

# Executive Functions in the Context of Professional Competencies of Future Teachers

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**Abstract** – This paper focuses on the scientific analysis of the interrelationships between executive functions and the professional competencies of future teachers. The research aims to reveal this relationship by measuring the interaction styles of future teachers (organiser, helping, understanding, leading to responsibility, insecure, dissatisfied, reprimanding, strict), didactic competencies (planning and preparing lessons, lesson implementation, classroom climate, diagnosis and evaluation, self-reflection), teaching styles (manager, knowledge-oriented, goal-oriented, supportive) and the level of their executive functions (planning, time management, organising, emotional regulation, behaviour regulation). The most significant findings are the moderate relationship between the executive functions and the interaction styles of the teaching adepts and between the executive functions and the didactic competencies of the teaching adepts. We found no statistically significant relationships between executive functions and teaching styles.

**Keywords** – executive functions, didactic teacher competencies, teacher interaction style, teaching style, future teachers.

## 1. Introduction

Executive functions are often defined as a control system that assigns priority to some processes while dampening the activity of others.

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We understand executive functions as mental functions that control cognitive functions, condition the processing of stimuli, and distribute resources for their processing and use. They manifest themselves in the processes of inhibition, attentional control, working memory, self-regulation, and planning [1].

Lezak et al. [2] define executive functions as one of the most complex types of behaviour: „executive functions are inherent in the ability to respond adaptively to new situations and are the basis for many cognitive, emotional and social skills.“

The domain of these functions is the ability to avoid inappropriate responses, resist distraction and interference, sustain behaviour for a longer time, use multiple sources of information simultaneously, understand the nature of a complex situation, and plan and act comprehensively [3].

It is possible to characterise professional competence as „the comprehensive ability or competence to perform a profession successfully. It includes knowledge, skills, attitudes, values, motives and personality traits that are manifested in certain characteristic behaviours and influence the level of performance and activity. Other factors also determine teachers' behaviours: their experience, way of thinking, teaching style, their conception of teaching, their perception of self in the role of teacher, ability for self-reflection, willingness to develop further, etc.“ [4].

Professional competence is „the totality of competencies that teachers should have to effectively teach and educate as well as to improve their pedagogical activity, and which should be formed, cultivated or even improved in student teachers“ [5].

Each country has agreed on the standard sets of specific professional competencies for the teaching profession. We do not currently have clearly defined and classified teaching professional competencies in the Slovak Republic. Approximately eight competence models have been identified [6]. The basis for the development of professional standards for teachers in Slovakia was the competence model by Kasáčová and Kosová [7], [8]. It is based on the interactive teacher education and competence model and includes learner-centred competencies, competencies oriented towards educational processes and teacher self-development competencies.

According to Ballová Mikušková [9], teachers' professional competencies consist mainly of their didactic competencies and teaching and interaction styles.

Didactic competencies are specifically related to the process of planning, organising, managing, evaluating and implementing the teaching process [10]. Teachers with developed didactic competencies should have pedagogy, ontogenetic psychology and Didactic knowledge. They should know and use innovative teaching forms and methods, design teaching objectives, content, methods and forms, and evaluate the educational process [11].

Teaching style represents the way a teacher communicates, manages tasks, supervises processes, and socialises students and learners [12], [13], [14]. Further studies [12], [13] have developed the Grasha-Reichmann model consisting of five basic teaching styles. Based on the above authors' works, we examined four teaching styles: manager, knowledge-oriented, goal-oriented, and supportive.

A teacher's interaction style is a relatively stable way of interaction, behaviour and communication that helps students anticipate the teacher's actions [15], [16], [17]. The interaction style represents the teacher's characteristics, skills, methods and procedures used to develop the pupil's personality. They directly impact the classroom climate, pupils' relations with the teacher, and didactic, organisational and communicative activities [18]. In this study, we based on Leary's model of personality [19]. We derived a model of teacher interaction behaviour [20], which consisted of the following interaction styles: organiser, helping, understanding, leading to responsibility, uncertain, dissatisfied, reprimanding, and strict.

Executive functioning and readiness to deliver high-quality performance are closely interrelated and often mutually contingent, as it is evident in some research [21], [22].

Friedman-Krauss, Raver, Neuspiel & Kinsel [23] found that more developed executive functions have an impact on reducing teachers' job stress.

