BRAIN-COMPATIBLE TEACHING AND PSYCHO-DIDACTIC ASPECTS OF EDUCATION AS DETERMINANTS SUPPORTING THE DEVELOPMENT OF CRITICAL THINKING IN STUDENTS

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Abstract

In the educational process, the teacher should respect the brain-compatible and psychodidactic aspects: how to select and organize the subject, respect the learning styles and teaching styles, develop the metacognitive processes of the students, and support the development of critical thinking. In the present paper, the authors focus on students' work with text, which is strongly determined by several attributes described in the paper. The authors carried out research about the perception of text and text structure at students of the Slovak pedagogical college.

Key words

brain-compatible teaching, psycho-didactic aspects of education, critical thinking

1. Delineating the concepts

In the recent past rejecting transmissiveness in the teaching process has been occurring in the pedagogical as well as the psychological environment, and gradually teaching that respects the principles of brain-compatibility has been coming to the fore and methodologies are being developed that address psycho-didactic issues (such as respecting the learning styles of students and teaching styles of teachers, developing metacognition, meaningful teaching, and using appropriate ways of structuring the subject matter). This means that the psycho-didactic approach in school teaching focuses primarily on the student's performance, yet the emotional aspects of education should be considered as well.

A teacher respecting the principles of brain-compatible teaching discusses the new subject matter in a systematic way, creates a logical structure of respective knowledge items and puts emphasis on the internal motivation of students and encourages their interest in the discussed subject matter, makes sure that the already discussed subject matter is reviewed with the students, and prefers teaching based on involving as many senses as possible because that is when the synapses in the student's brain become more stabilized.

E. Petlák et al. (2011) understand brain-compatible teaching as teaching based on the principle of how the knowledge related to brain structures and functions is transformed into the instructional and educational process. The authors discuss how the human brain works within the educational process, what principles and strategies teachers deliberately choose to accomplish the instructional and educational goal and more. This is where one can see

where the brain-compatible and psycho-didactic principles come together in teaching.

It is important in brain-compatible teaching that respective information is arranged systematically and followed up because the isolated information that people are unable to associate with other knowledge is difficult to remember. As a result, empty verbalism instead of meaningful learning occurs.

To make the teachers' pedagogical effort effective it is necessary to know what is happening in the human brain during learning. The more information teachers have about what is going on in the brain and under which conditions it works most effectively and in what way it can achieve the best results, the more successful teachers' efforts can be. The more the teaching leans on the acquired knowledge, the more opportunity the students have to see the benefit of their own learning and their attitude to education is more favorable. Another immensely important prerequisite for the instructional and educational process is compatibility of the teacher's teaching style and the learning style of the students. We believe that not enough emphasis is put on the learning styles of students and they are not considered to their full potential in schools. We view this as an immense drawback since teaching that fosters the learning styles of students can achieve better and, even more importantly, more effective results.

It should be remembered that the human brain is an active organ that needs to be developed and constantly stimulated. Knowing how the brain works and its learning processes help teachers identify the ways in which individual students learn and what strategies they use. Knowing that teachers can modify the learning performance of students and apply a relevant methodology that respects individual peculiarities within the learning process. The issues of learning styles have been in the focus of global research for almost forty years and the awareness of it is also in our literature through studies and specialized papers such as I. Turek (2002), R. Riding, S. Rayner (2009), L. Kaliská (2008, 2009), T. Zaťková (2011), R. Murray-Harvey (1994), J. S. Renzulli and L.H. Smith (1978), R. M. Felder and B. A. Soloman (2001), and G. Caine and R. Caine (2001).

A student's learning style needs to be viewed as a life-long process that combines several personality components, and in that way, the content of the learning style keeps developing and changing.

The process of acquiring knowledge of the world is influenced by the individual's learning style that, according to G. V. Tassel (2010), is the sum of ways in which an individual responds in day-to-day life and reflects a number of positions, emotional reactions, and preferences of the individual. Knowing an individual style presents foundations for the manner of communication with each style-user in how to process stimuli and inputs from the environment and how to store them more effectively.

