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The learner's brain cannot be fooled – a vicious circle of didactic assumptions

Introduction

Didactics is trapped in a vicious circle of seeking better solutions to problems of which it is the source itself. It leads to inadequacy of a part of the teaching process proposed by schools when it comes to meeting students' abilities and needs. And here it should be strongly emphasized: opportunities and needs widely regulated not only by the school culture, but also by the natural mechanisms of the brain. This is neither new nor surprising; for decades we have been observing the continuing inadequacy of school teaching when addressing the phenomenon of learning in a smoothly transforming society. The futility of the effort of school didactics seems to have reached a disturbing stability.

What keeps us trapped is the condition of being immersed in the didactical tradition, which is deeply rooted in the objectivist paradigms, where both the normative and instructive didactics created certain frames in which to understand and realize the didactic process in schools. The two kinds of didactics are poorly based on the correct understanding of the role of the cognitive subject in the educating process. They assume that the reality the subject experiences is independent from him/her. So, the school as the repository of knowledge gathered through learning is supposed to transmit it directly to other generations of students. Little do they know about the working mechanisms of the brain in the process of learning. As a consequence, it leads to an enormous reduction of the roles of both students and teachers. What is more, it reduces the school to a non-meaningful institution, isolating a person from acquiring real knowledge and skills.

A practical effect of the above is didactics which is well-described by an adjective 'transmissive". The pejoratively comprehended transmission of didactics results in teaching being seen as a mechanical transmission of knowledge from the outside world to the students' brains. Such a model of education clashes with natural working mechanisms of the brain and contradicts the perceptive mechanisms of it (Grabowska, 2012). Striving to increase the adequacy of teaching in connection with the abilities and needs of the natural mechanisms of the learning brain, we need to state firmly that on the grounds of didactics, we cannot fool our students' brains by persuading them that their brains should react in a different way to our teaching activity. It is a dangerous didactic illusion, which we have been sticking to for a long time. It is an illusion making it even more difficult for us to escape from the vicious circle of seeking ways to remove didactic stumbling blocks which we have ourselves created.

Meanwhile, on the grounds of didactics, we need to make an attempt to get away from the situation described above. Better understanding of the brain activity may prove to be valuable help in making the didactical influence real. Full understanding of how the brain works (based on as much as we know today) will allow us to form a clear picture of learners' abilities and update the didactic perspective of understanding the process of learning.

The brain – towards the facts

A long time was needed to pass in the history of mankind before the man found out that the brain was actually useful to him. It was some Greek rationalists, represented by Alcmaeon, Hippocrates and Herofilus (to name but a few) who offered a good impulse by defining the main function of the brain and placing the human psychic sphere there, but for a long time in the Middle Ages the Aristotle-Galen notion, when it comes to the physiology of man, was the dominant one (Zemełka, 2016). According to the notion, the heart had the advantage over the brain in creating the human psyche. Another long period passed before the anatomy and function of the brain were examined again more carefully. It was the 20th century, however, that turned out to be a true heyday when it comes to the knowledge of the subject. All the magnificent discoveries concerned mainly the medical area. It was only in the second part of the century when we could expect serious reference of the neurological aspects to the field of education. It was then when the mechanisms of the working brain in relation to the learning process started to be looked into more thoroughly.

We started to recognize that what we know about the mechanisms of the learning brain could provide didactics (which managed to fall behind over the previous decades) with a fresh start. We also began to acknowledge that the current perception of the brain shed light on what we had perceived as a dogma in didactics until then. What we started to understand was that the arguments from the neurological field concerning the learning process were more difficult to disregard than those strictly pedagogical or psychological.

Understanding how the brain works is one of the most essential challenges for both modern science and education. We are speaking of an organ which constitutes us. It lets us live and be who we are. It provides us with irreplaceable services, making it possible for us to adapt to the environment we live in each and every single day of our lives. At the same time, it controls the senses, thanks to which we are able to perceive the world surrounding us; it controls the motor system, thanks to which we move, it creates consciousness, thanks to which we assess what surrounds us and make decisions about ourselves. It does all these in every single second of our lives, doing hundreds of complicated calculations and decoding information (impulses, stimuli) coming to it from our senses which are connected with one another (O'Shea, 2012). It is paradoxical, however, that at the same time we are able to marvel at the brain and still underestimate it or not even consider its total influence on how we have become who we are. In the field of education it means being constantly stuck in the vicious circle of false assumptions or being in a kind of 'didactic trap'.