Biecheler's research [24] indicates that while teachers are familiar with the concept of executive functions and understand their importance in academic settings, their ability to implement that knowledge into practice is lower.

If there were a positive correlation between executive functions and teachers' individual professional competencies, it would be possible to develop them by acting on executive functions. There are several development programmes in the area of executive functions, e.g. Cogmed computer-based training for working memory and reasoning [25], Smart but Scattered Teens – The „Executive Skills“ Program for Helping Teens Reach Their Potential [26] and others.

Given the above facts, the main objective of our research was to find the closeness of the relationship between the level of executive functions and the professional competencies of future teachers. Then, the sub-objectives were to verify whether there is a relationship between the level of executive functions and the level of interaction styles. We also wanted to confirm whether there is a relationship between the level of executive functions and the level

of didactic competence. We were interested to know whether there is a relationship between the level of executive functions and the level of the teaching style of future teachers.

To achieve the above objectives, we set the following hypotheses:

- H1. We hypothesise that there is a relationship between the level of executive functions and the level of interaction style of future teachers.
- H2. We hypothesise that there is a relationship between the level of executive functions and the level of didactic competence of future teachers.
- H3. We hypothesise that there is a relationship between the level of executive functions and the level of future teachers' teaching styles.

## 2. Methodology

We chose the following questionnaires to collect the data used in the research:

The Executive Function Questionnaire ESQ-R [27] contains 25 items aimed at ascertaining the level of the executive functions Planning, Time Management, Organising, Emotional Regulation, and Behavioural Regulation. The items have an inverse character. Respondents rate their behaviour across the 25 statements on a 5–point scale, with 1 = never and 5 = always.

The Interaction Styles Questionnaire [9] - the original assessment questionnaire of teacher interaction QTI [15], [28] was modified into a self-assessment form and validated by the team of researchers of the project VEGA 1/0084/21 Personal, cognitive and motivational predictors of teachers' professional competencies in pre-graduate preparation and practice. Self-assessment takes place in eight dimensions of teacher behaviour based on Leary's personality model: Organiser, helper, understanding, leading to responsibility, insecure, dissatisfied, reprimanding, and strict. Respondents rate their behaviour in 40 statements on a 5–point scale, with 1 = never and 5 = always.

The Didactic Competencies Questionnaire [9] was compiled by the team of researchers of the project VEGA 1/0084/21 Personal, cognitive and motivational predictors of teachers' professional competencies in pre-graduate preparation and practice. Respondents rate their behaviour on five dimensions corresponding to the different phases of the lesson (planning and preparation, implementation, classroom climate, diagnostics and evaluation, or self-reflection) on a 5–point Likert scale, where 1 = completely disagree and 5 = agree entirely. The questionnaire consists of 57 items.

The Teacher Teaching Styles Questionnaire [9] was translated and modified by the team of researchers of the project VEGA 1/0084/21 Personality, cognitive and motivational predictors of teachers' professional competencies in pre-graduate

preparation and practice. The modification consisted of a combination of items from the Inventory of Teaching Styles [12], [13] and The Staffordshire Evaluation of Teaching Styles [14]. The resulting questionnaire was psychometrically validated in Slovak conditions. Respondents rate their teaching style on a 5–point Likert scale, where 1 = completely disagree and 5 = agree entirely. The questionnaire has four dimensions corresponding to individual teaching styles (managerial, knowledge-oriented, goal-oriented, and supportive). For each dimension, it is possible to calculate an average score. The questionnaire consists of 20 items.

We processed the results of our research in the statistical program JASP. We used descriptive statistics to describe the individual sample characteristics. Pearson's correlation coefficient method was used in the statistical processing of the data.

The research sample consisted of 61 students from the Secondary School of Education. Regarding gender structure, there were 59 female and two male students. We made the selection of the respondents deliberately; they were students of teacher education in their final year. The age structure of the research sample ranged from 17 to 19 years. The respondents were personally briefed about the implementation of the questionnaires and gave written consent for the research and data processing.

### 3. Research Results

In Tables 1 – 4, we present the results of descriptive statistics of the individual variables under study (Executive functions, Teacher's interaction style, Teacher's didactic competencies, and Teacher's teaching style). Namely, we mention the research sample size, the mean values, the minimum and maximum values achieved and the standard deviation.

