FACTUAL TEXT COMPREHENSION TASKS AS A TOOL FOR STIMULATING EXECUTIVE FUNCTIONS IN 9- TO 10-YEAR-OLD CHILDREN

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Abstract

The qualitative analysis of the relationship of executive functions and text comprehension presented in this theoretical study provides a platform for its authors' original approach to designing their domain-specific model for cognitive stimulation in teaching/learning L1. The model for the stimulation of executive functioning in 9- to 10-year-old children utilises text comprehension as a curricular area of Slovak Language (L1) in primary education. The reason for choosing the domain of pupils' receptive competences with a focus on reading and comprehension of a factual text is in its complex, abstract and relational nature; a condition which activates executive functions. Executive functions (working memory, attentional control and cognitive planning) direct and control mental processes and metacognition organises working with acquired knowledge. Deficient executive functioning is a limiting factor for the higher level of text comprehension and knowledge integration. Enhancing pupils' cognitive performance through the stimulation of their executive functioning increases the prospect of their literacy development. This article presents: a) review of basic theoretical approaches to researching the relationship of executive functions and the processes of text comprehension, b) design of the educational model for stimulating executive functions through the processes of text comprehension, c) description of the model's application and the examples of stimulating tasks.

Keywords: executive functions, text comprehension, stimulating pupil's executive functioning, stimulating tasks, junior-school-aged children, L1 (Slovak language)

1. INTRODUCTION

This article is theoretical in character and reflects recent developments in L1 education drawn from psychology and educational sciences. It describes the application of cognitive education findings to teaching L1. Cognitive education accentuates the need to activate the pupil's cognitive functions as mental tools for learning within the so-called cognitive curriculum in addition to acquiring knowledge within the disciplinary curriculum (Jensen, 2003, 2009; Kovalčíková, 2015). Executive functions as a component of cognition that direct and control mental processes are one of the key concepts of the cognitive education paradigm (Dawson & Guare, 2010; Ferjenčík, Bobáková, Kovalčíková, Ropovik, & Slavkovská, 2014; Fuster, 2008). Learning outcomes, in the context of cognitive education, therefore include not only the mastery of the content in different areas of knowledge, but also the development of thinking and learning skills (Jensen, 2003). Implementation of various cognitive education procedures is currently underway at both institutional and national levels in several countries (Lebeer, Candeias, & Gracio, 2011).

Developing pupils' cognitive abilities in the processes of education has been integrated into the strategic aims of the education policy in Slovakia. Slovak educational theory and practice, however, significantly lag behind the rhetoric of intention. Slovak curricular implementation of cognitive development has still not gone beyond declarations about the general need to develop higher cognitive processes in pupils. It is therefore obvious that the design of a viable programme for pupils' cognitive development should be tackled in Slovakia. In order to seek ways and means for implementation of such a project, an interdisciplinary research project on *Executive Functions as a Structural Component of the Ability to Learn: Diagnostics and Stimulation* was launched to operationalise some of the key concepts from the field of cognitive education, recently introduced by the Slovak educational legislation. The interdisciplinary research team, which included the authors of this study, consisted of psychologists, experts in educational science and experts in the theory of teaching Mathematics and Slovak Language.

The project had two main objectives. First, it was necessary to adapt some of the existing diagnostic tools in order to measure cognitive and executive functions of Slovak pupils. Designing the procedures for subsequent cognitive intervention was the second main objective of the project. In the first (diagnostic) phase of the project, a comprehensive assessment battery for higher cognitive/executive functions—D-KEFS (Delis-Kaplan Executive Functions Scales) was selected and then standardised for the Slovak educational environment. The battery is based on the latest concepts from the field of executive functioning and represents a new diagnostic tool in Slovakia (Ferjenčík et al., 2014; Ropovik, Bobáková, Ferjenčík, Filičková, Kovalčíková, & Slavkovská, 2015). In the second (intervention) phase of the project, domain-specific units for stimulating executive functions were elaborated. The stimulation units contain a set of tasks reflecting the primary curricula of Mathematics and Slovak Language. Thus, the idea of the authors was to achieve cognitive

transfer by applying a more domain-specific than domain-general approach to executive functions stimulation. The data obtained from the diagnostic phase of the project indicated that, in the group of 9- to 10-year-old children from the standard Slovak population, the following executive functions should be stimulated: attentional control (inhibition and selective attention), working memory, cognitive planning and metacognition (Ferjenčík, Slavkovská, & Kresila, 2015).

The target age group of the project were 9- to 10-year-old children. This is the age at which children in Slovakia complete their primary education (4th grade) and progress to the lower secondary stage. The reason for targeting stimulation of executive functions in this age group is the identified range of learning problems at the transition from primary to secondary stage. An unsatisfactory level of learning outcomes of Slovak fourth-graders is indicated in the results of the Progress in International Reading Literacy Study (PIRLS) survey and in Trends in International Mathematics and Science Study (TIMSS) (cf. Mullis, Martin, Foy, & Drucker, 2012; for the results of TIMSS see http://pirls.bc.edu/timss2011/index.html, http://timss2015.org/#/?playlistId=0&videoId=0).