In the educational aspect, school has not accepted yet that the student's brain (the most magnificent and most mysterious fruit of evolution) is the teacher's workplace (Spitzer, 2011). The brain: created from the same atoms of the periodic table which stars are made of, atoms composed in a very specific way so that thoughts, words and actions can be created and, as a consequence, culture (also the didactic one).

Didactics which wants to be adequate with the actual learning competencies in certain periods of humans' psychophysical development cannot be deaf to the reflections resulting from millions of years of the brain evolution or to the latest data presented in the neurobiological field. The contemporary brain, with all its potential, characteristics, abilities, pros and cons has not appeared out of nowhere. It did not become at once what it is now. On the contrary, it has changed its topography for many years in close relation to evolution, during which it inherited specific structures which appeared in the previous periods. Thus, it has become bigger, more complex and complicated as well as much more effective. What it means is the rules that our brains follow in order to work and learn are a lot different from the concepts behind creating both the school and didactics which we are still so deeply involved in.

To find out what functions and tasks our brains have evolved for, it is worth asking the most basic question: what actually is the brain? Based on all available knowledge, a definition can be suggested: the brain is an organically powered, multi-functioning unit which evolved to react immediately to changes in the surrounding environment (Turlejski, 2012). Nothing more, nothing less, still keeping in mind that with the increase in complexity, possible reactions also diversified. If we put aside simplified and limited understanding of the brain's role in the process of education, we will understand that it has not evolved for so many years with a secret educational plan. Passive transmission of information during long-lasting educational sessions with a body glued to a chair and a desk was definitely not supposed to be the crowning achievement of the brain's evolution. From the biological and neurobiological perspective, such an understanding of education is a procedure that is inadequate to the abilities and needs connected with the mechanisms of the learning brain.

The brain evolved in order to provide the whole organism with better and better reaction to the surrounding world. For many years, it has taken care of our safety, nutrition (by the ability of getting food) and reproduction so that we can survive. Thus, a question arises: is the educational mainstream (practiced for decades) not too big a barrier for the brain between what lies in its nature and what it is flooded with? The main task of the brain is not to collect as much data as possible (as the school seems to be convinced). The most important aspect is to acquire knowledge and skills which are meaningful (and refer to the survival).

Because of evolution, we receive sensory information and react to it in a way that is characteristic to our species. In the most fundamental meaning, the nervous system is a device for the integration between senses and movement. Its main function is to connect sensory receptors with effectors. The system exists mainly to help 'the owner' survive interactions with the surrounding environment. The help means receiving sensory information and generating applicable reactions (Barrett, 2021).

Reducing information to a written or spoken word is a mistake from the perspective of how the brain works and such an understanding cannot be a fundamental aspect of educational impingement. Stimuli (information) are present everywhere and everything can be a stimulus. Every physical or biochemical agent that reaches us and causes a reaction of any cell begins a chain of phenomena in our organism. Since the fetal stage, we are bombarded with a variety of stimuli that shape us.

The human brain is characterized by large numbers. It consists of approximately 86 billion neurons and each neuron creates on average a few thousands of connections with other nerve cells. It needs to be mentioned, however, that Lisa Feldman Barrett claims that an average human brain creates 128 billion of neurons. The number was obtained by a stereological method known as optical fractionator technique. The number 86 (mentioned above) was obtained using an isotopic fractionator. It can be said that each of us carries inside our heads an unimaginably complicated net of hundreds of billiards??? of connections. The stimuli that constantly reach our neurons are pieces of information in the form of neural impulses. Each impulse changes the chemical environment of the synapses, bringing about specific reactions to the surroundings. The process is accompanied by creating more and more connections between sensory cells and reorganization of the already existing ones (Kossut, 2012; Linden 2021; NIH, 2021).

The never-ending data analysis performed by the brain as well as all the reactions, conclusions, learning and memory resulting from it are not a matter of currently received stimuli but they comprise all the knowledge we have gained throughout our lives, also the one we have gained subconsciously. So, when organizing the learning process, one should supply the brain with such stimuli (information) which allow the organ to convert the evolutionary conditionings since the circumstances our ancestors used to live in for a few million years and their evolutionary paths set the working mechanisms of the learning brain that are distinctive to us (Kaczmarzyk, 2017).