In Table 1, we report the research sample size, the mean values, the minimum and maximum values achieved, and the standard deviation of the respondents' executive function levels.

Table 1. Descriptive statistics of the research sample concerning the level of executive functions

Executive function	N	AM	Max	Min	SD
Planning		3,25	5	1	1,25
Time management		2,89	5	1	1,17
Organizing	61	3,32	5	1	1,44
Emotional regulation		2,87	5	1	1,29
Behavioral regulation		2,87	5	1	1,06

Legend: N = number, AM = arithmetic mean, Max = highest value reached, Min = lowest value reached, SD = standard deviation

In Table 2, we report the research sample size, mean values, minimum and maximum values attained and the standard deviation of the respondents' teacher interaction style level.

Table 2. Descriptive statistics of the research sample concerning the level of teacher's interaction style

Interaction style	N	AM	Max	Min	SD
Organiser		4,11	5	1	0,88
Helping		4,47	5	1	0,85
Understanding		4,19	5	1	2,41
Leading to responsibility	61	3,94	5	1	1,12
Uncertain		2,52	5	1	1,22
Dissatisfied		2,07	5	1	1,13
Reprimanding		2,16	5	1	1,20
Strict		2,91	5	1	1,18

Legend: N = number, AM = arithmetic mean, Max = highest value reached, Min = lowest value reached, SD = standard deviation

In Table 3, we present the research sample size, mean values, minimum and maximum values achieved and the standard deviation of the level of didactic competencies of the respondents.

Table 3. Descriptive statistics of the research sample concerning the level of didactic competencies of the teachers

Didactic competence	N	AM	Max	Min	SD
Planning and preparing lessons		3,84	5	1	0,98
Implementation of lessons		3,81	5	1	0,95
Classroom climate	61	4,00	5	1	1,02
Diagnostics and evaluation		3,80	5	1	0,97
Self reflection		3,72	5	1	1,11

Legend: N = number, AM = arithmetic mean, Max = highest value reached, Min = lowest value reached, SD = standard deviation

In Table 4, we report the research sample size, mean values, minimum and maximum values achieved and the respondents' teaching style level standard deviation.

Table 4. Descriptive statistics of the research sample concerning the level of the teacher's teaching style

Teaching style	N	AM	Max	Min	SD
Manager		3,04	5	1	1,17
Knowledge oriented		3,25	5	1	1,03
Goal oriented	61	3,61	5	1	0,99
Supporting		3,99	5	1	1,06

Legend: N = number, AM = arithmetic mean, Max = highest value reached, Min = lowest value reached, SD = standard deviation

We carried out the analysis to determine the closeness of the relationships between the variables through Pearson's correlation coefficient. We verified the closeness of the relationships between the executive functions and the other variables studied (interaction style, didactic competence and teaching style). The obtained results are presented in the context of each variable concerning the executive functions.

The first area examined was the relationship between executive functions and teacher interaction styles. The closeness of the relationships was identified at the weak relationship level ( $r > 0.2$ ) and the moderate relationship level ( $r > 0.3$ ). We identified two relationships at the  $p < 0.05$  level and one relationship at the borderline level of significance. Through Pearson's correlation analysis, we identified a weak, negative relationship between Organiser Interaction Style and Emotional Regulation as an executive function ( $r = -0.268$ ;  $p = 0.040$ ), a weak, negative relationship between the interactional style - Uncertain and Planning as an executive function ( $r = -.293$ ;  $p = 0.020$ ), and a moderate, negative relationship between the interactional style Reprimanding and Emotional Regulation as an executive function ( $r = -0.308$ ;  $p = 0.018$ ). The results are presented in Table 5. Thus, the relationship between executive functions and teacher interaction styles exists in the three areas of teacher interaction styles (Organiser, Uncertain, Reprimanding) concerning the three executive functions (Plan Management, Emotional Regulation, and Behavioural Regulation).