Our task, within the above project, was to draw up a programme for stimulating executive functioning in 9- to 10-year-old children utilising the selected curricular areas of L1 (Slovak) in primary education. The relevant curricular domain chosen for the stimulation programme is pupil's receptive competences with the focus on reading and comprehension of a factual text. The reason for this choice is the complex, abstract and relational nature of the receptive processes, which involve the recipient's cognitive activity at different hierarchical levels of text comprehension (Stanovich & West, 1981). According to the theory (Shallice, in Walsch, 1978), executive functions are triggered in educational situations that are complex in nature, fall outside the routine way of thinking and create the need to integrate multiple sources of information. The processes of text comprehension requiring cognitively active, adaptive and flexible verbal behaviour from the pupil are thus educational situations that activate executive functions. At the same time, we assume that the quality of executive functioning affects the level of the pupils' comprehension, and therefore their literacy development.

There are many intervention programmes aimed at stimulation of the cognitive/executive functions of a pupil. The reason for designing our own stimulation programme and not adopting some of the existing foreign models is mainly the fact that the majority of them are domain-general. The Mind's Ladder (Jensen, 2009) and MiCOSA (Mediation in the Classroom: An Open Systems Approach; Robinson-Zanartu, Doerr, & Portman, 2015) were, however, the most inspiring programmes for our research. These models are applicable to many areas of the school curriculum and at all stages of education. Their strength is in their explanation of the relationship between objectives and processes, while their selection of content is open and dependent on the intention of the intervention plan. In our programme, we focus on the specified content areas (tasks testing reception of factual text), which sets the frame for educational implementation of the stimulation tasks.

When comparing our approach with other pedagogical-psychological models that integrate development of both cognitive skills and executive functions of pupils with text comprehension, some similarities and differences emerge. We briefly compare our approach with the following intervention programmes: Reciprocal Teaching (Palincsar & Brown, 1984), Modified Reciprocal Teaching (Paris & Winograd, 1990), POSSE (Predict—Organize—Search—Summarize—Evaluate; Englert, Tarrant, Mariage, & Oxer, 1994), the PREP (The PASS Reading Enhancement Programme; Das, Naglieri, & Kirby, 1994), the PHAST (Phonological and Strategy Training; Lovett, Lacerenza, & Borden, 2000). These programmes can be collectively called cognitive training of reading comprehension (cf. Ashman & Conway, 2002), from which it follows that the target dimension of these programmes is text comprehension. In our approach, however, the area of reading comprehension is not the target, but the content of stimulation. Despite this, when comparing the models, several common features can be identified: e.g. some of the models focus on acquiring effective strategies in reading and comprehension (e.g. POSSE, PHAST). In our approach, the pupil gains experience of using effective cognitive and metacognitive strategies: how to deal with several pieces of text information at once, how to control attention when decoding and comprehending text, how to assess the success of reading comprehension etc. A common platform can also be found in the principles of individual and pair stimulation (PREP, PHAST), the principles of learning with the support of a more advanced partner, the principles of participation in communicating the contents of reading (Reciprocal Teaching), activating metacognitive strategies through communicating about thinking (Modified Reciprocal Teaching, POSSE, PHAST) and in practising executive functions of cognitive planning and attentional control (PREP).

This study offers a review of basic theoretical approaches to researching the relationship between executive functions and the processes of text comprehension (part 2). It also describes the process of designing an original educational model for stimulating the pupil's executive functions and justifies the approach to designing the stimulation tasks (part 3). Our study, theoretical in character, is the result of a qualitative analysis of relevant concepts and does not provide empirical data. Experimental verification of the compiled stimulation programme is the objective of the follow-up project.

2. EXECUTIVE FUNCTIONS AND TEXT COMPREHENSION

Despite the relatively short history of exploring the concept of executive functions (hereinafter the abbreviation EF) there are now sufficient theoretical and empirical observations of the relationship between the ability to process, comprehend, organise, store and apply information obtained by reading text on the one hand and executive control of human cognition on the other (Block & Parris, 2008; Alvermann, Unrau, & Ruddell, 2013; Cartwright, 2015). In this part of the paper, we provide a basic overview of representative theoretical approaches to investigating the

relationship of executive functions and processes of comprehension. Executive functions are manifested mainly in the processes of attentional control (inhibition and selective attention), working memory and cognitive planning (Fuster, 2008). In addition to these features, we pay attention to metacognition as it is also a part of the system of executive functions (Dawson & Guare, 2010).

2.1 Text comprehension and working memory

The reader's working memory plays a key role in text comprehension acting as a "bridge" connecting the sensory inputs with long-term memory. A comprehensive study by Unrau & Alverman (2013) highlights the significance of several research theories on memory in general and working memory specifically, especially those approaching memory from the aspect of constructivism and the theory of cognitive information processing. Within the *theory of constructivism*, the most important research findings on decoding and reading text were brought by *schema theory* (Spiro, 1980; Unrau & Alvermann, 2013). The schema theory explains how knowledge is structured and how it is stored in the memory. Constructivist teaching utilises such concepts as knowledge of the topic, previous experience and the assimilation scheme of the learner. This demonstrates that schema theory has found a firm place in educational reality globally (McVee, Dunsmore, & Gavelek, 2013). *The theory of cognitive information processing* (LaBerge & Samuels, 1974; Schunk, 1996) has contributed to the research into reading and literacy with some inspiring findings. Within this theory, the following approaches have been researched: sensory input, attention switching, understanding symbols, using strategies, organisation of knowledge and storing it in short-term and long-term memory, outputs in the form of mental representations of a text and their comprehension (Unrau & Alvermann, 2013).

