that the definition of neutrality is slightly positive; the fact being expressed by the quantitative median avg = 4.773 in the evaluation interval 1-7 (Figure 5). That implies that teachers do not consider knowledge of technical creativity as important or indispensable when incorporating it into their teaching. Hence, we might even ponder the possibility that teachers regard the actual application of developing technical creativity in students as a specific area where knowledge of technical creativity plays a rather secondary role compared to other necessary thought processes such as analysing, imagining or evaluating. On closer inspection, there is no strikingly obvious abnormality in the category of the knowledge of technical creativity. Despite the fact that the mean values of the individual aspects can be systematically ranked, the difference between the mean of the first and the last aspect is $\Delta avg. = 0.72$.

Figure 5

Results of Category - Knowledge



The standard deviations for each aspect vary from 1.398 to 1.497 (Figure 6), where teachers deviate from each other by more than 1 degree in their responses. All the standard deviations of the aspects are within the aforementioned tolerance of SD < 1.5; the trend being consistent and uniform. This fact is not refuted by other

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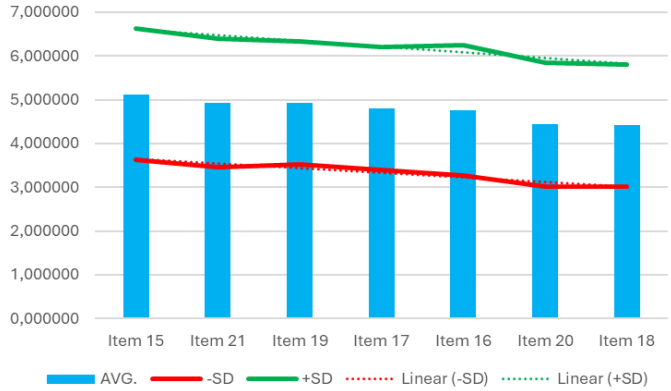
descriptive values. Based on the mean values and standard deviations, the category of the knowledge of technical creativity can therefore be considered to be uniform and stable.

Figure 6

Consistency of means and SD in Category - Knowledge



As the dominant aspect of the technical creativity knowledge category was determined Item 15 as it is the only one which extremely exceeded the average value avg. = 5.13 into the positive significance interval. In terms of knowledge, teachers consider understanding the concept of technical creativity as well as the ability to explain the topic to be at least partially important. The differences between mean values were not demonstrated by T-test at the significance level of $p > 0.05$ as follows:

- Item 15 vs. Item 21, Item 19

However, the results further show that although Item 15 slightly stands out above the other aspects, the core of the concept of the technical creativity knowledge category comprises 4 aspects. No statistically significant differences were identified between Item 21, Item 19, Item 17, and Item 16.

Teachers agree that the category of knowledge of technical creativity is neutral and the most important is knowledge of the topic. Nevertheless, this includes knowledge of materials, tools, appropriate activities and the proper choice of the aforementioned in terms of pupils' development.

4.3.3 Structural links between categories

An analysis of Pearson's correlation coefficient was conducted to determine the structural links. In particular, we focused on strong and very strong correlation links of $r \geq 0.6$ - see Evans (1996).

We shall start by an insight into the internal structural links within each category.

Table 5 shows that in the perception category, Item 4 has no relationship to the other aspects in the category, which supports the above findings that, in fact, this aspect is considered or understood differently by teachers. On the contrary, the remaining aspects form strong links indicating structural interdependence of the perception of technical creativity. The strongest links are observed for the perception of the necessity of the topic of technical creativity.

In contrast, we see the weakest links for Item 3 related to the attractiveness of technical creativity, the result which we are in agreement with as well.

