

# Managerial Competencies of a Teacher in the Context of Learners' Critical Thinking Development: Exploratory Factor Analysis of a Research Tool and the Results of the Research

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**Abstract** – The following study presents the results of a factor analysis of a questionnaire *Strategies of Critical and Creative Thinking within the Teaching* questionnaire (SCCTT). The instrument contains 40 items that cover 6 strategies for critical thinking development in the teaching process. The factors were extracted using the exploratory factor analysis on a sample of N = 556 university students. The study also presents the results in relation to the management of the selection and implementation of strategies that develop critical thinking in students during the teaching practice and compares the management of selection and application of strategies for the development of critical and creative thinking by the group of field didactics.

**Keywords** - critical thinking, creative thinking, factor analysis, management of strategies selection, teacher's managerial competence.

## 1. Introduction

Optimization of the content and scope of practical preparation of future teachers and the development of psychodidactic competencies of the teacher are two

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of the contemporary challenges of subject didactics. Psychodidactic competencies are among other things professional skills for the application of strategies that stimulate the critical and creative thinking of learners. The stated challenges resonate at the centre of interest in field didactics, pedagogy and pedagogical psychology as they relate to the results of international PISA measurements [1] of the OECD countries in the area of natural sciences, reading literacy, mathematical literacy [2].

Managing the selection of teaching strategies is a key psychodidactic competence that is developed in the preparation of undergraduate students in the teacher education programmes; subsequently it is consolidated in the adaptation stage of the teacher's career growth and furthermore acquires an autonomous dimension in the individual conception of teaching of the professional teacher – expert. The management of teaching strategies selection predicts the effectiveness of the educational process in the level of targets shaping indicators of critical and creative thinking development. In order to identify cognitive teaching strategies that constitute the content base of planning, realization, management of teaching and evaluation of its effectiveness in specific field didactics, we have constructed a questionnaire: *Strategies of Critical and Creative Thinking within the Teaching* in this study, with focus on its internal consistency and the analysis of the factors that fulfil the questionnaire.

## 2. Theoretical and Empirical Starting Points

Critical thinking is defined in reverse to the standard researched concept of: creativity, motivation, metacognition as a unique skill that cannot be identified with any of them. Paul & Elder [3] note that creativity and critical thinking are aspects of "good" and purposeful thinking and critical thinking and creativity represent two sides of the same coin. Aimful thinking requires the ability to consciously and strategically create intellectual

products that are directly linked to creativity. Both concepts are inseparably interconnected and they are developed in parallel. Therefore, the authors emphasize the necessity to integrate creative and critical thinking during teaching.

The source for allocation of strategies for the development of critical and creative thinking is the definition of a constructive plane of critical and creative thinking as well as the evidence that critical thinking skills can be directly influenced in the education process, as many authors claim (e.g. [4, 5, 6]). The definition of the concept of critical thinking remains still inconsistent despite the many philosophical, psychological and pedagogical perspectives and attempts [7]. The search for a unified understanding collapses on arguments of the essence of critical thinking.

Proponents of philosophical definition have based their approach on the designation of hypothetical characteristics of a critical thinker hence on the construction of an ideally thinking human or a description of his behaviour [8].

Representatives of cognitive psychology in defining the essence of critical thinking agree on the opinion that critical thinking represents mental processes, strategies and representations that people use to solve problems [9]. They criticize definitions based on behavioural or experimental approach of skills enumeration or the precise description of thought processes (standards of good thinking), with the grounding that thinking is not only a summary of discrete, independent steps, observable and explicitly expressible procedures leading to a measurable result.

Van Galder [10] emphasizes that thinking is more than the summary of its parts. The pedagogical approach, despite the criticized evaluation and measurement of results, finds its basis in the definition of education outcomes that are systemically elaborated in individual taxonomies. Taxonomies of education objectives present tools allowing the evaluation of thinking within subjects during learning. The orientation towards the observable performance of a learner is in the didactic level considered as a space for expression of the effectiveness of the didactic situation. Even this is the reason why many experts (e.g. [5]) return to Bloom's Taxonomy.

The importance of Bloom's taxonomy revised by Anderson and Krathwohl [11], lies in the fact that it allows the selection of educational strategies according to the degree of difficulty of cognitive activities [12].

Despite the considerable inconsistency of philosophical, psychological and pedagogical thought approaches there are efforts to agree on

a determination of specific abilities included in the definition of critical thinking [13].

Critical thinking is defined as "*intentional, regulated, judgment leading from a rigorous consideration of evidence, concepts, methods, criteria, and connections aimed at the interpretation, analysis, evaluation and drawing conclusions*" [14]. Authors who attempted for operationalization in multiple constructs overlap and therefore critical thinking is usually determined by the designation of individual cognitive competences that are subsequently examined in the relationship field toward other personality components (such as motivation, cognitive abilities, creativity, features), or a psychological process (learning, attention...) or other basal skills (reading, writing). According to Lai [7] these mainly dominate as follows:

- analysis of arguments, claims or evidence [4, 13];
- deduction based on inductive or deductive arguments [15];
- review and evaluation [15];
- decision-making or solution of problems [14];
- answers to clarification questions [8];
- definition of terms [8];
- identification of hypotheses [3];
- explanation [13];
- verbal reasoning particularly regarding the phenomenon of probability and uncertainty [5];
- prediction [16];
- looking at a problem from several points of view [14];
- rigorous mental activity aimed at evaluation of arguments or statements for formulation of conclusions [14].