Reconciling the above models of working memory with the processes of reading and comprehension, current researches have demonstrated a strong correlation between the capacity of working memory and text comprehension in children of junior school age (Cain, 2006; Seigneuric, Ehrlich, Oakhill, & Yuill, 2000; van der School, Reijntjes, & van Lieshout, 2012). The existing research findings, however, point to the fact that (Hannon, 2013) the processes of lower level reading (decoding words) and working memory are independent constructs. On the other hand, the theories on the relationship of working memory and text comprehension (Daneman & Carpenter, 1980; Just & Carpenter, 1992) indicate that the capacity of working memory is a limiting factor for higher level comprehension and knowledge integration. As pointed out by Hannon in his study (2013), these claims were confirmed by research that has showed that readers with a higher capacity of working memory are better able to establish bridging inferences than readers with a lower capacity of working memory. Similar findings have also been presented in research conducted in a cohort of junior-school-aged children (Cain, Oakhill, & Bryant, 2004) as well as in pre-readers (Hannon & Frias, 2012).

The following findings were drawn from the diagnostic phase of our research (see introduction). The most relevant finding for the concept of working memory and its educational application is that it is working memory out of all executive functions that has a direct impact on the ability to learn (Ropovik, 2014). The effects of other EF on learning are secondary with working memory acting as a mediating element. Thus, improvement in such executive functions as inhibition or attentional control tends to increase the efficiency of working memory whose capacity and quality then directly affect the ability of a child to learn.

2.2 Text comprehension and attentional control

If the comprehension of the text is without complications and the reader, without significant difficulties, constructs the meaning of the text, the reader's cognition then operates with low executive control. But the reverse situation occurs when the reader misreads a word, finds a discrepancy between the text information and his/her prior knowledge or (in the case of an experienced reader) finds inconsistencies between two or more pieces of text information. In such cases, a higher level of attentional control and orienting behaviour are necessary. Among the theories explaining reading processes in relation to human cognition, transactional theory and cognitive information processing theory attribute the most prominent role to attention and its control.

According to *transactional theory*, every act of reading is a transaction between a particular reader and a specific text in a given time and particular context (Rosenblatt, 1969; Culler, 1980). The meaning of the text is neither in the text nor in the reader but results from their transaction. The reader activates their own knowledge and cognitive processes by which they create a mental representation of what was read. Selective attention plays a central role here; elements are selected, organised and synthesised by which the meaning of the text is constituted (Rosenblatt, 2013). The concept of selective attention is related, in this theory, to the efferent–aesthetic continuum. When reading a scientific text, attention is drawn particularly to what remains after reading, to what information is derived from the text, while in reading an artistic text attention is concentrated on what happens during the reading, what the reader is experiencing in relation to the text (Rosenblatt, 2013; Unrau & Alvermann, 2013).

Attention as a regulatory mechanism for processing text information also comes to prominence in the model of LaBerge & Samuels (1974) (Samuels, 2013), which is one of the first representatives of the *theories of cognitive information processing*. Attention is of a twofold nature there: external attention is observable in the orienting behaviour of the reader, directing his/her sight while internal control as a more important aspect of attention is more difficult to trace. Signs of internal attentional control are, according to Samuels (2013), alertness, selectivity and limited capacity. When comparing the allocation of attention while reading, Samuels takes advantage of the simple view of reading (Gough & Tunmer, 1986), where reading is

explained in two phases as decoding (simply in terms of reading letters) and comprehension (simply in terms of creating relationships between words and sentences of the text). The weak reader's attention switches from decoding to understanding and vice versa, while in the proficient reader the decoding process is automatic, so all attention can be focused on comprehension.

Within the educational implications of research into the relationship of attentional control and text comprehension there are fundamental empirical findings on the relationship between inhibition and acquisition of literacy. Research has not yet confirmed a causal relationship between inhibition and development of literacy. However, it has shown that the importance and the level of attentional control vary in relation to the degree of the child's literacy development (Jabłoński, 2013).

2.3 Text comprehension and cognitive planning

Planning is, in psychological theory and research, explained most often as the ability of the person to create mental representations of the problem to determine effective strategies for its solution (Ward & Morris, 2005). A plan for solving a problem is processed by working memory in which collected information and steps in the solution are temporarily stored. Executive control provides monitoring of the solution (Ward & Morris, 2005). From the perspective of the theories of reading and their contribution to exploring the relationships between cognitive planning and text comprehension, the most prominent position is held by *sociocognitive theories and models of reading* (Unrau & Alvermann, 2013). Projecting the course of mental activity in the form of cognitive planning is the background monitoring of the whole process of reading from goal setting through decoding to creating a mental representation of the text in the mind of the reader. Planning occurs in the theories of reading and in their educational applications as an organiser of working with existing knowledge (cf. Gakins, Satlow, & Pressley, 2007; Ruddell & Unrau, 2013). Processes of executive control are involved in the reader's planning, directing, collecting and organising available cognitive structures and processes to achieve the goals of comprehension. In the literature, the following executive functions necessary for ensuring the control of cognitive processes and the activities needed for comprehension are mentioned most frequently: planning, setting priorities, organising knowledge and information, flexible switching of mind, self-control and self-assessment (Gaskins, Satlow, & Pressley, 2007).