J. Mareš (1998, p. 75) characterized learning style as a complex of procedures that an individual uses in learning and in her/his life. It is a specific learning procedure that the person uses in various learning situations.

In one's lifetime, every person develops a certain system of behavior during learning that seems most effective to her/him. This is the learning style that differs from person to person in terms of its structure, quality, and flexibility. R. Riding and S. Rayner (2009, p. 51) interpreted learning styles through groups that they combined by similarities in their psychometric schemes, meaning in relation to shaping their learning strategy. The authors view learning style as a unique set of indicators that include personal preferences in teaching and the form of learning activities. The groups of models of learning styles are based on:

•   Learning processes – experiential, empirical learning,
•   Learning processes – study orientation,
•   Development of cognitive skills and learning strategies,
•   Teaching preference.

Learning styles can be characterized in such a broad way that certain methods for their categorization were developed. An example is the learning styles classification by P. B. Guild (2001) who categorized them by whether they have effects on behavior, affectiveness, cognition, and conceptualization.

Much knowledge of student learning styles was summarized by R. Dunna and K. Dunna (2002). The authors write that respecting the students' learning styles at school enhances their attitude to learning, internalizes their motivation to learn and improves the accomplished learning outcome. According to the authors, proper information processing and creation of association links are the foundations of a learning style, and for that reason, the individual learning style of every student must be respected.

Understanding learning styles require understanding the neuro-biological aspects of learning associated with knowledge of the brain and its functions. According to B. S. Kimmel (1998), certain learning style theories claim that specific points in the brain are associated with certain functions. The left and the right hemispheres use different strategies, and that is why, depending on the domination of one hemisphere, individuals can be more analytical (left hemisphere) or global (right hemisphere). Analytical individuals prefer learning step by step, along with a sequential format going from detail to grasping more complex information, whereas the global individuals prefer learning that progresses from general conclusions to gradually deriving the specifics.

An analysis of learning styles should also take into account the teaching style of an individual teacher since that is an important factor determining the success of the education process. Applying a certain analogy to learning styles, a teaching style can be characterized as a way of teaching, and the individual concept of the teacher that s/he uses to address various educational situations.

A teacher's teaching style is related to the overall context of understanding teaching. There are teachers who welcome innovation in teaching (in certain instances even without any critical assessment) in contrast with other teachers who strictly reject innovation and teachers who work with innovation, think about it and verify it in their practical teaching process.

G. D. Fenstermacher and J. F. Soltis (2008) defined three basic categories of teaching styles, namely the managerial style (teacher is perceived as the

teaching manager), facilitation style (teacher fostering authentic personality of students while respecting their needs and relations and interaction among them as well as interaction with the teacher), and the pragmatic style (teacher puts emphasis primarily on the subject matter and educational goals).

We also mention the teaching style that draws from teacher-student interaction, the so-called interactive teaching style. The characteristics of this teaching style are generally assessed along eight dimensions (organizing, facilitating, understanding, leading students to responsibility, uncertain, dissatisfied, criticizing and strict). The interactive style can be significantly modified in the course of a teacher's practical experience.

As outlined above, understanding various learning styles requires understanding neuro-biological aspects of learning that are associated with knowledge of the brain and its functions. The knowledge of these determining factors should be respected by teachers when they set up the teaching texts, its forms and its ways of presentation. We consider the issue of structuring the subject matter and working with the texts as the essential psycho-didactic aspect and a building block for critical thinking. These issues have been studied by J. Mareš (2001, 2011), P. Gavora (2012), J. Duchovičová and D. Gunišová (2015), G. Petrová and N. Kozárová (2015) and others in Slovakia.

The key role of structuring the subject matter is improving the teaching strategy to improve the learning processes of the student. There is need to improve the student's activities in selecting the subject matter, remembering it and retrieving it from memory. The information that student stores during learning are not isolated pieces of information, but they are very similar to the structure of a teaching text. Children in pre-school facilities already come across this structure when they get in touch with the structure of a story.