In an attempt to define the key constructs of critical thinking required for the evaluation of education outcomes, the experts attempted to create a consensual definition that was published in the Delphi Report [13]. The core of critical thinking consists of two dimensions:

1. *specific categories of cognitive capabilities: interpretation, analysis, evaluation, judgment, explanation, self-regulation;*
2. *dimension of personality dispositions.*

Facione [13] explains categories of cognitive capabilities and personality dispositions in the sense of the Delphi Report as follows:

- Interpretation implements categorization, decoding of meaning and importance. Practically it is about recognition of a problem, identification of the main idea, sorting of information in a broad professional text, clear definition of terms, paraphrasing, interpretation of data in tables,

graphs, recognition of the meaning of non-verbal signals in communication and so on.

- The analysis presents the identification and analysis of arguments, the determination of relationships and contexts, the determination of similar and dissimilar features, the recognition of arguments and the evidence in an argument, as well as the identification of unpredictable assumptions;
- The assessment is the judgment of the reliability of arguments and their quality. It also includes evaluation of reliability of the source of information, identification of logical gaps in argumentation, assessing the strengths and weaknesses of alternative theories, assessment of justifications;
- Inference presents creation of conclusions based on evidence, formulation of alternative suggestions to problem solutions, prediction of consequences.
- Explanation includes submission of conclusions, results, presentation in the form of tables, schemes, creation of models representing the relations between variables, justification of procedures, justification of the methodological approach, arguments formulation, anticipation of counter-arguments;
- Self-regulation is monitoring and correction of one's own thought processes, identification of emotions, prejudices, stereotypes, cognitive abbreviations, in one's own reasoning and argumentation is control of the adequacy of the chosen strategy for a solution of a problem.

Personality dispositions associated with critical thinking are defined as follows [13]:

- a wide range of interests;
- the effort to be well informed;
- trust in the power of reason and one's own judgment;
- openness of mind to multiple worldviews;
- willingness to consider different alternatives; and points of view, and impartially evaluate the justifications;
- caution when drawing conclusions;
- willingness to admit egocentric inclinations, prejudices, stereotypes and logical gaps in their own thinking;
- willingness to reconsider one's own standpoint or attitude.

These features as evolving qualities of a personality [18] require effective educational strategies and their expert application. In the teaching profession expertise generated by systematized professional knowledge covers the rationalization and verbalization of hidden or silenced (tacit knowledge) prerequisites for decision-making and

action. Expertise includes the teacher's own theory in a unique situation (for each case a new theory). An expert autonomously selects teaching strategies that ensure the transformation of subject content and brings about a permanent reflection of practical activity and the self-reflection.

The expert teacher does not work routinely nor automatically, by deduction or by induction but by abduction – by the choice of one of several already made hypotheses. It is a managerial quality based on permanent communication between theoretical and practical, explicit and implicit, objective and subjective knowledge. Managerial competence represents the quality of a particular teacher contained in an individual concept, which is developed in undergraduate preparation of teacher trainees through reflected pedagogical practice [19, 20] subsequently anchored in the adaptation stage of the career growth of a teacher [21].

Key managerial competences that create teacher's expertise are skills applied in the planning and preparation of the educational process, in the realization of the educational process, in the guidance and organization of the educational process, in the evaluation of educational process effectiveness and in self-reflection and self-evaluation [22]. For effective implementation of strategies that develop critical thinking it is necessary to require managerial competencies that intervene in:

- planning of an educational target linked to the subject, taking into account the complexity of cognitive activities;
- selection of effective strategies to develop critical and creative thinking and its implementation into the particular subject;
- control of learner's studying activity, including the acquisition of factual but especially conceptual, procedural and metacognitive knowledge;
- evaluation of effectiveness of applied educational strategy and the effectiveness of one's own educational activity by identifying the quality of educational performance, classroom management efficiency, managing teaching time, fulfilling the goals and differentiation considering the diversity of learners in class [23].

International research studies (e.g. ICMI, TEDS, *Preparing Teachers around the World* [24], Standards of Practice [25,26]), provide a fairly comprehensive overview of the scientific research of teacher preparation for individual subjects (the most detailed of which is the preparation system of mathematics teachers) that allow one to gain an objective view of the pedagogical practice standard abroad and the quality of teacher training in the Slovak Republic [27]. By analysis of comparative

studies that focus on the professional training of future teachers and the development of their expertise [28,29] we identify differences between countries in the scope of practical training and in competence standards of practical training [30], particularly in the area of particular competences and managerial skills to apply adaptive teaching procedures. The differences mentioned relate mainly to competences for applying a cognitively oriented approach, meaningful learning, developing critical thinking of learners, stimulating creativity, reflection of the learning style and specificities in the mental structure and concept of a learner [31]. Although the suggested topics are only selected categories of psychodidactics [32], their perception is specific in the context of individual subject didactics. This is also indicated by OECD research efforts [27] in the definition of a need to include natural science-oriented, arts-oriented and human-oriented subjects due to their specific subject didactic concepts.