2.4 Text comprehension and metacognition

Developing comprehension also depends on stimulating metacognitive processes (Gavora, 1992). Cognitive and metacognitive processes are intertwined and are sometimes difficult to distinguish in educational stimulation. What is important, however, is the significantly positive effect of stimulating both cognitive and metacognitive processes within the pupil's ability to learn and solve problems (Larkin,

2010). As underlined by Larkin (ibid.), the most important metacognitive theory is considered to be Flavell's metacognitive model. The Flavell model of metacognition includes: metacognitive knowledge, metacognitive experience, goals (or tasks), and actions (or strategies) (Flavell, 1971, 1979). Metacognitive knowledge is the knowledge of one's own cognitive state and the cognitive state of others; the knowledge of the nature of cognition. Metacognitive knowledge is the understanding of how our thinking can be influenced by such factors as personal traits, type of task, or type of applied strategy. Metacognitive skills are developed through metacognitive experience that pupils can acquire in metacognitive tasks. The tasks stimulate cognitive thinking such as problem solving in new roles or new situations in which each step requires planning and evaluation (Flavell apud Larkin, 2010).

Of the many models, theories and explored aspects of metacognition, we will briefly mention those which are related to executive functions. Our description is based on the work of Larkin (2010). The first component of metacognition that was explored is the concept of *metamemory* (Flavell 1971; Flavell & Wellman, 1977). It concerns the knowledge of one's own memory, its functioning, the factors that affect it, and the strategies that can help control and monitor memory in order to remember better. Research has shown that in children aged 6-11 years there is a rapid development of knowledge about memory, memory strategies and their use. Another aspect related to EF is *meta-knowing* (e.g. Kuhn, 2000, apud Larkin, 2010, pp. 37-39). This is awareness and understanding of one's own and other people's cognitive functions. Kuhn distinguishes, in the concept of meta-knowing, declarative knowledge (knowing that) and procedural knowledge (knowing how). According to Kuhn, declarative knowledge develops in early childhood, while metastrategic knowledge, i.e. awareness of mental processes (knowing how) develops later and enables children to use cognitive strategies spontaneously. Another important aspect of metacognition with respect to EF is *self-regulation*; i.e. the aspect of monitoring and control of thinking and learning (Larkin, 2010). Larkin especially underlines Nelson and Narens` model in which control processes are triggered by the monitoring process and may include the timing of tasks, selection of strategies, change of strategy and decision to end the task. Skills in monitoring and control of learning lead to more efficient, self-regulatory learning. Larkin (2010) analyses the different views on the relationship of self-regulation and metacognition and is inclined towards understanding of self-regulation as the broader concept that involves metacognition. Larkin sees the difference between self-regulation and metacognition in the fact that while the theories of metacognition are based on Piaget's theory, the theories of self-regulatory learning are based on Vygotsky's (ibid.).

In this part of the study we have justified the relevance of the relationship between EF and text comprehension. We have emphasized that the capacity of working memory is a limiting factor for the higher levels of comprehension and for integrating knowledge. We have pointed out the role of the reader's conscious control of attention in decoding and text comprehension. We have also reported that the processes of executive control are involved in how the reader plans, directs, selects
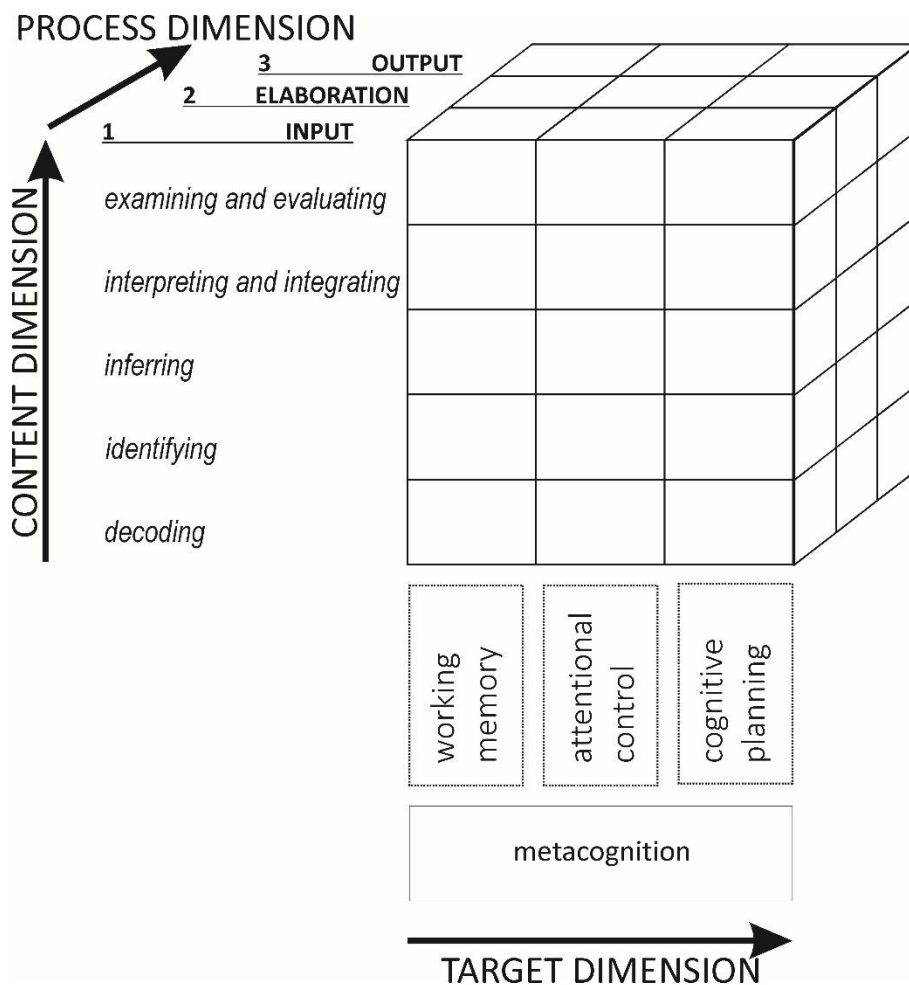
and organizes available cognitive structures and processes to achieve the objective of comprehension. Finally, we have indicated the role of metacognition and self-regulation in monitoring and control of comprehension, as well as the supreme role of metacognitive processes in relation to other executive functions.