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Table 5

Correlation matrix of items in Category – Perception

	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7
Item 1		0.785	0.670	-0.013	0.608	0.605	0.636
Item 2	0.785		0.719	-0.036	0.694	0.761	0.766
Item 3	0.670	0.719		0.040	0.577	0.574	0.614
Item 4	-0.013	-0.036	0.040		0.014	-0.088	0.023
Item 5	0.608	0.694	0.577	0.014		0.710	0.725
Item 6	0.605	0.761	0.574	-0.088	0.710		0.727
Item 7	0.636	0.766	0.614	0.023	0.725	0.727	

Pearson's r ≥ 0,7
Pearson's 0,6 ≤ r < 0,7
Pearson's 0,5 ≤ r < 0,6

The structural links between the aspects in the knowledge category form slightly weaker linkages compared to the ones in the previous category, however, from an overall perspective, the incidence of strong links is higher here. The structure is consistent and balanced. The dominant aspect Item 17 clearly forms the strongest links and connects all aspects across the category.

Table 6

Correlation matrix of items in Category – Knowledge

	Item 15	Item 16	Item 17	Item 18	Item 19	Item 20	Item 21
Item 15		0.688	0.729	0.580	0.649	0.568	0.645
Item 16	0.688		0.793	0.686	0.697	0.658	0.621
Item 17	0.729	0.793		0.714	0.780	0.721	0.721
Item 18	0.580	0.686	0.714		0.680	0.683	0.584
Item 19	0.649	0.697	0.780	0.680		0.772	0.757
Item 20	0.568	0.658	0.721	0.683	0.772		0.698
Item 21	0.645	0.621	0.721	0.584	0.757	0.698	

Pearson's r ≥ 0,7
Pearson's 0,6 ≤ r < 0,7
Pearson's 0,5 ≤ r < 0,6

Structural links between the categories of perception and knowledge of technical creativity were identified for only three aspects (see Figure 7). These are the medium-strength links Item 15 vs. Item 2 (r = 0.507) and Item 15 vs. Item 7 (r = 0.526). Item 15 forms links with the other aspects as well, but those showed to be weaker.

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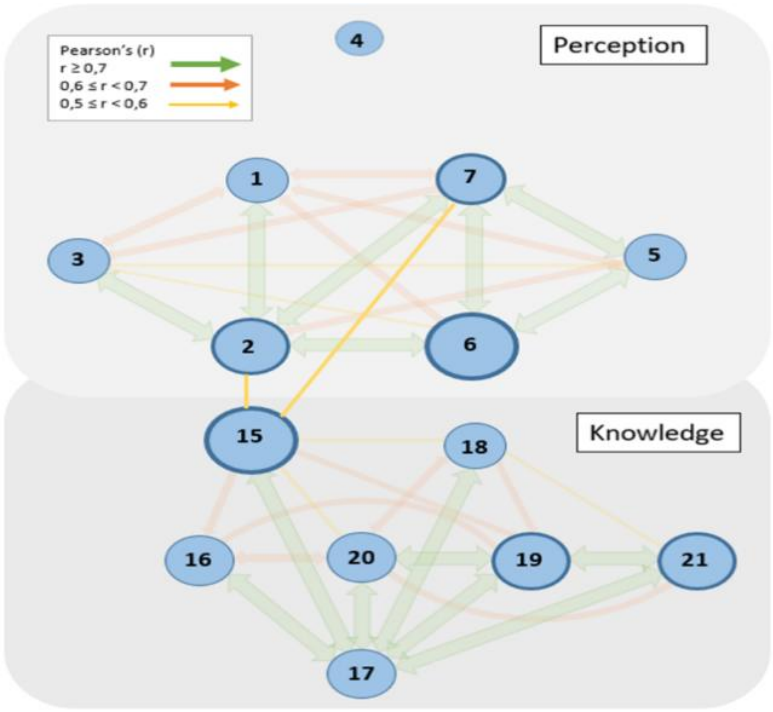
Figure 7
Model of relationships between categories



5. Discussion

The research investigation carried out falls into the category of basic research. On the basis of the stated objectives, the research problems were formulated in the form of questions aimed at a general description of the issue; the concept of technical creativity and the specific focus on the field of primary education being only marginally addressed by the expertise. Insufficient empirically verified expert knowledge made the prediction of the results difficult. Therefore, it was necessary to formulate hypotheses as open-ended research questions.