We receive confirmation from many fields, such as neuroscience, evolutionary biology or psychology that continuous learning is in a way imprinted in the brain activity. Thus, it is worth considering the conditions in which the process proceeds optimally. Is passive, encyclopedic and one direction oriented teaching a model compatible with what the evolution equipped us with? The rules and mechanisms of the working brain shaped by the evolution determine the way we function in our daily lives, how we perceive reality and how we learn.

And contrary to the illusion the brain makes for us, living and learning is not about recording a ready-made external reality. What the brain does is provide us with an image of the world which is as real and coherent as possible. It enables us to construct our reality in an active and dynamic way, revising the external stimuli.

Therefore, a popular belief that sensory experiences are an exact reflection of the external world and are created automatically as a result of sensory stimulation is false. Consequently, an educational assumption reducing learning to and automated transfer of information from the teacher’s to the student’s head is also a false one because perception only partly results from stimulating the sensory systems. It is, however, a process of reception and analysis of sensory information and its interpretation in the light of the knowledge one already has. It means the information coming to the brain from different senses is just like a thread that the brain uses to 'weave' our impressions. The right pattern is formed thanks to the brain constantly interpreting the information it receives based on what it already knows (Grabowska, 2012; Eagleman, 2018).

In each act of perception, pieces of information coming from different senses are coordinated. It happens even when external stimulation refers to only one modality. It is possible because the currently activated stimuli activate patterns of connections in the brain (Wróbel, 2012), specific memory traces which were produced there before as a result of previous personal school and out-of-school experiences. It means that perception is a process which reaches beyond the received information (especially in the educational context) because the reality we perceive is not a reflection but an interpretation (Grabowska, 2012). It does not correspond with teaching organized around automatically selected pieces of information to remember and recreate precisely.

Forming memory is not like cramming a storage room with successive pieces of information. Such a way of thinking when we refer to education can only make learning more difficult. The process of forming memory which includes natural mechanisms of the brain work is based on its abilities to make associations. It requires making connections between sensory stimuli, concepts and emotional states which have not been related before. It results from the relationship between the anatomy and physiology of the brain.

The structures vital for the memory forming process are located in different areas of the brain (Nolte, 2009). The first level of the system is the amygdala and hippocampus. It is here where the information formed in the final stages of sensory systems (which deal with stimuli reception) is delivered. The next step is the activation of two parallel neural pathways, through which the information leaves the amygdala and the hippocampus respectively. Both pathways carry the information to another level of the system, the thalamic nuclei and then from a part of dorsomedial hypothalamic nucleus to the ventral orbitofrontal cortex and from the anterior nuclei to medial cingulate gyrus cortex (Longstaff, 2012; Lewis, Taylor, 2021).

Remembering originates in characteristic activity patterns of the brain, the activity induced by sensory experiences connected with other contextual information, such as mood, personal history (it helps to assess our experience as an important one) and so on.

The long-lasting dominant understanding of what remembering is (which the school represents) is far from how the brain itself realizes the remembering process, which brings about negative consequences to how teaching is carried out.

Let us follow the natural course of remembering at an example of an educational school trip referring to biology lessons. Let us imagine the trip being held in Słowiński National Park. The memory of the time spent in the park is simultaneously formed from the introduced and discussed content, lying on the sand in the sun, listening to seagulls and waves, the feeling of the wind on the skin, the smell of the sea, jokes and smiles and all the other stimuli received at the same time with all the senses. But this is not the end. All the sensory information is interlaced with what is happening at a person's life in the specific moment (whether it is school-related stress, health condition or family problems).

All the information reaching the brain is coded in such a way that they cause the stimulation of neurons in its different parts, both in the areas processing sensory stimuli and in higher cognitive functions. An important part of this process is the action of neurotransmitters (Snyder, 2021). At this level, they are merely short-term memory traces. At this moment, the key role is played by the hippocampus. It receives the information about which areas of the brain have been stimulated during the trip, it records which neurons have been activated, stores the record to be able to access it in the future and arranges the new material, linking it to the previous ones.

The memories created during the educational trip can be stored with memories from other trips to similar regions or with other experiences or events from the same period.

Owing to such a way of forming and interlacing the stored information, the brain is able to associate similar experiences or notions (Grabowska, 2012). Consequently, it gives us an incredible ability to create connections between different memories, which influences the effectiveness of evoking information and learning.