3. DESIGNING THE EDUCATIONAL MODEL FOR STIMULATING EXECUTIVE FUNCTIONS

Theoretical analysis of the relationship between text comprehension and executive functions served as a foundation for developing our original model for EF stimulation designated for educational setting. The principles of the model were adopted in the latter stage of the project when we were designing a specific stimulation programme adjusted to the needs of the target group. As indicated in the introduction, the created model is domain-specific, in contrast to the domain-general models such as Mind's Ladder (Jensen, 2009) or MiCOSA (Robinson-Zanartu, Doerr, & Portman, 2015). Even though our model for EF stimulation is curriculum based, text comprehension was, in contrast to other existing curriculum based programmes, intended to be the means of stimulation and not its target. The designed educational model for stimulation of executive functions in 9- to 10-year-old children covers the abstract system of relationships and connections between the three basic pedagogical categories: learning objective (target), content and process of instruction. The educational model for EF stimulation is designed to be used by a teacher of primary education and to be, by its nature, as close as possible to the standard process of teaching. Hence, in designing the model we worked with the target dimension (aim of the stimulation), content dimension (content of the stimulation), and process dimension (processes of teaching and learning). Correlating the *target dimension* (stimulation of executive functions), *content dimension* (procedures of factual text reception) and *process dimension* (phases of learning process), we obtained a three-dimensional model for stimulation revealing the relations between its individual dimensions.

The target dimension of the educational model answers the question *of what is to be stimulated* in the pupil. The target dimension comprises executive functions, i.e. such mental processes that organise and control cognitive processes. Based on the above mentioned theories on the relationship between EF and comprehension processes (see 2.1, 2.2, 2.3, 2.4), we focused on the following EF: (1) working memory (the ability to retain information in one's mind while solving a complex task, the ability to exploit prior knowledge and experience in the processing of information); (2) attentional control (i.e. control of impulsiveness/inhibition and selective attention); (3) cognitive planning (includes the ability to make the sequence of steps for solving the problem, the ability to rank stages of learning by relevance) and (4) metacognitive processes (processes of monitoring and control of comprehension, i.e. detecting errors and making self-corrections).

Figure 1. Target, content and process dimensions of the model for EF stimulation in educational setting

PROCESS DIMENSION

3	OUTPUT	
2	ELABORATION	
1	INPUT	

CONTENT DIMENSION

examining and evaluating

interpreting and integrating

inferring

identifying

decoding

working memory   attentional control   cognitive planning

metacognition

TARGET DIMENSION

The content dimension of the educational model answers the question *of how (by means of what) EF are stimulated*. The research shows that stimulation and secure transfer of newly acquired knowledge and experience are more effective if done within the curricular context (Houck, 1993). Regulation of the pupil's behaviour (learning) by the given executive functions is therefore connected, during stimulation, with the content of primary education. Tasks in the stimulation programme are based on the primary curriculum of L1 (Slovak), particularly on developing text

reception competence in the pupil. The domain of developing text comprehension is generally an established part of L1 education. As mentioned above, text reception, i.e. decoding and comprehension, is a curricular area characterised by complexity and cognitive demands; therefore it is helpful to create educational situations in which executive functions are activated in the pupil. The content of EF stimulation aggregates the tasks that are assigned before, during, and after reading a factual text. The tasks activate the following levels of reception processes (cf. Clarke, Dickinson, & Westbrook, 2010; Gavora, 1992; Mullis, Martin, Foy, & Drucker, 2012; Stanovich & West, 1981):

(1) the ability of the reader to decode a text on a word and sentence level by applying perceptual, phonological and grammar-logical processes (simply—decoding); (2) the ability of the reader to identify explicitly stated information in the text (simply—identifying); (3) the ability of the reader to infer information from the text based on implicit intra-textual reference links (simply—inferring); (4) the ability of the reader to interpret the information from the text and integrate it with prior knowledge (simply—interpreting and integrating); (5) the ability of the reader to critically analyse and evaluate the text (simply—examining and evaluating).

The above theoretical basis for the processes and levels of comprehension was applied in our educational model, although not as the objective of stimulation, but as the content for EF stimulation. The reading of a factual text and the process of reception (decoding, identifying, inferring, interpreting and integrating, examining and evaluating) therefore serve the purpose of stimulating relevant executive functions in the pupil.