Table 5. Relationship between executive functions and interaction styles

Interaction style	Executive function			
	Planning	Time management	Organising	
Organiser	r	0,080	-0,086	0,031
	p	0,545	0,519	0,818
Helping	r	0,094	0,006	-0,053
	p	0,480	0,963	0,689
Under standing	r	-0,118	-0,084	0,015
	p	0,374	0,527	0,909
Leading to responsi bility	r	0,016	-0,139	-0,052
	p	0,901	0,293	0,694
Uncertain	r	-0,293	-0,239	-0,171
	p	0,025*	0,068	0,196
Dis satisfied	r	-0,168	-0,247	-0,150
	p	0,203	0,059	0,258
Repri manding	r	0,039	-0,099	-0,231
	p	0,768	0,458	0,078
Strict	r	0,083	0,002	0,163
	p	0,531	0,968	0,216

Legend:  $r$  = Pearson's correlation coefficient,  $p$  = significance; \* =  $p < 0.05$

Table 5. – continue. Relationship between executive functions and interaction styles

Interaction style	Executive function		
	Emotional regulation	Behavioural regulation	
Organiser	r	-0,268	-0,126
	p	0,040*	0,340
Helping	r	-0,210	-0,182
	p	0,111	0,167
Understanding	r	-0,010	-0,054
	p	0,937	0,685
Leading to responsibility	r	0,033	-0,191
	p	0,802	0,148
Uncertain	r	0,030	-0,017
	p	0,823	0,898
Dissatisfied	r	-0,010	0,021
	p	0,942	0,872
Reprimanding	r	-0,308	-0,153
	p	0,018*	0,248
Strict	r	-0,022	0,025
	p	0,867	0,848

Legend:  $r$  = Pearson's correlation coefficient,  $p$  = significance; \* =  $p < 0.05$

The second area investigated was the relationship between executive functions and didactic competencies. The closeness of the relationships was identified at the level of weak relationship ( $r > 0.2$ ) and moderate relationship ( $r > 0.3$ ). We identified all relationships at the significance level of  $p < 0.05$ . Through Pearson's correlation analysis, we found a weak negative relationship between Lesson Implementation as a didactic competence and Emotional Regulation as an executive function ( $r = -.276$ ;  $p = 0.034$ ), a weak negative relationship between Lesson Implementation as a didactic competence and Behavioural Regulation as an executive function ( $r = -0.257$ ;  $p = 0.049$ ), a moderate negative relationship between the didactic competence Self-reflection and Emotional Regulation as an executive function ( $r = -0.326$ ;  $p = 0.012$ ), and a moderate negative relationship between the didactic competence Diagnostics and Evaluation and the executive function Emotional Regulation ( $r = -0.309$ ;  $p = 0.017$ ). The results are presented in Table 6.

Table 6. Relationship between executive functions and didactic competencies

Didactic competencies	Executive function			
	Planni ng	Time management	Organising	
Lesson planning and preparation	r	0,134	0,006	0,058
	p	0,312	0,961	0,662
Lesson implemen tation	r	0,238	-0,098	-0,073
	p	0,069	0,459	0,585
Classroom	r	0,137	0,121	-0,079

climate	p	0,302	0,363	0,552
Diagnostics	r	0,231	-0,020	0,048
and				
evaluation	p	0,078	0,881	0,718
Self	r	-0,089	-0,202	-0,151
reflection	p	0,502	0,125	0,252

Legend: *r* = Pearson's correlation coefficient, *p* = significance; \* = *p* < 0.05

Table 6. – continue. Relationship between executive functions and didactic competencies

Didactic competencies		Executive function	
		Emotional regulation	Behavioural regulation
Lesson planning and preparation	r	-0,100	-0,117
	p	0,452	0,376
Lesson implementation	r	-0,276	-0,076
	p	0,034*	0,568
Classroom climate	r	-0,226	-0,205
	p	0,085	0,120
Diagnostics and evaluation	r	-0,309	-0,149
	p	0,017*	0,259
Self reflection	r	-0,326	-0,257
	p	0,012*	0,049*

Legend: *r* = Pearson's correlation coefficient, *p* = significance; \* = *p* < 0.05

Thus, the relationship between the executive functions and didactic competencies exists in the three didactic competence areas (Lesson Implementation, Diagnostics and Evaluation, Self-reflection) concerning the two executive functions (Emotional Regulation and Behavioural Regulation).

The third area examined was the relationship between executive functions and teaching styles. The results are presented in Table 7. We found no statistically significant relationships between the executive functions and teaching style domains.