It can be said that the interpretation (stored by the hippocampus) of which brain parts have been activated when experiencing learning awaits an impulse which will stimulate the memory of the event. It can be a word, an image, a recollection, a smell, an emotion, etc. Then, such an indication will again stimulate the parts of the brain involved in the original learning experience. At the same time, the hippocampus will recognize the reappearing activity as a part of a previous activity pattern. As a result, it will re-activate the net which was stimulated while forming the learning memory for the first time (Sadowski, 2012; Passingham, 2021). Each re-stimulation of a net will reinforce the connections between its neurons as the basis for memory consolidation is the process of continuous stimulation and reinforcement of connections. It is essential in order to transform short-term memory traces into long-term memory. It means that a permanent memory trace is stored in different parts of the cerebral cortex which were activated while experiencing learning.

Didactics – towards the facts

Wanting to keep the prospective character or a real influence on the teaching results, didactics cannot forget that its strength comes from the combination of research done in the didactic field and the one carried out in other sciences. Currently, the especially important suggestions come from the neurosciences. The arguments resulting from research on the brain and neural conditionings of learning appear on a large scale and make us reflect on education (Blakemore, Bunge, 2012).

The information seems to be of high value as they provide us with a new perspective when it comes to looking into the process of learning. The field studies how education changes the brain and what are the mechanisms that lead to behavior change through education. The influence of other sciences on the body of knowledge explaining human behavior and also learning processes, such as psychology, cannot be overestimated. But it is primarily neuroscience that is the area in which the brain mechanisms underlying human behavior and learning can be explained (Thomas, Ansari, Knowland, 2019).

It can be said that suitably transposed knowledge of the brain is a valuable source of suggestions for designing a more adequate teaching process (the one that considers students' abilities and needs). Indeed, the main role of didactics is to formulate regularities of the educational process. To be effective, then, didactics cannot be isolated and needs to connect with social reality and with other sciences (Kupisiewicz, 2010), as it is changing its general assumptions slowly, while faster changes can be observed in theories, subject content and related sciences (Półturzycki, 1996).

We all do not have to- and cannot - think about learning and teaching in a uniform way. Taking a multi-paradigm perspective on didactics, that is abandoning unification in favour of broader understanding of learning and teaching processes supported by impulses from philosophy, psychology or sociology, leads us to differentiating educational assumptions and arguments. Thus, it provides a valuable and substantive critique of the so-called transmission model, which has its roots in objectivist paradigms. Different types of didactics comprised within the constructivist, interpretive, or transformative paradigms have questioned the assumptions of objectivist didactics. The mentioned objectivity was considered an illusion leading to superficiality and selectivity not corresponding to the complex and multi-layered reality of schooling (Klus-Stańska, 2018). The new learning theories positioned normative and instructional didactics as destructive towards the student. Therefore, it was natural for the new pedagogical reflection to move away from the homogenizing pressure of school.

The nascent concepts resulted in creating the New Education movement, and John Dewey is credited its founder. The ideas of this movement have made school a place where students are not totally guided by the teacher, and the textbook itself is not the main source of knowledge. Progressivism has prioritized the opportunity for continuous student improvement based on student freedom, respect for interests, and cooperative activities. The goal is primarily student independence exercised in the interdisciplinary content, with preference for individualization of working in small groups.

We can find indications of active production of knowledge by the individual (either individually or in social interaction) rather than absorption of ready portions of information from the outside also in concepts developed by other prominent educational thinkers, e.g. Piaget and Vygotski (Śliwerski, 2012; Jaworska-Witkowska, 2011). The activity itself should be produced by the student in the greatest extent, while the teacher should be a source of support, not ready-made knowledge. He or she is supposed to create a rich environment of communication, inspiration and appropriately selected tasks, interfering as little as possible in the learning process, to facilitate it.

Non-objectivist didactic models emphasize that the course of learning is so highly individualized that it is impossible to plan an exact learning process. Lesson planning is more about designing learning opportunities. Putting_students in problem-solving situations and creating the conditions for solving them on their own is more important than dry instruction, since attempts to guide students' reasoning are unsuccessful and may even inhibit learning.

In the view of non-objectivist didacticians, a student's memory contains primarily cognitive procedures for arriving at learning outcomes. Therefore, it is crucial for the learner to try to act independently in various ways, as this promotes the activation of already rooted personal knowledge, as well as the transformation and expansion of already existing structures. This didactics maintains that it is not possible to adopt someone else's message and a way of understanding the world, because building one's own understanding is based on active reconstruction of one's own thoughts. This is facilitated by making mistakes - unwelcome in traditional didactic approaches - which are a natural part of learning by stimulating thinking and transforming knowledge (Klus-Stańska, 2018; Barron, Darling-Hammond, 2008).