The process dimension of the EF stimulation model is based on the answer to the question *of what the course of the stimulation process is*. In conceiving the process dimension, we greatly relied on existing educational models, especially those which emphasise the mental activity of the learner. Such stimulation is, in its essence, a learning from the text. Learning is a process that involves the mental activity of the learner. External stimuli provided by the teacher facilitate the internal processes of the learner (so called events of learning: gain the learner's attention, inform the learner of objectives, stimulate recall of prerequisites, present stimulus for learning, provide prompts and guidance, provide for practice, provide feedback, assess the performance, promote transfer and retention; see Gagné, 1974). In solving a task, the pupil gradually progresses through three phases of the mental act: input (gathering information)—elaboration (transforming information)—output (communicating information) (Jensen, 2003, 2009). In accord with the phases of the mental act, thinking skills activated in the learning process fall within the following three categories (Robinson-Zanartu, Doerr, & Portman, 2015):

(1) thinking skills for gathering information (input phase): systematic search, focus and attention, labels, words, and concepts, multiple sources, position in space, position in time, precision and accuracy;

(2) thinking skills for transforming information (elaboration phase): goal setting, planning, comparing, ordering, grouping, and categorising, finding connections

and relationships, visualising, inferring, cause and effect (hypothesising), summarising;

(3) thinking skills for communicating information (output phase): labels, words, and concepts, precision and accuracy, appropriate pragmatics, feedback for self-regulation, collaboration.

The processes dimension of EF stimulation thus implies that children will be engaged in work on a factual text and exposed to procedures enabling them to learn how to deal with this text.

3.1 Description of the model's application

The model for EF stimulation designated for educational setting was devised by a) confronting the theories of the relationship between EF and text comprehension (see section 2) and b) analysing the pedagogic relationships between target, content and processual educational dimensions (see the previous part of section 3). Subsequently, the principles of EF stimulation model were applied in designing actual EF stimulation programme.

The stimulation programme is intended for individual or pair stimulation. The administrator of the stimulation programme can be a primary school teacher who has completed training aimed at acquiring theoretical and practical aspects of cognitive education with a special focus on the relationship of executive functions and processes of text reception in the early school years.

The stimulation programme contains stimulation units. A stimulation unit is a structured set of learning tasks that are administered before reading, during reading, and after reading a factual text. Since the informative function of a factual text enables freer manipulation with linguistic material without distorting the overall meaning of the text, as opposed to an artistic text, it was a factual text, both a linear and nonlinear popular science text, that was selected for the stimulation programme. In each stimulation unit, tasks are arranged systematically depending on the unit's *target* (which EF is stimulated) and the *content* to be worked with (which receptive process is concerned). The EF stimulation process is in each stimulation unit guided by the phases of the mental act (input—elaboration—output). The sequence of tasks in a stimulation unit is determined by the administrator who assesses the pupil's behaviour during solving of the task. The pupil's incorrect approach to problem solving obliges the administrator to identify the cognitive problem by referring to the thinking skill activated in the task-solving process (Robinson-Zanartu, Doerr, & Portman, 2015). Solving the tasks in the stimulation unit is concluded by generalising the pupil's learning experience at two levels: a) the level of the strategy applied by the reader (e.g. predicting content, visualisation, activating previous knowledge, summarizing etc.); b) the level of the executive function that was stimulated.

Working with one stimulation unit takes 30 to 45 minutes (depending on how successful the pupil is). Each stimulation unit contains a set of teaching aids (factual

texts in different formats in an extended and reduced form, reading windows, pictures, tables for notes, mind maps, schemes, organizers and other tools).

The task in the stimulation unit serves as a platform for mediating the learning experience of the reader. The administrator, based on the pupil's responses, gives directions and guidelines in the course of working with the text so that the given EF is stimulated. For illustration, we present some examples from the stimulation programme.

3.2 Examples of stimulation tasks

Relationships between the dimensions of the educational model and their projections into the stimulation programme will be demonstrated in the following two examples of tasks for EF stimulation. The first task illustrates how to stimulate EF in the area of text comprehension at the word level of. The second task illustrates how to stimulate EF at the level of text.

Example 1

The first example is a task from the stimulation unit focused on the construction of word meaning. The words in the task are taken from a factual text on Greek mythology, specifically the Greek gods, their symbols and their areas of government. This task precedes actual reading of the text. Its aim is to stimulate the pupil's working memory. This task is a follow-up to the preceding part of the stimulation unit in which the reader is acquainted with the names of Greek gods and goddesses, and confronts new knowledge with their previous knowledge of Greek mythology.