Table 7. Relationship between executive functions and teaching styles

Teaching style		Executive function		
		Planning	Time management	Organising
Manager	r	0,232	-0,168	-0,060
	p	0,077	0,204	0,650
Knowledge oriented	r	-0,019	-0,094	0,145
	p	0,888	0,479	0,273
Goal oriented	r	-0,042	-0,035	-0,115
	p	0,753	0,792	0,386
Supportive	r	-0,006	-0,207	-0,123
	p	0,962	0,115	0,352

Legend: *r* = Pearson's correlation coefficient, *p* = significance; \* = *p* < 0.05

Table 7. – continue. Relationship between executive functions and teaching styles

Teaching style		Executive function	
		Emotional regulation	Behavioural regulation
Manager	r	-0,014	0,026
	p	0,919	0,846
Knowledge oriented	r	0,149	0,042
	p	0,261	0,755
Goal-oriented	r	-0,222	-0,221
	p	0,092	0,093
Supportive	r	0,106	-0,202
	p	0,423	0,124

Legend: *r* = Pearson's correlation coefficient, *p* = significance; \* = *p* < 0.05

#### 4. Conclusion

The issue of professional competencies is currently receiving increasing attention. Every teacher should possess and be able to apply professional competencies effectively in teaching to achieve educational goals. However, it is impossible to achieve its development without the support of executive functions, which plays an irreplaceable role in the teacher's activity and each individual's life.

This work investigated the closeness of the relationships between executive functions and interaction style, didactic competence and teaching style. In doing so, we know that the degree of correlation between the two variables is not static but can vary significantly over the time.

In validating the results of the correlation research, we identified significant relationships between variables in varying degrees of intensity. While the executive functions concerning some variables under study showed a moderately strong or weaker negative relationship, some variables did not establish a relationship to the executive functions. We found statistically significant relationships between the executive functions of Planning, Emotional Regulation, and Behavioural Regulation and the interaction styles of the teacher (Organiser, Uncertain, and Reprimanding). Based on this statement, we accept hypotheses 1 and 2. We do not accept Hypothesis 3 because no significant relationship has been demonstrated between the variables under study.

Interaction style is a teacher's „typical and relatively enduring personality characteristic manifested in their actions, behaviours, and communications during the classroom. Thus, it influences teacher's didactic, organisational and communicative activities“ [18]. The teacher's interaction style is a means that influences students and their approaches to learning. There is a reciprocal relationship between the teacher and the

pupil in teaching practice. These interactions of the teacher toward the pupil are called interaction styles. All teachers have different qualities, didactic approaches and emotions that they send to their pupils [29]. In the context of our findings, we would like to draw attention to the moderately strong negative relationship between the Reprimanding Interaction Style and the executive function of Emotional Regulation. From the results, we could consider that strengthening the Emotional Regulation of future teachers may reduce the Reprimanding Interaction Style in favour of interaction styles that are more desirable in the individual development of the student (e.g., Helping, Understanding, Leading to Responsibility).

When examining the relationship between executive functions and didactic competencies, we concluded that there is a moderately strong negative relationship between the didactic competence Self-reflection and the executive functions of Emotional regulation and Behavioural regulation, and also between the didactic competence - Diagnostics and Evaluation and the executive function - Emotional regulation. Within the framework of interpretation, we could talk about the negative relationship between Emotional Regulation and Behavioral Regulation and Self-reflection and the negative relationship between Emotional Regulation and the competence of Diagnostics and Evaluation of students. In this context, we encounter findings of the opposite nature in the literature, that is, that the variables in question are positively correlated [30], [31].

In connection with the findings of the above authors, we are inclined to the opinion that didactic competencies are an essential part of teachers' professional competencies. Their development is addressed not only in the context of pre-graduate teacher preparation but also in continuing education, carried out through many accredited training programmes. It appears necessary to pay more attention to the development of practical competencies and skills of both students and teachers, especially in the school environment, thus promoting its development as a learning organisation [11].

In contrast to previous findings, when examining the relationship between executive functions and teaching styles, we find that there is no statistically significant relationship. Along the same lines, Patrawala [32] investigated the association between teachers' workload and their executive functions, and similar to our research, he found no significant relationship.

We consider the most significant limitation of our work to be the research sample size. We assume that this limitation may have caused biases in our results,

which brings additional challenges to our investigation.

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