Using the knowledge of the text structure by students is the elementary component of learning skills. According to P. Gavora (2011) these skills can include:

- 	Interlinking the already acquired knowledge with new information,
- 	Underscoring key information in the text,
- 	Taking notes from the text,
- 	Searching for the book content,
- 	Searching through the book index,
- 	Looking things up in dictionaries,
- 	Integrating information from various sources,
- 	Discerning facts from opinions,
- 	Finding the meaning of the text and assessing arguments,
- 	Seeking to find relations within the subject matter,
- 	Finding interconnections between the subject matter and one's own experience and constructing one's own version of the subject matter.

J. Mareš (2001) emphasized the need to present the subject matter not only in the school environment but also within the subject matter structure and stated his conviction that the right structure of a procedure helps to construct cognition and develop critical thinking. If development of critical thinking within the instructional and educational process is discussed, it means the "capability to assess new information, examine it attentively and critically

from various angles and draw judgements about its credibility and value, assess the meaning of the new ideas and information for one's own needs" (Grecmanová et al., 2000, p. 7).

The theory of critical thinking as a teaching model draws from the constructivist teaching theory. The teaching model that brings the student to create and reconstruct the way of information acquisition also fosters and helps to develop effective learning strategies.

2. Survey analyzing how university students work with text

The research conducted so far has pointed out that students have difficulties in working with text, including an inability to identify the key ideas of the text and derive their own judgments from the text (Gavora, 2008, in Červenková, I. 2010). Many students work with the text in a spontaneous way, often using the trial and error system. On the other hand, there are a quite numerous number of students who can learn from a text very successfully, meaning that they know how to work with the text in a systematic and consistent way. Some of them even arrive at effective procedures faster; others need more time and yet others, lamentably, keep using ineffective learning procedures that make the overall learning process more difficult.

R. L. Oxford (1990) refers to direct and indirect learning strategies. Direct strategies include procedures facilitating the process of remembering, storing and retrieving from memory. The outcome is a change in the mental structures and ideas of the study subject. The indirect strategies are not focused on the subject to be mastered and indirectly foster acquisition of the subject matter. Our survey drew from the theory of surveying direct and indirect learning strategies and procedures.

We used the mentioned theoretical analyses to set up the descriptive research problem: Application of procedures in working with text in the learning process.

The goal was to find preferences for procedures and strategies in working with text in students studying to become teachers.

The selected group was 238 students at Constantine the Philosopher University in Nitra, 157 (66 percent) of whom are full-time students of pedagogy and 81 (34 percent) of whom are part-time students. Of the total number, 95 (40 percent) were third-year students, 91 (38 percent) were second-year students, and 52 (22 percent) were first-year students. Descriptive data on the students by a form of study and year is shown in Table 1.

Form of study	Study year			
	Year 1	Year 2	Year 3	Total
Full-time	52 (22%)	73 (31%)	32 (13%)	157 (66%)
Part-time	0 (0%)	18 (8%)	63 (26%)	81 (34%)
Total	52 (22%)	91 (38%)	95 (39%)	238 (100%)

Table 1: Respondents by a form of study and year (numbers in parentheses are a percentage of the total number of 238 respondents)

For data distribution, we chose the research methodology known as Questionnaire that predicted the quantitative design of the project. The questionnaire consisted of nine questions that are shown in Tables 2-9. For statistical processing the chi-squared ($\chi2$) statistical test was used to assess the independence of the choice of responses by respondents for each question, considering the form of study and year. Cramer V was used to quantify the degree of the correlation.