The example below shows the overall focus of the stimulation task (see Table 1), exact wording of the instruction, the difficulty level and the ways of administering EF stimulation.
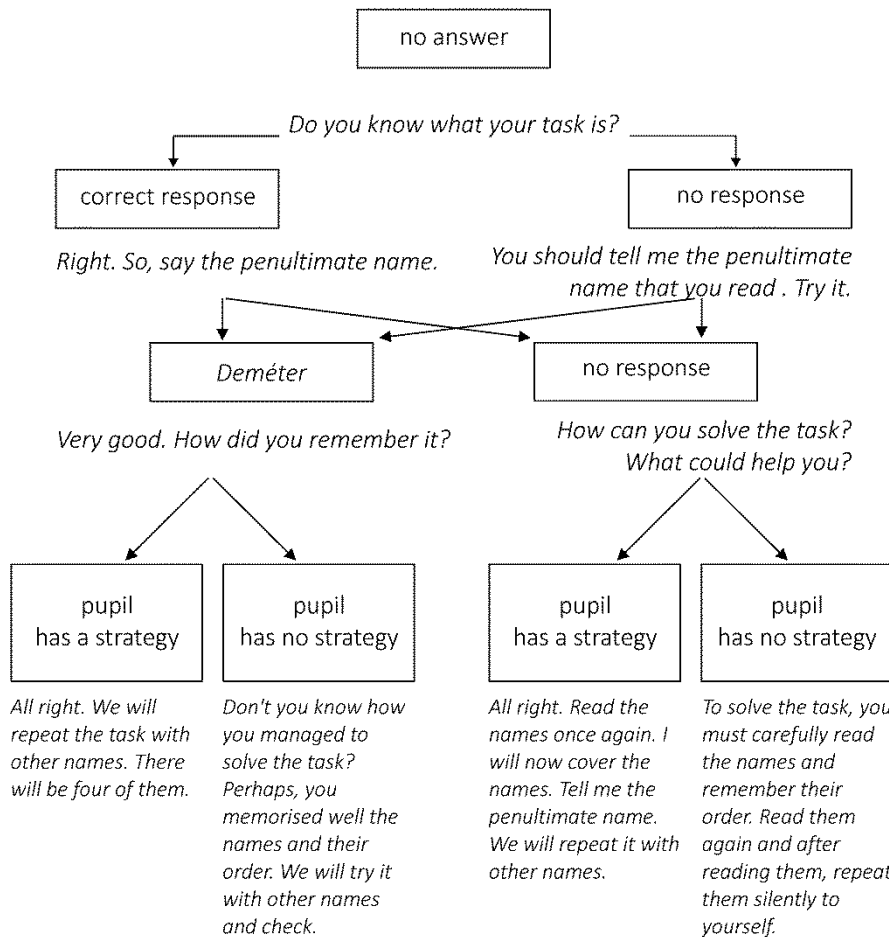
In the case of an incorrect solution, the administrator puts the question to the pupil to see if s/he has any strategy or whether s/he proceeds randomly without any awareness of algorithms. The questions are then directed to inferring a strategy that could be effective. The possible questions are illustrated in the example when a pupil is not able to answer the question or provides an incorrect answer to the question about the penultimate name (see Figure 2).

Table 1. Focus of stimulation task

	Stimulation relevant to	Pupil's performance
TARGET DIMENSION *(executive functions)*	Working memory	*Working memory*: To keep the information in mind while solving another task. To exploit prior knowledge and experience in the processing of information.
	Attentional control	*Attentional control*: To pick the stimuli to be further processed and cut off other stimuli that are irrelevant to the goal (*selective attention*). To suppress consciously automatic mental processes when addressing a certain task (*inhibition*).
	Metacognition	*Metacognition*: To monitor and control text comprehension on the word-level, i.e. by detecting errors and making self-corrections.
CONTENT DIMENSION *(factual text reception)*	Decoding	*Decoding* of verbal symbols and signs applying perceptual, phonological and grammar-logical knowledge.
	Identifying	*Identifying* explicitly stated information in the list of names.
PROCESS DIMENSION *(phases of mental act and corresponding thinking skills)*	Thinking skills for gathering information (input phase)	*Input phase*: Retrieving labels, words and concepts Confronting prior knowledge Evoking from memory Activating focus and attention
	Thinking skills for transforming information (elaboration phase)	*Elaboration phase*: Goal setting Planning Activating focus and attention Ordering, grouping and categorising Inferring Visualising Summarising
	Thinking skills for communicating information (output phase)	*Output phase*: Acquiring and using labels, words, and concepts Using appropriate pragmatics Checking feedback for self-regulation

Figure 2. Example of branching in task-solving procedure

Tell me the penultimate name that you read.

| no answer |

Do you know what your task is?

| correct response | | no response |

Right. So, say the penultimate name.   *You should tell me the penultimate name that you read . Try it.*

| Deméter | | no response |

Very good. How did you remember it?   *How can you solve the task? What could help you?*

| pupil has a strategy | pupil has no strategy | pupil has a strategy | pupil has no strategy |

All right. We will repeat the task with other names. There will be four of them.

Don't you know how you managed to solve the task? Perhaps, you memorised well the names and their order. We will try it with other names and check.

All right. Read the names once again. I will now cover the names. Tell me the penultimate name. We will repeat it with other names.

To solve the task, you must carefully read the names and remember their order. Read them again and after reading them, repeat them silently to yourself.

Note: Given the scope and complexity of the entire stimulation process in all situations that may occur, only one selected procedure is featured in Figure 2.

Instruction for the pupil (the lowest difficulty level—3 names of the gods; to increase the task's difficulty level: medium—4 names, higher—5 names, the highest difficulty level—6 names):

Let us play a game together. Carefully read the names of these Greek gods. Your task is to memorise them in order. After you finish reading them, the names will be covered.
• Ares, Demeter, Zeus
a) Say the names that you have read from left to right.

b) Say the penultimate name of those names that you have read.
c) Which name did you read first?
d) Which was the last name on the list?
      Various situations may arise when pupils answer those questions. One pupil may solve the task without any problem, but in other cases the order of names can be mixed up. In both cases (if a pupil can handle the task without any problem or the solution is incomplete) a discussion about the solution's strategy follows. In the case of successful solution, the administrator puts the following questions to a pupil in order to verbalise the successful strategy:
• How did you proceed when solving the task?
• What helped you in coping with the task? What did you most concentrate on?

Example 2

The second example of the stimulation task is taken from the unit that is designated for the post-reading phase, after reading the factual text about the Greek gods. The text for stimulation provides information on a certain number of Greek gods (3, 5 or 9 in total according to the needs and performance of the pupils), with the symbol accompanying each of the gods as well as their name and their specific area of government or power over nature and human lives. Overall, there are three attributes given for each of the Greek gods, which ensures that the text will provide some completely new information to the pupils.