The criticism of the commonly conducted educational process by non-objectivist didactics allowed to clearly see the weaknesses of this educational offer, most often reduced to a passive and one-way transmission of information from the teacher to the student. This provided a valuable impulse to inspire changes in pedagogy and didactics, towards greater involvement of students as active researchers in the process of learning and experiencing educational reality.

Neurodidactics fits well into this area of reflection, its conclusions reinforcing the need to move away from traditional didactics to a model more adequate to the knowledge provided by neuroscience. Brain research contributes to substantive criticism of objectivist models and strengthens the search for a model tailored to the needs of a 21st century learner.

At present, we are facing the necessity to understand that the knowledge of the brain becomes a specific borderline for didactics and wanting to make a step forward, it needs to assimilate the knowledge of the natural mechanisms that control learning. The reason is obvious: anything that happens at school requires cooperation with the student's brain (Bielecki, 2016; Brookman, 2016). To understand the mind better, contemporary didactics needs active transposing of the knowledge of how the brain works to its own ground. It is most essential, however, to understand the brain's informative functions such as gaining (perception), collecting (memory), processing (thinking) and generating (controlling) specific information (Tadeusiewicz, 2010).

A teacher who understands how the mechanisms responsible for the learning process function, will be able to construct the teaching process in a more cognizant and practicable way. Teachers aware of their role should constantly ask themselves fundamental questions, such as: what is learning? How does it proceed? Why do I need didactic knowledge? Looking for answers to the questions, one can rely on the knowledge from the neuroscientific field. The knowledge of the neural background of learning provides us with valuable suggestions as to educational situations that can be offered to students. Without understanding what conditions, external stimuli, and context elicit an optimal neural reaction, suggested teaching may be highly inadequate to the student's abilities and needs.

It is not enough for contemporary teachers to be aware that the process of learning is connected with the brain. Such an awareness will not lead to organizing the learning process in accordance with the functioning of the brain. On the contrary, it will only reassure the teacher that it is he/she who has full control over the student's central nervous system and is able to make it work as he/she wants it (Klus-Stańska, 2018). From an educational standpoint, it is a false and harmful assumption, which results in maintaining the vicious circle of didactic assumptions made in the past. Meanwhile, various modern tools which broaden our understanding of the mechanisms of the learning brain, encourage us to integrate the knowledge with the educational one to identify the didactical myths more effectively.

Therefore, didactics being a scientific discipline interested in the learning mechanisms, needs to keep the demand for creating stronger bonds with disciplines which used to be independent. As a result, the achievements of all the fields will be more effectively adapted in the teaching process (Rostowski, 2012). The most basic perspective for didactics is *homo addiscens.* The fundamental feature of a human's organism is realized by the cerebellum. Taking into account the neurobiological dependencies of learning will have a positive influence on creating the prospective-oriented didactics.

Speaking of the educational benefits of the knowledge we have thanks to the research on the brain, one cannot forget an unusual feature of the organ, which is its plasticity. Considering the importance of the feature for our living and learning, it is worth mentioning that plasticity is underrated in the educational activity but the potential of our learning (and behavior, in general) is a result of neuroplasticity (plasticity of synapses). It can be observed in the dynamic process of changing the strength of connections between synapses.

The plasticity of the brain is the ability to modify the organization of neural connections under the influence of stimuli. In other words, it is the process of creating 'priority roads' where information circulates, which requires the selection of neurons, the improvement in the number of connections between them or the release of a bigger amount of substances transferring signals, so called neuromediators (Vetulani, 2012; Snyder 2021). To give a more detailed description of this extraordinary mechanism, it needs to be mentioned that the result of the plastic changes is also the process of dying out and creating new neurons, the expansion or regression of their processes. Neuroplasticity can also result in formation or atrophy of synaptic spines and the synapses themselves. To conclude, neuroplasticity is the ability of the brain to undergo permanent changes as a result of sensory stimuli (Żernicki, 1980; Lau, Cline 2021) as well as motor stimuli (Dylak, 2013).

Transferring the above phenomena to the didactic ground, one can make the following statement: the way you learn is the way you know things (Dylak, Ubermanowicz, Chmiel, 2009). It definitely suggests the need to shift our attention from the expected result to the process leading to the result. It automatically modifies the roles of the teacher and student in the school education. It allows the teacher to notice that which connections and circuits in the brain will be enhanced and which will be removed depends on the process of teaching he/she carries out (Spitzer, 2011).