Q1 You best prefer a teacher who prefers the following during classes (questionnaire item)	Form of study		Study year			Total
	Full-time (n=157)	Part-time (n=81)	1. (n=52)	2. (n=91)	3. (n=95)	
Uses a textbook or distributes printed materials	20%	22%	27%	18%	20%	21%
Uses tables, schemes, maps, videos, photos	32%	38%	35%	38%	31%	34%
Organizes field trips, laboratory activities	26%	17%	29%	20%	23%	23%
Discusses with students	75%	74%	73%	73%	77%	74%

Table 2: Relative numbers of responses to question 1 considering the form of study and year

This table shows that students of both forms of study and in all study years prefer communication and discussion during classes. That is the kind of teaching that allows the students to get feedback not only from the teacher but also from other students. The style allows the teacher to find out whether students have grasped the subject matter and remedy any beginning errors in learning to prevent their reoccurrence and snowballing within the following learning process.

Discussion in the instructional and educational process also allows students to critically assess various findings and take positions on them. The students simultaneously learn to respect others' opinions and to assertively express their ideas and thoughts.

Q2 In learning you proceed as follows: (questionnaire item)	Form of study		Study year			
	Full-time (n=157)	Part-time (n=81)	1. (n=52)	2. (n=91)	3. (n=95)	Total
Read the subject matter several times	37%	28%	33%	41%	28%	34%
Underscore relevant facts for the subject matter	76%	69%	79%	70%	75%	74%
Take notes (make an	34%	37%	42%	29%	37%	35%

abstract of the text)					
Study also other information sources in addition to the core text	4%	7%	0%	10%	3%	5%

Table 3: Relative numbers of responses to question 2 considering the form of study and year

From Table 3 it follows that students underscore and highlight fundamentals in the text which, however, means that they adopted the structure that was presented to them by their teacher or displayed in the textbooks. What we found surprising was that students rarely look up information in other sources and in that way they miss the fundamental prerequisite for the development of critical thinking, as well as for self-study and self-regulation of one's own learning. Critical thinking emphasizes subjecting every idea to thorough analysis, examination, and criticism, comparing it against opposite opinions and adopting one's own position on the issue.

P3 How do you review the subject matter? (questionnaire item)	Form of study		Study year			
	Full-time (n=157)	Part-time (n=81)	1. (n=52)	2. (n=91)	3. (n=95)	Total
I focus on memorizing the subject matter	37%	30%	27%	47%	26%	34%
I explain the subject matter to someone else or to myself in my own words	57%	41%	62%	48%	49%	52%
I re-tell the subject matter of core points/concepts that I have written out during studying	29%	44%	37%	26%	40%	34%
I go through the questions at the end of the text (lesson), or someone else asks me questions about the text	1%	1%	2%	1%	1%	1%

Table 4: Relative numbers of responses to question 3 considering the form of study and year

The results in Table 4 indicate that full-time students above all (57 percent) re-tell the lesson they have learned. Among part-time students, there was a minimal difference (44 percent) dwelling on also using another form of structure, namely writing out the core points/concepts. A very high percentage of both the full-time and part-time students preferred memorizing information that is difficult or impossible to retrieve and use in real situations. Word-to-word memorizing of text causes poor success also because the students then do not comprehend the subject matter in its essence, and instead, they sink into insubstantial details. Learning something

we do not understand requires a lot of effort, but the outcome still is not satisfactory because the non-comprehended material easily is forgotten.

P4 How do you select key words for abstracting? (questionnaire item)	Form of study		Study year			
	Full-time (n=157)	Part-time (n=81)	1. (n=52)	2. (n=91)	3. (n=95)	Total
I choose fundamental names and dates	17%	19%	15%	20%	16%	17%
I do not select key words; I learn the entire text the way it was prescribed	15%	14%	8%	18%	16%	15%
I always choose the beginning of the section of the prescribed material	4%	4%	6%	4%	3%	4%
I choose concepts in a logical way, following up the events	75%	75%	85%	71%	73%	75%

Table 5: Relative numbers of responses to question 4 considering the form of study and year

The results in Table 5 are identical for full-time and part-time students because 75 percent of both groups claimed in their responses that they choose concepts as they logically follow up on the discussed subject matter. We consider this way as the most beneficial because the selection of relevant concepts as they follow up is related to storing of the text structure presented this way into long-term memory. The knowledge has logical interconnections, and there is not just empty verbalism. To the contrary, there is no isolated concept.