Related to research of management of the cognitive-oriented learning strategies selection, specifically strategies for developing critical and creative thinking, the priority is to identify critical and creative thinking strategies in the classroom process and so to make the undergraduate preparation of future teachers more effective by increasing the level of managerial skills. Our goal in this study is:

- design and verification of validity and reliability of a research tool that measures the extent of application of critical and creative thinking in teaching by teachers, training teachers and

- undergraduate students within their pedagogical practice,
- identification of specific strategies application (division according to factors) by students in pedagogical practice according to the dominant subject didactics.

### 3. Structure of a Research Tool: Included Strategies of Critical and Creative Thinking

During construction of research tool items we consider the work of the cited authors and analyzed theories of critical thinking and other works (for example [5, 8, 13]). We have prepared various educational strategies of critical thinking and creative thinking while considering the cognitive and dispositional components of critical thinking which in theory have the potential to assist in the development of the individual factors of critical thinking and creativity. These formulated strategies presented specific items of the research tool that we subjected to exploratory factor analysis to determine its feasibility for inclusion in the construct of critical thinking and creativity.

We expect that the result of this analysis will ascertain the factors fulfilling the strategies for the development of cognitive skills, strategies for the development of dispositional skills, strategies for the development of creative thinking, strategies supporting analysis and synthesis, inductive-deductive strategies and problem-solving strategies. The items of the research tool are listed in the following Table 1.

Table 1. Educational Strategies included in the Questionnaire: Strategies of Critical and Creative Thinking within the Teaching.

Factor	Item no.	Questionnaire Item
F1: Strategies for Development of Self-regulation	1	Using small work groups when teaching
	2	Using problem solving teaching
	3	Using the discussion as a space for exploration of learner's own feelings, remarks and opinions
	4	Creating space for learner's discovery, curiosity
	5	Using similarities and analogies
	6	Using project assignments
	7	Creating space for self-presentation, presentation of a learner's own solutions
	8	Creating space for presenting different views, attitudes and cultural differences among learners
	9	Preference of tasks with multiple correct solutions

Factor	Item no.	Questionnaire Item
F2: Strategies for Development of Systematic and Interpretative Skills	10	Leading to summarize and interpret the curriculum (say the learning content in own words)
	11	Using procedures for understanding
	12	Identification and definition of basic terms and their relations by a teacher, creation of notes
	13	Using associations (initial ideas associated with a certain term, phenomenon)
	14	Preference of cognitively more challenging tasks (tasks with analysis, evaluation, creativity) with one right solution
	15	Guiding learners towards creation of original ideas, solutions and products
	16	Using categorization (division - sorting based on a certain criterion)
	17	Leading learners towards deduction, specification (drawing on specific examples from general theories)
	18	Using techniques for remembering
F3: Argumentation Strategies	19	Using various sources (other than a textbook)
	20	Using debate in lessons (requiring analysis and arguments)
	21	Guidance toward formulation of questions that support thinking (question types like: What is the essence of it? What does it mean? Why is it happening? What if? etc.)
	22	Creating space for presenting learners' ideas, their confrontation and improvement
	23	Solution of problems and drafting conclusions
	24	Guidance of learners towards identification, naming the problems
	25	Respect for interdisciplinary relationships
F4: Strategies for Drawing Conclusions and Problems Solutions	26	Leading to application of the subject matter in unusual situations and tasks
	27	Learners' guidance to graphic design of the subject matter (conceptual maps, handout, table, graphic representations)
	28	Using role plays
	29	Use of contradictions and conflicts, guidance to argumentation
	30	Managing learners to assess the credibility of the resource, leading to argumentation
F5: Strategies for Development of Assessment	31	Leading learners towards identification of the differences between fact and opinion
	32	Leading learners towards drawing conclusions and generalization
	33	Asking questions to repeat the subject matter already learnt by heart
	34	Guiding pupils to identify the cause and effect
	35	Structuring of the subject curriculum based on defined goals according to specific taxonomies (Bloom, Simpson, Harrow, Krathwohl, Tollinger...)
	36	Leading learners to identify key and relevant facts and ideas in the curriculum
F6: Strategies for Development of Reading Skills	37	Leading learners to work with text and to create their own notes
	38	Creation of presentations and supporting learning materials for learners
	39	Use of digital study materials, programmes and applications
	40	Using graphical representations for presentation of the curriculum (conceptual maps, handout, table, graphic representations)