Effective learning happens through a constant modification of how neural connections are organized. To make it possible, we need an adequate learning environment, the environment that triggers the student's activity (which is able to change the strength of neural connections). Thanks to them, more and more new 'priority roads' of carrying information are being created. This is the brain's response to the reality it experiences. Its continuous work expressed by thousands of different operations (in the form of perception, thinking, learning) under the influence of millions of situations, stimuli and emotions configures us all the time.

What we know is that cognitive processes are active ones and they are not simply a reflection that is created independently from a human entity. The representations are created in accordance with the needs and the task assigned (Maruszewski, 2011). We can therefore agree with Dylak and say it is important not only what you learn, but also how you learn, or maybe even more: you know as much as you have learnt, planned, performed (Dylak, 2013). As long as students treat the learning process as an activity they do for other people (not for themselves), it will be difficult to find an individual, personal meaning in the school education. Thus, without full student's engagement in both designing and realizing the learning process, and then analyzing the results, it will be difficult to achieve a true didactic progress or keep its prospective character.

Showing us the mechanisms of the working brain more and more precisely, neurosciences confirm what seems to be their common element for the most essential didactical phenomena, which is learning. The element is activity. The task of didactics, then, is to search for optimal conditions for the student's activity. At the same time, we should be aware that the research on the brain will not present us with simple patterns for effective education.

It proves that what we really need nowadays is the transfer of the knowledge of developmental processes based on experience and the one based on neurobiological experiments, to our educational solutions (Singer, 2008).

The data concerning the mechanisms of brainwork suggests that designing the teaching-learning process based on mastering ready-made final effects of cognitive processes (notions, rules, definitions) rather than active and individual discovery of procedures leading to such results is not an optimal way of getting effective knowledge and skills. It results from the fact that the knowledge of the world is a human interpretation made in the process of intersubjective communication and testing, in the process of discovering and creating laws and not in the process of assimilation. The world is not a book already written, it is a book to be written (Dylak, 2013).

And so, each day at school we deal with the process of writing consecutive paragraphs, pages and chapters of an individual book of each student. It means our students' brains change physically in reaction to the suggested teaching process. It is possible because serotonin, adrenalin and dopamine (working especially intensively when there are emotions engaged in learning) modify the synaptic connections essential for the learning process (Zull, 2002).

Improving the quality of the didactic procedure requires considering conclusions about the plasticity of the brain. Therefore, it should be obvious for teachers that the key factor deciding about the course and quality of learning is sensory stimulation in the form of adequately designed educational activities since undoubtedly, the brain anatomy and the chemical processes happening in it change under the influence of experiences (Hock, 2003). Neural networks are formed during the learning procedure and it turns out that the tasks difficult enough and appearing to be novelties conduce the development of the cognitive potential by constant modification of neural circuits (Goritz, Frisen, 2012).

The extraordinary potential of the human brain has been acquired in the process of the phylogenetic struggle. We gained the *homo sapiens sapiens* potential with the passage of time, by overcoming obstacles and dealing with difficulties. It is the cognitive effort and reflection that let us move on from the automatic learning and reach for the potential (Geary, 2011). Hence, students at school should be assigned tasks difficult enough for them, but also perceived as achievable, attractive and individually meaningful (Dylak, 2013) as real knowledge is not a result of transmission but personal cognitive effort. Useful knowledge is not vicarious and it is not gained by reception but by perception.

Active knowledge (the one we need when it comes to the school reality) is not a result of passive addition of subsequent portions of information, but first and foremost, it is a series of continuously received assumptions and their verification based on the knowledge, skills and emotional attitude to the activities taking place at school. Our evolutionary and (at the same time) neurobiological constitution makes us practitioners by nature. Evolving towards more and more complex, immediate reaction to the surrounding reality and creating internal references of psychic condition in reaction to environmental stimuli, the human brain poses the main question: why? what for?

Recognizing a situation as vital and useful, the brain activates further necessary mechanisms in order to acquire knowledge leading to reflection. Active knowledge is a combination of information, emotions, action and attitudes formed as a result of being active. Then it becomes possible to place the new resources in the already existing knowledge contexts.

Therefore, the key factor to change effectively the resources of knowledge we have acquired is the learning process, as the kind and course of gaining knowledge changes physically the microstructures of the neural net so, at the same time, the cognitive structures are also changed. We can therefore say that the kind of the cognitive process itself leads to the change in the way of cognition. How the learning procedure is performed is essential for both the result and developing the competencies that enable attaining good learning results.