P5 What would you improve in the teaching texts? (questionnaire item)	Form of study		Study year			
	Full-time (n=157)	Part-time (n=81)	1. (n=52)	2. (n=91)	3. (n=95)	Total
They should include more components outside the text	16%	14%	23%	12%	14%	15%
They should include more assignments that present problems and ideas for thought	43%	40%	48%	36%	44%	42%
I would reorganize the way the subject matter is arranged	15%	11%	19%	14%	11%	14%
I would change nothing;	31%	38%	17%	40%	36%	33%

I like it the way it is							

Table 6: Relative numbers of responses to question 5 considering the form of study and year

This table shows that both full-time (43 percent) and part-time (40 percent) students are aware of the need to improve the school texts to include logical assignments and assignments that will make the students think further. The student-respondents often criticized the specialized texts that present just facts and do not allow developing one's higher cognition processes and creativity.

P6 How do I work with the text? (questionnaire item)	Form of study		Study year			
	Full-time (n=157)	Part-time (n=81)	1. (n=52)	2. (n=91)	3. (n=95)	Total
I make a concept map	12%	20%	6%	11%	23%	15%
I do not need things to make sense; it is enough for me to cram the material	5%	4%	0%	10%	2%	5%
I color-highlight the important things in the text	82%	79%	90%	80%	77%	81%
I have to copy the material; I can only learn from my notes	20%	10%	21%	18%	14%	17%

Table 7: Relative numbers of responses to question 6 considering the form of study and year

The main responses by students shown in Table 7 indicate that mostly they use underscoring the text, meaning they primarily analyze the text through visual representation. Among the full-time students, 20 percent responded that they take notes that are in a linear form and only 20 percent of the part-time students responded that they process the text into a concept map, which is a certain form of the non-linear structure of the subject matter. From numerous research projects it has been found that students who use concept maps do have to put the effort in excerpting the concepts from the text, in expressing the relations and bonds among concepts, but then they better understand interrelationships and get to the core of the subject. Once the students have produced concept maps, they develop a comprehensive image of their knowledge, of how well they adopted the concepts and how they managed to extract key relationships and make various relational links. Making a map involves creative thinking, logic and critical thinking.

P7 Does your teacher point out what is important in the text to you?	Form of study		Study year			
	Full-time (n=157)	Part-time (n=81)	1. (n=52)	2. (n=91)	3. (n=95)	Total

172

(questionnaire item)						
No, they do not, but in the test they want us to know everything word for word	29%	6%	23%	31%	11%	21%
Yes, they do, and we discuss the issues a lot	17%	28%	15%	21%	24%	21%
Sometimes they point something out; they want us to understand the subject matter and know how to apply it practically	56%	62%	63%	55%	58%	58%
Points things out to us and wants us to memorize the material without making sure whether we grasped it or not	15%	11%	13%	11%	17%	14%

Table 8: Relative numbers of responses to question 7 considering the form of study and year

As Table 8 shows, students responded that teachers want them to analyze the subject matter, to take their own position and, above all, know how to apply it practically. This shows that teachers want their students to acquire strategies that are effective and lead primarily to grasping the issue, meaning development of higher cognitive functions. It also has to be pointed out that a rather high percentage (29 percent) of full-time students claimed that teachers want them to memorize the material word by word without having pointed out the important facts and relationships in the material to the students.