#### 4. Research Sample

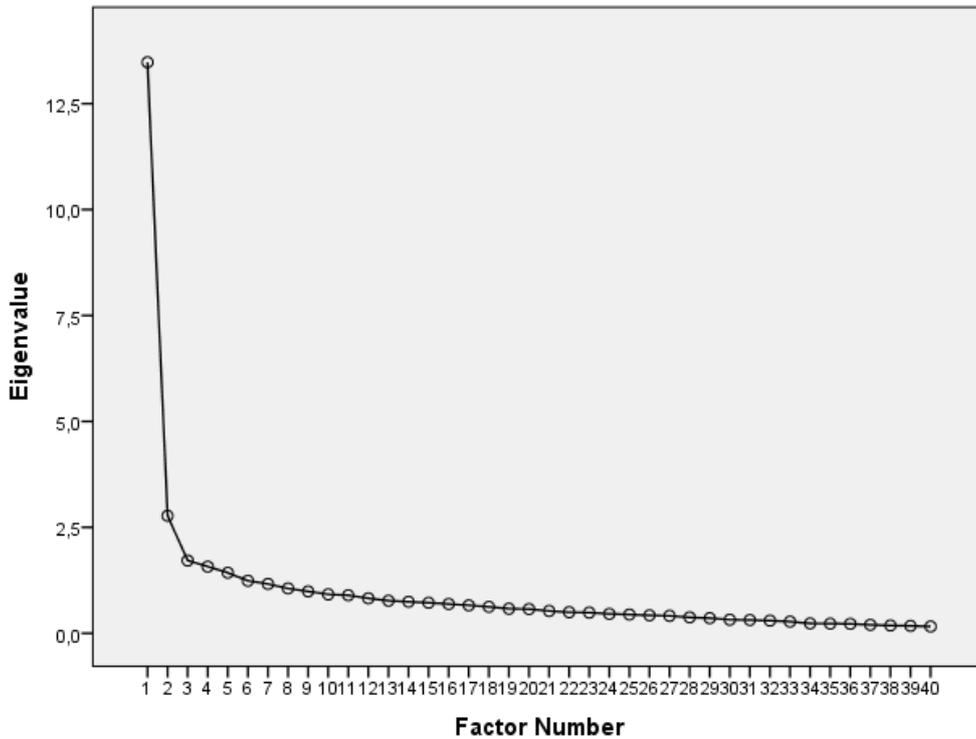
The survey sample was composed of N = 556 students in study programmes for the teaching of natural sciences, social sciences, languages, arts and educational subjects. The research included students of the bachelor (n = 342) and the master (n = 214) study programmes. Of the total number of participants n = 88 male respondents and n = 468 female respondents, average age of the respondents was M = 24.48 years with a standard deviation SD = 2.68 years (min = 21; max = 44).

With regard to the research target the respondents in the research body were classified into four basic groups according to the prevailing subject didactics taught at the faculty at which they study: 1. didactics of natural sciences subjects, mathematics and informatics – FPV (n = 175), didactics of societal sciences subjects, language subjects and the mother tongue – FF (n = 197), didactics of educational and artistic subjects, the English language – PF (n = 144) and didactics of mother tongue – FSS (n = 40).

**5. Exploratory Factor Analysis**

The Factor Analysis (Principal Axis Factoring with Varimax Rotation, Statistical Programme SPSS ver. 21) was used for the identification of individual factors. We used the graphic preview Scree Plot for the selection of the final number of factors for the

research tool. The Subjective Scree test is a point graph of numbers displaying reduced correlation matrix numbers (Eigenvalues; Table 1) sorted by the size in which are extracted those factors that fall into the part of the curve that is before the last major drop or decrease in the graph. The Scree Test stated that it is realistic to consider six factors (Graph 1).



Graph 1. Scree plot.

Table 2. Variability of Factors.

Factor	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	13.477	33.693	33.693	4.482	11.205	11.205
2	2.773	6.932	40.625	3.936	9.840	21.045
3	1.717	4.293	44.918	3.255	8.137	29.183
4	1.573	3.933	48.851	2.936	7.340	36.523
5	1.428	3.570	52.421	2.591	6.478	43.002
6	1.240	3.100	55.521	1.988	4.971	47.972

The number of possible factors was determined by the Kaiser method. Six factors were extracted through the analysis which had values > 1. The model explained 47.972 % of variability of variables in the researched file. The highest portion of variability of variables explain factors 1 and 2 (13.477%, 2.773). Factors 3 up to 6 explain variability of variables ranging from 1.717% to 1.240% (Table 2). The saturation of items of

individual factors is shown in Table 3. For clarity only values of the saturation coefficients above the level 0.300 are in the table. Among the factors only those items that saturated individual factors above the level 0.300 were implemented. None of the items had saturated a factor below the stated level, so none of the items was dropped from the model. None of the items is reversed (Table 3).

Table 3. Factor Structure of Research Tool SCCTTT.