The above are substantial facts for teachers because the transmogrification of the students' knowledge resources depends on the teaching model chosen. The teacher should decide on a model based on designing situations in which students will be able to activate the acquired knowledge to use it to construct new, broader and more in-depth resources rather than a model that makes learners assimilate information which is not related to them in any way. Taking into consideration the nature and mechanisms of the learning brain, the other solution seems less beneficial for the teaching and learning process. The knowledge we construct is not an exact representation of the world and the structures of the knowledge in the students' minds are designed under the influence of all their previous and present experiences.

Summary

The vicious circle of didactic assumptions generates solution-seeking. The solutions, however, will never bring expected results. The futile efforts suggested by didactics for decades result mainly from being stuck in objectivistic paradigms, where normative and instructive didactics set a benchmark as far as understanding and carrying out the didactic process at schools. It is assumed that the educational reality we get to know is independent from the knowing subject. So, the school as a trustee of knowledge collected by science is supposed to pass it on to next generations of students. Unfortunately, the result is the didactic process which is well-described by a term 'transmissive school'. In such a school teaching is perceived as a mechanical transfer of knowledge from the outside to the students' brains.

Meanwhile, what neurobiology suggests to didactics is that at schools we cannot fool our students' brains by trying to persuade them that their brains should react in another way to our didactic activity. Transmissive teaching will not fool the perceptive mechanisms of the brain. Using a metaphor, there is no shortcut in this situation. We are not able to circumvent the mechanisms. The human brain is the 'product' of millions of years of evolution, which supplied it with specific features. The features enable us to receive reality in accordance with specific cognitive skills.

One can be confronted with a common but false opinion that perceptive experiences are an exact reflection of the outside world (also the educational one) and are generated automatically as a result of activating the senses by different stimuli. What we notice during the teaching-learning process is slightly different for each person, as our perception only partly results from the stimulation of our sensory systems. Complex motor, color, sound or touch sensations which we experience while learning are not a simple record of external phenomena but certain psychic structures created in the brain. It means the reality perceived by us is not its simple reflection but rather an interpretation. Knowing that, we can say that the student is not a passive recipient of information. On the contrary, the student actively processes, selects and interprets it in the light of knowledge already recorded in the memory.

We cannot fool the students' brains at school, but thanks to current knowledge of neurophysiology and the latest technology, we have gained a chance to look into mechanisms whose existence we could only guess. The physical image of our minds has been unclear and based on speculations. The course of neural activity connected with creating psychic phenomena in our heads has been impossible to observe. Now we understand better the way such an activity changes our neural networks (Bielecki, 2020).

Contemporary educational reflection cannot ignore the neurobiological dependences explaining the learning phenomenon. The didactic idea having a real effect on education cannot disregard such a thought. Neurosciences are becoming a more and more important source of knowledge which is supposed to suggest how to design the course of teaching to make learning the most effective.

And though we will never be exempt from asking questions about the current state of research on the brain and education (after all, it is hard to come up with irrefutable theses about the influence of external factors and methodological

interactions on the formation of internal knowledge patterns), the information coming from neuroscience and adapted in the field of neurodidactics concerning the factors that foster learning, does not so much suggest change as talks about making it mandatory.

It is gratifying to see that the current state of research on the course of the learning process confirms the compatibility of the postulates of great thinkers and educational reformers (e.g. J. Dewey, J. Piaget, M. Montessori, R. Steiner) with the latest research on neural conditionings of learning. The most strongly emphasized (both by the precursor concepts of pedagogical progressivism and contemporary neurodidactic argumentation) general demand is to move away from the teaching model in which the teacher "transmits" information to students in the form of passive one-way transmission. Such a direction of change is given credence by the analyses of the course of learning in terms of the response of neural structures.

We already know well that the nature of the learning process is not purely cognitive but cognitive-affective. It is therefore necessary that the student becomes the subject of the teaching-learning process. Achieving it is based on suitable teacher-student relationships and the friendly learning environment resulting from such relationships. Therefore, the teacher who wants to broaden the range of didactic interventions with the postulates of non-objective didactics supported by research in the field of neuroscience, has a difficult task. The task is to take the role in which he/she becomes the trigger of student activities and it could be brought about only by taking into account the biological-cultural complexity of the phenomenon of learning.

