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AN ACADEMIC-SCIENTIFIC TECHNICAL TEXT AS A MEANS OF PEDAGOGICAL COMMUNICATION

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Abstract

The presented study aims to examine the psychological process of resolving a problem situation as the methodological basis of problem-based learning, design thinking training technologies, and microtext understanding, to propose a methodology for working with microtexts within the framework of a course on Russian language and culture of speech for students majoring in engineering, and to assess the pedagogical and educational potential of such learning. The purpose of the methodology is to enhance the communicative and heuristic competence of students as well as to facilitate their own reflection on their educational activities. Implementation of this methodology of working with microtexts prepares students to efficient communication in the professional sphere and rational management of their creative and innovative activities when solving professional, social, private, and business problems. The proposed methodology of working with microtexts is based on a communicative-pragmatic and structural-semantic analysis of texts from technical and humanitarian textbooks conducted by the author. The analysis has allowed the author to come up with an original classification of microtexts (types A, B, C, and D (in Russian А, Б, В, Г), each with its own structural features), a methodology for identifying the main idea of a microtext, and an algorithm of finding and correcting errors in the composition of a microtext. Working with microtexts makes it possible to achieve such goals of pedagogical communication as development of the competence, reflection capability, and creative potential of students.

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Keywords: Design thinking, microtext, problem-based learning (PBL), reflection, resolving a problem situation, Russian language and culture of speech.

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1. Introduction

The need to enhance the communicative competence and creativity of students in the pedagogical process as well as their ability to produce innovations in business, technology, production, and different social spheres requires innovative learning technologies that would make it possible to solve several problems at once (Khutorskoy, 2003; Razinkina et al., 2018; Klochkova et al., 2016).

2. Problem Statement

We believe that the psychological process of resolving a problem situation described by psychologists, particularly by S.L. Rubinstein in his monography "The Principles of General Psychology" (Rubinstein, 1989), can be used as the methodological basis of an innovative technology of teaching Russian language and culture of speech.

At the modern stage of social development, the system of education faces the challenge of developing the creative potential of students and their ability to find innovative solutions (Almazova et al., 2016; Kogan, Khalyapina, & Popova, 2017; Khalyapina, 2017). In this context, problem-based learning is becoming increasingly popular. Based on the ideas of American psychologist, philosopher, and educator John Dewey (Dewey, 1907), this learning method facilitates the students' creative capabilities (Barell, 2007; Raucent & Bourret, 2010). Business workshops on creating innovation using the design thinking methodology are popular across the world (Brown, 2008, 2009; Liedtka & Ogilvie, 2011). In the 1950s – 1960s industrial design developed rapidly, establishing the important role of intuition in the process of solving engineering problems. As a result, in 1969, expert in artificial intelligence and cognitive sciences Herbert A. Simon established the fundamentals of design thinking as an innovative methodology for making decisions and solving complex problems (Simon, 1969).

We believe that at the heart of this methodology lies the psychological process of resolving a problem situation described in both Russian and foreign psychology in the middle of the 20th century.

Problem-based learning is based on the idea that the learning process should involve conditions and challenges that would encourage students to think. "The main thing about conditions which present intellectual challenges is that a person (child) cannot solve such a problem in a known way. In order to solve the problem, they need to find a new way. Such situations, which facilitate the thinking process, are called *problem situations* in psychology, while the corresponding tasks are called *problem tasks*...A typical problem situation is a problem task that requires the scientist to explain an unknown phenomenon or to discover a new law" (Matyushkin, 1972, pp. 8-9).