P8 I think I can work with text (I can pick the important things in the text)	Form of study		Study year			
	Full-time (n=157)	Part-time (n=81)	1. (n=52)	2. (n=91)	3. (n=95)	Total
Yes, it is not a problem to me	33%	31%	33%	32%	33%	32%
It depends on the subject I am studying at the moment	54%	58%	46%	56%	59%	55%
It depends on the teacher and her/his demands	30%	27%	35%	34%	21%	29%

I always have difficulties in that respect; I go to take the test all anxious over whether I have picked the substance from the study matter						
study matter	3%	5%	2%	5%	3%	4%

Table 9: Relative number of responses to question 8 considering the form of study and year

Table 9 presents the percentage of students' conviction that they know how to work with text. The most frequent responses from full-time students (54 percent) and part-time students (58 percent) were that how they work with the text depends on the subject. This is an important finding that presents ideas for more research analyses of this issue

P9 I learned to work with the text at:	Form of study		Study year			
	Full-time (n=157)	Part-time (n=81)	1. (n=52)	2. (n=91)	3. (n=95)	Total
Primary school	25%	19%	37%	16%	21%	23%
Secondary school	68%	57%	65%	69%	58%	64%
Higher education institution	17%	30%	12%	18%	29%	21%
I still do not know how to do it	3%	4%	2%	3%	3%	3%

Table 10: Relative number of responses to question 9 considering the form of study and year

A dominating percentage of students claimed that they learned to work with text at secondary school. Our opinion is that teachers should cover structuring of the text and work with the text already at primary school because already then they will be able to make their students' learning process easier. The important thing in this process also is to respect the learning style of the student and adjust relevant strategies accordingly.

According to P. Gavora (2008), there are two degrees of teacher's assistance for a student in text comprehension. The differences between the two are of strategic importance. One is the lower level, and the other is the higher, the pedagogically more valuable level. The first degree is referred to as episodic instruction, and the second degree is systematic practicing of procedures for text comprehension.

a) *Episodic instruction*

The teacher leads the students to the specific comprehension of the text, guides them to understand the text, points out important points in the text and asks questions. Episodic instruction is very useful, but it is a rather non-systematic aid to students in learning from text. For example, a student has arrived in a situation where s/he does not understand a certain portion of the text and receives assistance that helps her/him to get "unstuck." This is

specific and situational assistance, but usually, it does not address the way how to teach the student those procedures that s/he may use independently (from the teacher) in other situations.

b)   Systematic practicing of procedures and text comprehension

A more effective approach is one in which the teacher helps the student to work systematically with text is systematic practicing of procedures and text comprehension; these procedures can be used for a wide array of text contents. The goal of this procedure is bringing the student to acquire self-regulation procedures in working with text. The foundation of this is the development of the student's meta-cognition (active monitoring and controlling one's own cognitive processes).

Prerequisite 1 for practicing text comprehension is a *conviction of the teacher* of the necessity of that activity. Meaning that the methodological aspect of the comprehension practicing is secondary and what is of primary importance is the teacher believing that systematic practicing is useful.

Prerequisite 2 is transforming the *conviction of the students*. Many learners tend to prefer an inappropriate strategy, and they often learn the subject matter by heart, without understanding it. The responsibility of the teacher is not only to teach the students the procedures for working with text but also to persuade them that these methods will be beneficial and make their future learning easier.

3. Conclusion

The survey showed that working with text is still a significant and lasting problem in our education system. This was pointed out also by numerous OECD measurements. Students in Slovakia are able to learn any text without major difficulties, but they tend to learn isolated facts rather than the overall logical coherence of the subject matter.

The problem is the area within the instructional and educational process where the assignment is for the student to give her/his position or to engage in critical thinking. We do agree with the opinion of P. Gavora (2008) who stated that students have to be taught the strategy to learn. Students need to grasp the sense and purpose of the particular procedure and especially what its function is in working with text. E.R. Lai (2011) for example talks about "thinking aloud" where students can watch their teacher create the text and what arguments s/he chooses to make sure the text has a logical structure so that the subject matter is easier to grasp. The teacher presents a kind of a model procedure and then the practical exercising of the procedure with the students who, while practicing, assume more responsibility for their learning and become more motivated and their learning is more effective. What is most important is that the students are able to grasp the internal logical structure of the text and respective hierarchic relations among the used concepts.

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177