	<b>F1</b>	<b>F2</b>	<b>F3</b>	<b>F4</b>	<b>F5</b>	<b>F6</b>
Item 1	<b>0.720</b>					
Item 2	<b>0.702</b>					
Item 3	<b>0.639</b>					
Item 4	<b>0.626</b>					
Item 5	<b>0.585</b>					
Item 6	<b>0.517</b>		0.390			
Item 7	<b>0.512</b>	0.425				
Item 8	<b>0.486</b>	0.376				
Item 9	<b>0.406</b>		0.397			
Item 10		<b>0.659</b>				
Item 11		<b>0.588</b>				
Item 12		<b>0.540</b>				
Item 13		<b>0.534</b>				
Item 14		<b>0.524</b>	0.382			
Item 15	0.380	<b>0,505</b>				
Item 16	0.381	<b>0.482</b>				
Item 17		<b>0.413</b>				
Item 18		<b>0.394</b>			0.343	
Item 19				<b>0.620</b>		
Item 20				<b>0.610</b>		
Item 21		0.355		<b>0.562</b>		
Item 22				<b>0.480</b>		
Item 23				<b>0.447</b>		
Item 24				<b>0.427</b>		
Item 25				<b>0.351</b>		
Item 26	0.401	0.365	<b>0.523</b>			
Item 27			<b>0.518</b>			
Item 28			<b>0.459</b>			
Item 29			<b>0.412</b>			
Item 30			<b>0.335</b>			
Item 31			0.498		<b>0.320</b>	
Item 32				0.494	<b>0.330</b>	
Item 33					<b>0.552</b>	
Item 34					<b>0.446</b>	
Item 35					<b>0.404</b>	
Item 36					<b>0.366</b>	
Item 37					0.398	<b>0.305</b>
Item 38						<b>0.720</b>
Item 39						<b>0.604</b>
Item 40					0.367	<b>0.380</b>

*\*Note: F1 – Strategies for Development of Self-regulation; F2 – Strategies for Development of Systematic and Interpretive Skills; F3 – Argumentation Strategies; F4 – Strategies for Drawing Conclusions and Problems Solutions; F5 – Strategies for Development of Assessment; F6 – Strategies for Development of Reading Skills.*

As part of the research, extraction of the factors of the research tool *Strategies of Critical and Creative Thinking in Teaching*, the reliability of the whole instrument and its individual sub-scales via the Cronbach's alpha coefficient was also investigated. Cronbach's alpha coefficient at a level of individual sub-scales ranges from  $\alpha = 0.811$  to  $\alpha = 0.943$  and for the whole range  $\alpha = 0.979$ . The version created on the basis of the exploratory factor analysis with six sub-scales had Cronbach's alpha coefficient for the subgroup of the Strategies for the Development of Cognitive Skills  $\alpha = 0.936$  (8 items), Strategies for the Development of Disposition Skills  $\alpha = 0.925$  (7 items), Strategies for Developmental of Analytical, Synthetic and Creative Thinking  $\alpha = 0.943$  (9 items), Problems Solution  $\alpha = 0.811$  (5 items), Structure of the Curriculum  $\alpha = 0.861$  (4 items), Strategies for the Development of Inductive and Deductive Thinking  $\alpha = 0.888$  (6 items). The alpha coefficient of individual sub-scales is high, so neither of the sub-scales appears to be a problematic factor in terms of internal consistency of the research tool.

### 5.1. Descriptive Statistics

In the following section of the text we focus on:

- identification of the use for individual strategies of critical thinking (extent) by students during pedagogical practice when considering specific factors of critical thinking (managerial quality in relation to the realization of the teaching process).
- identification of differences in the management of selection and application of critical thinking strategies according to the group of subject didactics, according to the subjects for which the training is being prepared at the relevant faculty (SCCTT questionnaire variable).

Statistical analyses were carried out in the statistical programme IBM SPSS 20 (Statistical Package for the Social Sciences). Methods of descriptive statistics for the description of research data were used, namely: number, mean, average of items (summary score divided by the number of items in a factor), standard deviation, standard error of mean, minimum, maximum, obliquity and tapering of data distribution [17]. The results are shown in Table 4.

Table 4. Descriptive Statistics of Factors of SCCTT Questionnaire (Whole Research File).

Factor	N	M	IM	MIN	MAX	SD	SEM	S	C
Factor 1: Strategies for Development of Self-regulation	449	31.08	3.88	0.00	52.00	13.091	0.618	-1.036	0.518
Factor 2: Strategies for Development of Systematic and Interpretive Skills	448	35.17	3.91	0.00	52.00	12.916	0.610	-1.466	1.768
Factor 3: Argumentation Strategies	446	20.85	3.48	0.00	35.00	7.817	0.370	-1.037	0.847
Factor 4: Strategies for Drawing Conclusions and Problems Solutions	446	33.20	4.15	0.00	48.00	10.925	0.517	-1.776	3.049
Factor 5: Strategies for Development of Assessment	445	20.21	4.04	0.00	30.00	6.888	0.327	-1.669	2.657
Factor 6: Strategies for Development of Reading Skills	458	15.61	3.90	0.00	24.00	6.056	0.283	-1.215	0.964

\*Note.: N– number; M– mean; IM– item mean; SEM– standard error of mean; SD– standard deviation; S– skewness; C– kurtosis.