For a better understanding of the process of obtaining new knowledge and microtext structure, let us examine the stages of the psychological process of resolving a problem situation. S.L. Rubinstein identified the following stages: 1) emergence of a problem situation; 2) use of existing knowledge to solve the problem on the basis of **logical thinking**, growth of *negative emotions*; 3) active **intuitive-creative thinking**, intuitive choice of a solution, discovery of truth, guesswork, *positive emotions, trust in the guess*; 4) understanding of the chosen path, its verbalization, statement of a hypothesis; 5) test of the hypothesis through **logical operations**; 6) conclusion of the validity / acceptability of the hypothesis, its transformation into reliable knowledge or return to stage two (Rubinstein, 1989, p. 374). At the third stage, a new associative bond is formed between the situation under examination and the existing knowledge. This is

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often emphasized by experts in problem-based learning: "The main mechanism that enables people to discover a new, previously unknown relationship, property, or new semantic characteristic of a phenomenon, is the *formation of a new bond*. A new relationship or pattern unknown to man can only be revealed by forming new bonds with what is already known" (Matyshkin, 1972, p. 49). That said, it should be noted that the process of resolving a problem situation involves both logical and intuitive-creative thinking, with the latter playing a major role at the third stage, since it establishes the associative bond between the new situation and the existing knowledge.

Accordingly, business trainers distinguish between several stages in the design thinking methodology for finding innovative solutions. Different papers on this subject indicate a different number of stages with different names, but the essence of the process remains the same. For example, Herbert A. Simon identified seven stages of design thinking: 1) problem identification; 2) examination; 3) formation of ideas; 4) prototyping, i.e. creation of working models; 5) selection of the best solution; 7) assessment of results. Modern versions of this methodology usually include fewer stages, for example: 1) problem examination; 2) focusing on the problem; 3) generation of ideas to solve the problem; 4) creation of a solution prototype; 5) new prototype testing. It should be noted that, regardless of the version of the methodology, organizers devote significant attention to the psychological aspects of finding a solution: motivation, emotional state, physical feelings, a combination of logic and intuition, inspiration, visualization of information in the form of photos, diagrams, material objects, etc., which makes it possible to view the problem holistically and facilitates intuitive-creative thinking.

3. Research Questions

Thus, since problem-based learning, design thinking, creation and understanding of microtext are all based on similar logical and psychological patterns in creative thinking, we believe it is possible and rational to enhance the heuristic competence, reflection, and creativity of students by working with microtexts.

4. Purpose of the Study

The main aim of this study is to develop a methodology of working with scientific and academic microtexts within the framework of a course on Russian language and culture of speech that would enhance the creative potential and reflection of students, based on the process of resolving a problem situation.

5. Research Methods

Research methods include analysis of theoretical foundations of creative thinking and problem-based learning, structural-semantic and communicative-pragmatic analysis of academic-scientific texts, and pedagogical experiment.

6. Findings

Based on the known psychological patterns in the way memory, thinking, attention, and emotions work when trying to resolve a problem situation, we have analyzed a reality show "Design Thinking: Beyond the Bounds of Possibility" broadcasted on business channel "Success" in 2013. It was a nine-day

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intensive summer course on design thinking organized by the British Higher School of Art and Design with the support of the Wonderfull project laboratory. Over a couple of days, the participants – young specialists and entrepreneurs – had to solve a complex problem that a large company faced. The first day of the reality show was preparatory: the participants got to know each other, split into teams, underwent psychological preparation for the creative process, and got an insight into the theory and practice of design thinking. Throughout the entire learning process, organizers used various ways of stimulating subconsciousness and intuitive-creative thinking, including metaphors, atmosphere of play, limited time for completing tasks (for example, making acquaintance in 50 seconds — the participants have to communicate all the important information about themselves while learning as much as possible about the other person, and they talk to each of the other 35 participants of the intensive course), etc. Having analyzed the way the participants were finding solutions to the given tasks, we were able to identify the following general stages in the structure of this process (the stages do not match the days):

1) familiarizing yourself with the task or problem that needs to be solved, gathering information about the problem, acknowledging different aspects of the problem, i.e. forming a problem situation and outlining the range of problems;

2) examining the problem in detail, testing the problem situation by applying it to yourself and documenting all issues that arise using photos, videos, or text, gaining personal experience of facing a problem situation that needs resolving (making the problem more intimate, forming motivation and personal interest in finding a solution — a stage of empathy, i.e. involvement, the ability to feel the problem physically and morally). It is worth noting that at this stage the participants begin experiencing negative emotions, which facilitate intuitive-creative thinking and long-term memory;