As can be seen in Table 2, the task is aimed at stimulating the working memory, attentional control and metacognition. The reader is asked to summarise all information about the Greek gods, their symbols and area of governments represented in the text. If s/he fails to summarise it, it is probably because the text comprises too many "items" to remember and s/he:

   a) does not remember what s/he read or remembers only a limited number of text "items";
   b) has a problem combining multiple aspects and sources of information and organising them;
   c) does not understand connections between the symbol and the area of government of a particular god;
   d) is not paying full attention;
   e) fails to monitor the processing of multiple items of text at the same time.

Table 2. Focus of stimulation task

	Stimulation relevant to	Pupil's performance
TARGET DIMENSION *(executive functions)*	Working memory	*Working memory*: To keep the information in mind while solving a complex task. Divide the text into smaller meaningful units according to appropriate criteria.
	Attentional control	*Attentional control*: To pick the stimuli to be further processed and cut off other stimuli that are irrelevant to the goal (*selective attention*). To suppress consciously automatic mental processes when addressing a certain task (*inhibition*).
	Metacognition	*Metacognition*: To monitor and control text comprehension, i.e. detecting errors and making self-corrections.
CONTENT DIMENSION *(factual text reception)*	Decoding	*Decoding* of verbal and non-verbal symbols and signs by perceptual, phonological and grammar-logical processes.
	Identifying	*Identifying* explicitly stated information in the text.
	Inferring	*Inferring* information from the text based on implicit intra- and extra-textual reference links.
	Interpreting and Integrating	*Interpreting* information and *integrating* it with the pupil`s prior knowledge and experiences.
	Examining and Evaluating	*Examining* and *evaluating* what was obtained from the text.
PROCESS DIMENSION *(phases of the mental act and corresponding thinking skills)*	Thinking skills for gathering information (input phase)	*Input phase*: Retrieving labels words and concepts Confronting prior knowledge Evoking from memory Activating focus and attention
	Thinking skills for transforming information (elaboration phase)	*Elaboration phase*: Goal setting Planning Activating focus and attention Integrating multiple sources of information Position in space Ordering, grouping and categorising Inferring Visualising Summarising
	Thinking skills for communicating information (output phase)	*Output phase*: Acquiring and using labels, word, and concepts Using appropriate pragmatics Checking feedback for self-regulation

The teacher therefore adapts the stimulation process according to the reason why the pupil was unable to solve the task. In the case of the first, second and fifth situation, the teacher offers the pupil an opportunity to prepare a visual aid (table) in which the pupil records his/her analysis of the information from the text. In the case of the third reason for failure to solve the task, the teacher explains the connection between the symbol and the government area of the Greek god (illustrated by the example from the text); the pupil is then referred to the table so that s/he is able to discover connections by him/herself. In the case of the fourth reason for failure the teacher directs the pupil's attention to the process of task solving, or divides the text into parts according to the number of deities and symbols present in the given section. At the end of each stimulation unit, it is consistently required to generalise the learning experience—the teacher summarises what procedures and strategies led to the pupil successfully solving the task (in general, it goes in two lines—what has been learnt about reading and what has been learnt about thinking).

Communication between teacher and pupil about possible ways of addressing the particular task and the task as such becomes essential for stimulating individual executive functions. Specific cognitive and receptive needs of a pupil are revealed only at the process of stimulation. Conditions and possibilities for utilising the proposed EF stimulation programme are summarised in the conclusion.

4. CONCLUSION

In the theoretical analysis of the relationship between executive functions and processes of text comprehension we argue why we consider text reception a suitable curricular content for EF stimulation (working memory, attentional control, cognitive planning and metacognition). The theoretical part is followed by the description of designing an educational model for EF stimulation with the characteristic features of stimulation tasks.

The presented EF stimulation model is a conceptual framework that can serve primary education teachers as a template for designing similarly oriented educational tasks. Reflective application of the educational model can be achieved after training teachers in the field of cognitive education; i.e., the teacher should learn: a) new approaches to the cognitivist paradigm of education; b) the concept of cognitive and executive functions; c) the process of learning resulting from the phases of the mental act; d) relationships of cognitive processes and text reception; e) administration of the stimulation units; f) pedagogical tenets for selecting the optimum mode for individual/pair stimulation of a pupil.

Upon completing training in the field of cognitive education, the teacher should be prepared to apply the principles of designing tasks for EF stimulation. These principles reflect specific requirements: (1) choice of an appropriate factual text for stimulation (for example a text with a higher potential for inferential thinking); (2) content of stimulation (the text should be thoroughly analysed from the aspect of

the receptive process); (3) goal of stimulation (to clarify what executive function should by predominantly targeted); (4) stimulation procedure (to structure the work with a stimulation unit in relation to the phase of the mental act and activated thinking skills, and respecting the individual needs of a pupil, to flexibly adopt an alternative procedure for task administration).

The research project that is described in this article served as the basis for a new follow-up project that is currently in process. Its aim is to experimentally verify the effectiveness of the proposed stimulation tasks. After the experiment is completed, it will be possible to critically evaluate the merits and applicability of the presented approach to stimulation of executive functions. Based on the research data obtained from the experimental verification, it will be possible to compare the efficiency of this stimulation programme along with the other existing programmes for stimulation of cognitive/executive functions.

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