Observing the average score of items, the highest average score was measured in the factor for the Drawing Conclusion and Problems Solution Strategies (IM = 4.15). Approximately 0.10 points below the mean values were measured in the Development of Assessment Strategies (IM = 4.04). Comparably average values were found in the factors of Strategies for Developing Systematic and Interpretative Skills (IM = 3.91), Strategies for the Development of Reading Skills (IM = 3.90), and the Strategies for Development of Self-regulation (IM = 3.88) where the values were about 0.25 points lower in comparison to Conclusion Drawing Strategies and Problems Solution Strategies. The lowest average

score was measured in the factor of Argumentation Strategies (IM = 3.48), which when measured averaged 0.50 of a point lower as compared to other factors.

### 5.2. Comparison of Management of Critical and Creative Thinking Strategies in Teaching according to Subject Didactics

In the following part of the research, we will focus on the identification of the extent and the differences among students of individual research groups in the SCCTT questionnaire variables. Statistical analyses were conducted in the statistical programme IBM

SPSS 20 (Statistical Package for the Social Sciences).

Research data are described by multiplicity, average, average score of the items for a factor (summary score divided by the number of appropriate items in the factor), standard deviation,

standard error and the Confidence Interval for Mean. ANOVA was chosen to find out the differences between the research groups in the SCCTT questionnaire variables. The results are shown in Tables 5 and 6.

Table 5. Descriptive Statistics of the SCCTT Questionnaire Factors according to Subject Didactics at the Faculty.

		N	M	IM	SD	SE	95% Confidence Interval for Mean	
							Lower Bound	Upper Bound
Factor 1: Strategies for Development of Self-regulation	FPV	159	31.214	3.902	11.031	0.875	29.486	32.942
	FF	153	31.281	3.910	12.108	0.979	29.347	33.215
	PF	97	27.309	3.414	17.458	1.773	23.791	30.828
	FSS	40	38.900	4.863	7.452	1.178	36.517	41.283
Factor 2: Strategies for Development of Systematic and Interpretive Skills	FPV	159	36.642	4.071	9.569	0.759	35.143	38.140
	FF	150	35.993	3.999	12.075	0.986	34.045	37.942
	PF	99	28.788	3.199	17.608	1.770	25.276	32.300
	FSS	40	42.000	4.667	6.497	1.027	39.922	44.078
Factor 3: Argumentation Strategies	FPV	160	21.306	3.551	6.428	0.508	20.303	22.310
	FF	148	20.595	3.432	7.405	0.609	19.392	21.797
	PF	98	18.214	3.036	9.982	1.008	16.213	20.215
	FSS	40	26.450	4.408	4.857	0.768	24.897	28.003
Factor 4: Strategies for Drawing Conclusions and Problems Solutions	FPV	157	34.217	4.277	7.923	0.632	32.968	35.466
	FF	152	33.303	4.163	10.256	0.832	31.659	34.946
	PF	97	29.495	3.687	15.722	1.596	26.326	32.663
	FSS	40	37.800	4.725	5.928	0.937	35.904	39.696
Factor 5: Strategies for Development of Assessment	FPV	155	21.342	4.268	5.038	0.405	20.543	22.141
	FF	153	20.386	4.077	6.964	0.563	19.273	21.498
	PF	97	16.691	3.338	8.839	0.897	14.909	18.472
	FSS	40	23.700	4.740	3.172	0.502	22.686	24.714
Factor 6: Strategies for Development of Reading Skills	FPV	162	16.049	4.012	4.777	0.375	15.308	16.791
	FF	157	15.930	3.982	5.935	0.474	14.994	16.865
	PF	99	13.192	3.298	7.898	0.794	11.617	14.767
	FSS	40	18.575	4.644	3.580	0.566	17.430	19.720

\*Note.: N – number; M – mean; IM – item mean; SD – standard deviation; SE – standard error; FPV – didactics of natural sciences subjects of mathematics and informatics, FF – didactics of social sciences subjects, language subjects, PF – didactics of educational and artistic subjects and foreign language FSS – didactics of mother tongue

While observing the average values in Table 5, differences in the extent of all strategies for the development of critical and creative thinking in teaching among students were spotted. In general, the highest score of all variables was achieved by students who study mother tongue didactics – FSS, significantly lower scores in all variables were

achieved by students studying didactics of natural science subjects of mathematics and informatics – FPV, didactics of social sciences, language subjects – FF while students of didactics of educational and artistic subjects and foreign language – PF achieved the lowest score in all monitored variables.

Table 6. Comparison of Subject Didactics at Faculties in SCCTT Questionnaire Factors.