5.1 Q1: What is the internal organization of the categories focusing on the perception and the knowledge of the topic of technical creativity?

The intention was to clarify the internal organization of the categories of perception and knowledge of the topic of technical creativity in order to understand the composition and the hierarchy of the individual aspects of the above-mentioned categories. The perception category arrangement is partially inhomogeneous with one significant abnormality; specifically, aspect 4 – *The concept of technical creativity is not demanding on the teacher's knowledge and skills*.

On the contrary, the knowledge category is characterized by a unified homogeneous arrangement of all aspects. It is internally subdivided into items focusing on content expertise (15, 19, and 21) and didactic knowledge (16, 17, and 18). In contrast to the perception category, there is no aspect in the knowledge category which should differ significantly in average score from the other aspects. The fact that the respective differences are minimal makes their significance for the category in question very similar.

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5.2 Q2: Which aspect is dominant for the category of the perception of the topic of technical creativity?

The aim of a further analysis was to identify the potential dominance of a particular aspect within the category of the perception of the topic of technical creativity, in order to partially understand the emergence of possible central links within the category structure.

Within the framework of the category focused on the perception of the topic of technical creativity, aspect 6 - *The development of pupils' technical creativity is not limited to art lessons* prevails. The dominance is obvious, along with two other aspects, specifically aspect 2 - *The topic of technical creativity is necessary* and Aspect 7 - *The acquisition of basic skills and knowledge and the support of technical creativity are of equal importance at lower primary school*. Based on these data, it can be concluded that the respondents perceive technical creativity as a necessary part of primary school education. At the same time, the development of technical creativity is equated with the development of basic technical skills (Částková, 2020, 2022).

In terms of interest, aspect 4 - *The topic of technical creativity is not demanding on the teacher's knowledge and skills* are of great significance.

5.3 Q3: Which aspect is dominant within the category focusing on the knowledge of the topic of technical creativity?

The same analysis was conducted to identify the potential dominance of a particular aspect within the category of the knowledge of the topic of technical creativity and the emergence of possible links within the category structure. As regards the category of the concept knowledge, aspect 15 - *I understand and can explain the topic of technical creativity*, together with aspect 19 - *I know the aids, instruments and tools applicable for the sake of developing pupils` technical creativity* and 21- *I know different technical materials which can be used to develop pupils' technical creativity*, dominate.

However, two perspectives can be identified in the respondents' statements, namely the disciplinary expert perspective, and the didactic one. The dominant aspects are mainly represented by disciplinary expert knowledge, where knowledge of disciplinary didactics is described by aspect 17 - *I know what type of activities to choose so that they encourage the development of pupils' technical creativity,* and aspect 20 - *I know how to individualize the teaching to develop technical creativity in all pupils regardless of their skill level*.

A structure and a division (conscious or unconscious) into content knowledge and didactic knowledge are obvious in the respondents' answers. As far as the development of technical creativity is concerned, the understanding of the topic itself is more significant from the respondents' point of view.

In contrast to the perception category, there is no aspect in the knowledge category which would differ significantly in average score from the other aspects. Teachers who are familiar with the topic and knowledgeable about TT are logically well placed to choose appropriate activities and ways of working. They should be able to select materials, aids, tools and instruments correspondingly, taking into account the individuality of the pupil and his/her possible limitations.

5.4 Q4: What are the structural links within and between the categories of the perception and the knowledge of technical creativity?

The aim of the analysis was to describe the structural links and their strength within and between the categories of the perception and the knowledge of technical creativity. The identified interconnections and mutual influences of individual aspects contribute to a deeper knowledge and understanding of the formation and the meaning of implicit pedagogical knowledge.

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The structural links between the particular aspects of perception are mostly strong, with one item, namely item 4 - *The topic of technical creativity is not demanding on the teacher's knowledge and skills* showing no links to the other aspects. Aspects with strong links influence each other.