The brain - this unimaginably complex network made up of thousands of billions of constantly reorganizing connections, needs proper stimulation so that it can conduct its never-ending data analysis giving us, among other things, the ability to react, learn, remember and draw conclusions. Thus, the teacher is obliged to organize the time and educational space in such a way that it is dominated by the active student participation in solving problems and processing information, in compiling the material independently, categorizing and organizing the knowledge contained in it. Students must participate in projects that are relevant to them, that require them to engage and cooperate, to manage and construct their own knowledge, to consider alternatives and to analyze.

Such challenges cannot be met by the methods used in objectivist didactics. In these, excessive emphasis is put on the rigid managerial role of the teacher, on the realization of strictly consecutive links (activities), on top-down and non-negotiable goals, on a linear-sequential conception of knowledge, or on excessively detailed goals and their fragmentation. Such an implementation of education is currently not justified by psychological, socio-cultural and neurobiological factors. It is of little use to the educational practice of the 21st century.

Nowadays, effective education cannot be based on the passive transfer of information to memorize and apply algorithms, but must be a path that leads students to acquiring the competence of active, critical and creative self-education. Groups of activities (methods, forms) which suit here are these in which students in small teams work on improving their understanding of the content of the subject (cooperative learning) using various ways of cooperation. Working in a team, which enables all its participants to perform a common task, introduces a number of compositional possibilities in the educational space and a potential for flexible modelling of didactic procedures, and to a large extent meets the needs of the contemporary didactic model.

Not being able to work in these settings will block the implementation of certain forms and methods, for example:

- inquiry-based teaching, in which we observe a strong learner-centered approach; active approach to learning that focuses on questioning, critical thinking and problem solving will not be achievable;

- project-based learning will also not be possible; in this method, students must have suitable space to explore real-world problems while developing interdisciplinary working skills;

- similarly, problem-based learning will be questioned as it requires identifying relevant problems, identifying content deficiencies, generating problem-solving strategies, implementing the strategies, evaluating the results, and re-generating strategies as needed until the problem is solved;

- the same situation refers to design-based lessons; here, in-depth learning is achieved by imposing constraints, generating ideas, creating prototypes, developing plans or sketching; while maintaining the necessary activity during evaluation and redesigning the work, there is a continuous revision of the knowledge mastered (Barron, Darling-Hammond, 2008).

The development of the contemporary didactic model is based primarily on the flexible selection and use of activity groups (rather than single, standardized and repetitive ways of working) in which students maximally participate in the learning process. Apart from the activities suggested above, we can also mention: elaboration (or giving meaning to memories), visualisation (or inventing the structure of complex information), generation (or creating lasting memories), self-explanation (or going beyond the information provided) and teaching as a learning method (Schwartz, Tsang, Blair, 2017).

The above examples of the ways to implement the learning process coincide with research on the neural determinants of learning as for their impact on the natural mechanisms of the brain. Because of the process of implementation and the results obtained, these methods lead to the acquisition of critical skills of the 21st century.

While allowing students to engage in concrete creative work, the teacher also provides appropriate support and guidance without relinquishing team supervision. The resulting learning environment triggers the students' need to cooperate and to take on different roles. This includes arguing divergent viewpoints, sharing insights, explaining one's way of thinking, providing constructive criticism, and following the thinking and acting strategies of others. Here are examples of processes that objectivist didactics is unable to trigger.

One should remember, though, that however useful and needed neurosciences are, they alone will not revolutionize teaching. It can be achieved by teachers, pedagogists and school headmasters inspired by the research (Brookman-Byrne, Thomas, 2018). Since the brain works in accordance with specific mechanisms, it should not be ignored while designing didactic situations organizing the learning process. The students' brains at school cannot be fooled.

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The learner's brain cannot be fooled - a vicious circle of didactic assumptions

Abstract

The article presents chosen areas of didactics, pointing at the inadequacy of a part of teaching proposed at schools to students' natural abilities resulting from the mechanisms of the working brain. It also shows its selected mechanisms in the perspective of their practical influence on the learning process.
Contemporary didactics requires active transposition of the knowledge of the working brain to its ground in order to understand the mind better. It is essential for the teacher to be updated on the understanding of the informative functions of the brain such as gaining, collecting, processing and generating knowledge. The teacher, understanding the learning brain mechanisms, will be able to construct the teaching process in a more conscious way.

Keywords: didactics, brain, teaching-learning process, neuroscience, neuroplasticity, school, development

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