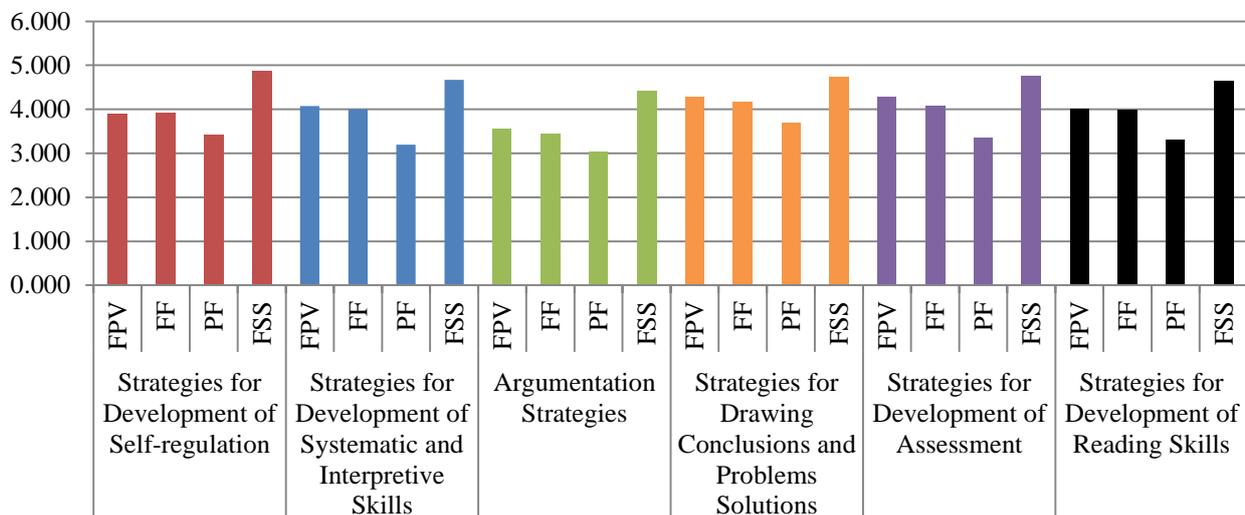
	Sum of Squares	df	MS	F	p
Factor 1: Strategies for Development of Self-regulation	3834.305	3	1278.102	7.798	<0.001
Factor 2: Strategies for Development of Systematic and Interpretive Skills	6344.339	3	2114.780	13.763	<0.001
Factor 3: Argumentation Strategies	1978.164	3	659.388	11.559	<0.001
Factor 4: Strategies for Drawing Conclusions and Problems Solutions	2341.877	3	780.626	6.796	<0.001
Factor 5: Strategies for Development of Assessment	1891.896	3	630.632	14.504	<0.001
Factor 6: Strategies for Development of Reading Skills	977.858	3	325.953	9.377	<0.001

\*Note.: *df* – degrees of freedom; *MS*– Mean Square; *F* – ANOVA; *p* – level of statistical significance.

In the inferential comparison of the research groups at the faculty where they study with respect to subject didactics we found a statistically significant difference at level of all factors of the SCCTT questionnaire at the level of statistical significance  $p < 0.001$ : Strategies for Development of Self-regulation ( $F = 7.798$ ;  $p < 0.001$ ) Strategies for Development of Systematic and Interpretive Skills ( $F = 13.763$ ;  $p < 0.001$ ), Argumentation Strategies ( $F = 11.559$ ;  $p < 0.001$ ), Strategies for Drawing

Conclusion and Problems Solution ( $F = 6.796$ ;  $p < 0.001$ ), Strategies for Development of Assessment ( $F = 14.504$ ;  $p < 0.001$ ) and the Strategies for Development of Reading Skills ( $F = 9.377$ ;  $p < 0.001$ ; Table 6).

Comparison of individual research groups in the implementation of strategies for the development of critical and creative thinking in education is graphically depicted in Graph 2.



Graph 2. Comparison according to Subjects Didactics at Faculties within the Factors of SCCTT Questionnaire.

## 6. Discussion and Conclusion: Recommendation for Modification of the SCCTT Research Tool

Individual factors of the research tool extracted by exploratory factor analysis can be interpreted as follows:

- Strategies for the development of self-regulation – present mainly strategies for developing personality, volition and emotion connected with

critical thinking such as: widening the circle of interests, motivation and stimulation of the need to be well informed, strengthen the trust in the power of reason and one’s own judgment, openness of mind towards diverse worldviews, willingness to consider different alternatives and points of view and without prejudice to consider substantiation, caution in drawing conclusions, willingness to admit egocentric inclinations,

prejudices, logical gaps in one's own thinking, willingness to re-evaluate one's own opinion and also the development of metacognitive skills, monitoring and correction of one's own thought processes, identification of emotions, prejudices, stereotypes, cognitive abbreviations, in one's own judgement and argumentation and control of the adequacy of the chosen problem-solving strategy.

- Strategies for the development of systematic and interpretative skills – present mainly strategies aimed at recognition of a problem, identification of main idea, classification of information in a broad professional text, clear definition of terms, paraphrasing, interpretation of data in tables, graphs, recognition of the meaning of non-verbal signals in communication and so on.
- Argumentation strategies – represent procedures leading to the identification and analysis of arguments, determination of relationships and connections, similar and dissimilar characters, recognition of arguments and evidence in an argument, identification of unexpressed assumptions.
- Strategies for drawing of conclusion and problems solving – these include mainly procedures leading to the formulation of alternative suggestions to solutions of a problem, prediction of consequences, presentation of conclusions, results, presenting in the form of tables, schemes, creation of models expressing relations between variables, justification of procedures, methodological approach, formulation of arguments, anticipation of counter-arguments.
- Development Assessment Strategies - assessment presents the judgement of the reliability of arguments and the quality of the arguments. It also includes judgement of the reliability of the source of information, identification of logical gaps in argumentation, assessing of strengths and weaknesses of alternative theories, judgement of the justifications.
- Strategies for the development of reading skills - we have included mainly strategies based on work with text that led to reading comprehension.