The linkage structure of the knowledge category is made up of slightly weaker linkages, which are, however, more consistent in number with one dominant aspect forming the linking basis of the category, namely aspect 17 - *I know what type of activities to choose so that they encourage the development of pupils' technical creativity*.

The interrelationships between the categories are numerically low, with the exception of two medium-strong links between aspect 15 - *I understand and can explain the concept of technical creativity* and aspect 7 - *The acquisition of basic skills and knowledge and the support of technical creativity are of equal importance at lower primary school*, aspect 15 - *I understand and can explain the topic of technical creativity*, and aspect 2 - *The topic of technical creativity is necessary*.

The data suggest that knowledge of the concept of technical creativity may also influence the overall perception of technical creativity.

The abnormality which emerged for aspect 4 – *The topic of technical creativity is not demanding on the teacher's knowledge and skills* in the category of perception may lead to the thought-provoking question whether the aspect could potentially belong to other categories. However, the teacher's self-reflection should include thinking about the knowledge and skills required within the specific content. The resulting abnormality may thus be justified by a lack of subject matter knowledge in the area of technical creativity.

Consequently, if the teacher knows the appropriate activities which shall support technical creativity, he or she is able to adapt these activities to the age of the pupils and choose materials and tools. However, an adequate idea on the teacher`s side of what the content of technical creativity is (Item 15 featuring the highest median in the category), is a prerequisite. Knowledge of the concept of technical creativity is therefore reflected in the perception of the need for technical creativity and its equal role in relation to the development of pupils' knowledge and skills. Naturally, the interpretation can be reversed as well; that is, the need for technical creativity and its equal role with respect to the development of pupils' knowledge and skills influences the teacher's level of understanding of the topic of technical creativity. However, a partial influence of a good knowledge of the topic of technical creativity on the overall perception of technical creativity is apparent.

6. Conclusion

The issue of implicit pedagogical knowledge of teachers is addressed in connection with the phenomenon of creativity and the specific application of the latter in practical activities of a technical nature at primary school. This knowledge is based on experiential cognition and shows to be crucial for pedagogical decision-making and classroom interactions. At the same time, it influences the choice of teaching methods, learning tasks and ways of working, determining the development of technical creativity in pupils. Despite the fact that implicit knowledge is often non-transferable and difficult to identify, it plays an important role in the educational process. As we argue in the text, implicit knowledge cannot be studied in isolation from explicit knowledge. The implicit level in the research results is precisely represented by the intensity of aspects and their interrelationships, which characterize the more general categories and their interconnectedness.

In order to identify these individual concepts, we conducted a quantitative research investigation. Through a self-reflective questionnaire, we aimed at the basic identification and verification of key categories of subjective knowledge and the structural relationships between the categories. The categories comprised the topic perception, creative self-concept, topic knowledge, experience, motivation, conditions, and implementation (process).

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Each category was represented by seven descriptive aspects. Given the scope of the study, we focused on only two selected ones, namely the category of the knowledge and the category of the perception of the topic of technical creativity.

The research objectives were shaped into four research questions by means of which we investigated the internal organization of the categories, the dominance of particular aspects in the categories of perception and knowledge, and/or the structural interrelationships within and between the categories. The research findings led to the formulation of further questions, for example *How might teachers' preferences and beliefs manifest themselves in teaching (for the application of pupil`s creativity development)?*, *What is the expertise of primary school teachers in the field of technical education?*, and/or *In what way is teaching focused on developing pupils' technical creativity implemented by teachers without expertise? a*nd others.

Given the paucity of research on teachers' implicit knowledge of technical creativity, the opportunities for comparison with existing research were very limited. Thus, this paper represents an initial text through which we aim to contribute to the development of the knowledge base in this area. The importance of the category dealing with the perception of the issue compared to the category focusing on the knowledge of the issue points to the necessity of promoting the acquisition of positive attitudes and values towards technical creativity, technical thinking and technical literacy.

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