From the point of view of reliability we consider the research tool to be satisfactory based on the results of Cronbach's alpha. The problem arises when assessing the validity of the research tool, given that some items saturate more than one factor above the level .300. The problem of classification of individual items is probably given by the very essence of thinking. As Van Galder stated [10] thinking is more than the summary of its parts and

similarly as critical thinking not even the strategies for the development of critical thinking are able to be built on an exact description of strategies developing isolated skills or thought processes. Nevertheless individual items saturate factors constructed based on the theoretical frameworks and reflect the pedagogical reality which is confirmed by the results of analyses presented in subchapters 5.1 and 5.2. Prospectively the research tool will be subjected to further analyses after the implementation of new items into existing factors in order to increase the validity and complexity in measuring the degree of implementation of strategies for the development of critical and creative thinking.

### ***6.1. Discussion and Conclusion: Management of Selection and Realization of Critical and Creative Thinking Strategies in Teaching according to the Subject Didactics***

Psychodidactic themes in undergraduate preparation of teachers lead to changes in the view of an individual's teaching. These themes allow students to see the teaching process in broader contexts, to recognize the essence of many problems and to find ways to solve them, thus becoming an important source of innovation in independent pedagogical thinking, planning, decision making, evaluation, meaning in managing of the educational process. We wondered if the management of selection and application of strategies developing critical thinking differs in terms of the preference of strategies of a particular factor of critical thinking by checking which strategies are used by students during the pedagogical practice most frequently and which the least. We found that the most often chosen and implemented were strategies for drawing conclusions and solving problems, namely the use of various resources other than textbooks, leading learners towards making conclusions and generalization, respecting inter-subject relationships, using debate and discussion in teaching which leads to creation of analyses and arguments, guiding toward the formulation of questions that support thinking (question types such as: What is the essence of...? What does it mean?, Why is it happening?, What if...?, etc.), creating space for presenting learners' ideas, for their confrontation and improvement, leading them towards identification, naming problems, solving the problem, and drawing conclusions. In the context of developing psychodidactic competencies and increasing the managerial skills of a future teacher, important for us are factors with strategies that have been chosen and applied least by students in the teaching process. These are strategies for the development of self-regulation and strategies of argumentation. In terms

of factor analysis results belong here: creating space for self presentation, presentation of learner's own solutions, creating space for presenting different opinions, attitudes and cultural differences among learners, using the discussion as a space for exploring their own feelings, views and learners' opinions, using the work of small groups in teaching, creating space for learners' exploration, curiosity, research, use of problem solving techniques, using similarities and analogies, using project teaching, preference of tasks with more correct solutions, using contradictions, guiding to argumentation, guiding learners to identify differences between fact and opinion, leading learners to graphical presentation of the subject matter (conceptual maps, handouts, tables, graphic representations, leading learners to assessment of resource credibility, argumentation, guidance to the application of the curriculum in unusual situations and tasks, use of the role playing method. The results are an important argument for the innovation of the content of didactic disciplines in teacher preparation and the innovation of the theory of teaching in the field of educational strategies.

The second area we focused our attention on in the management of critical thinking strategies was the selection and application of strategies of critical thinking by students according to a group of subject didactics, according to the subjects the student prepared at the relevant faculty (SCCTT questionnaire variables). We have found significant differences in the application of all the factors of the strategies for the development of critical and creative thinking according to the monitored subject didactics. The most strategies are applied by students of the mother tongue – FSS and in all factors. Possible association may be seen with the choice of strategies stimulating reading literacy which is preferentially put into the didactics of the mother tongue. According to developed categories of cognitive functions in natural sciences we expected a

significantly higher share of critical thinking strategies among students of teaching natural sciences subjects, mathematics and computer science. Surveyed results are in this case a fundamental finding not only for the subject didactics which has to focus one's own research intentions on psychodidactic themes but especially for the subject methodologies of relevant subjects, who must include in the preparation of future teachers the management of a selection of educational strategies taking into account constructivist and cognitive theory and implement it in the model of reflective pedagogical practice. Significantly less included in the teaching process are the strategies for critical and creative thinking by student teachers of educational and artistic subjects and the English language – PF, in all the factors of the observed strategies. A possible relation is seen in the essence and position of educational and artistic subjects among all of the subjects as well as at the level of elaboration of the psychodidactic themes in didactics of art-educational and pedagogical subjects, which is regarded as the lowest among all of the didactics. Statistically significant differences in the management of selection of strategies according to factors were not observed among the surveyed groups.

The results are an important finding for the theory of individual subjects' didactics and subject practitioners of relevant subjects provoking the need for innovation in the field of management of teaching strategies and the necessary innovation of the subject methodology, which will be complemented by tasks and assignments linked to the specific subject matter content. It is expected that the subjects' methodologies will be communicated by teacher trainers who will implement them in the practical preparation of students engaged in teaching programmes.

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