3) observing patterns in the environment to find inspiration: one group of participants had to walk in the park and look for something that would fascinate, surprise, delight, or annoy them, without thinking logically or trying to find a solution to the problem (so as not to interfere with intuitive-creative thinking);

4) comprehending the problem, remembering the obtained physical and emotional experience and on its basis mapping out the problem, analyzing different aspects of the problem and selecting the most important ones from the perspective of the participants (focusing stage);

5) brainstorming and hypothesizing (generation of ideas);

6) selecting solutions from the proposed options;

7) prototyping, i.e. developing a working model; organizers of the business training claim that at this stage it is possible to "put the finishing touches on the idea" if it hasn't been properly thought trough at the previous stage, or to propose another solution;

8) testing the selected solution to prove its viability;

9) assessing the efficiency of the proposed solution and presenting the results to the client (Reality show "Design Thinking: Beyond the Bounds of Possibility"- 2013).

Analysis shows that the organizers of the design thinking training course created the necessary conditions for finding an innovative solution, ensured that the participants have a personal motivation, facilitated intuitive-creative thinking, and provided enough time for creativity to manifest itself, efficiently combining it with logical-conceptual thinking. As a result, the workshop participants have psychologically gone through all stages of the process of resolving a problem situation both in individual tasks (microlevel)

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and the entire business training (macrolevel). Thus, the participants were able to understand through which stages they need to go through and in what order when solving a creative problem, and how to create favorable psychological conditions for each stage. They also gained practical experience of going through these psychological states and working as a team.

On the one hand, design thinking is an innovative methodology for solving complex problems, while on the other hand it is an efficient and popular training that facilitates creativity and development of new business ideas. We believe that showing this reality show to students and describing the psychological nature of each stage as shown above can facilitate students' reflection, self-control, and, consequently, their efficiency in completing educational tasks within their field of expertise as well as professional challenges they may face in the future.

Let us now consider how the developing potential of the design thinking methodology can be used when working with microtexts. Since the psychological process of resolving a problem situation is a universal mechanism of creative thinking, scholar of educational texts Doblayev (1982) regarded it as a foundation for understanding an educational text. However, this particular scholar didn't distinguish between individual stages of this process in a microtext, in which the process of resolving a problem situation is realized. In our previous studies, we proved that the length of a microtext should not exceed the human short-term memory span (up to seven sentences) and identified five parts that correspond to the stages of the process of resolving a problem situation, with each part represented by a word combination, a separate simple or compound sentence, or two-three sentences (Anisina, 2012). Through theoretical studies and experimentation, we developed a methodology for microtext editing and an algorithm for identifying the main idea of a microtext (Anisina, 2012, 2016).

Our analysis of texts from university textbooks in terms of reflection of the process of resolving a problem situation allowed us to identify five logical parts in a microtext, each of which can be represented by a part of a sentence or one-two sentences.

Part I – introduction of a new topic and establishment of a problem situation for the readers, since they have to relate the concept that appears in a new context to the existing knowledge;

II – introduction of additional information, specification of the topic;

III – introduction of a concept that is new for this problem situation and will determine further development of the microtext, serving as a basis for the relationship between the new and the known. At the beginning of this part, such conjunctions as *however, but* and sentence connectors such as *at the same time, in spite of this* are often used, which emphasizes the surprising, somehow contradictory, and illogical way the information develops. Using these wordings reflects the psychological aspect of this stage of the process of resolving a problem situation. Additionally, this part of a microtext always stands out against the context both lexically and grammatically;

IV – development of the new concept introduced in part III, drawing logical conclusions from it;

V – summary (Anisina, 2012).

It is while reading information in part III that a new associative bond forms between the content of a microtext and the reader's existing knowledge, which is key to understanding the text: "The most appropriate examples of manifestation of this pattern [formation of a new associative bond – N.A.] in our thinking process would be the cases of understanding, which are mainly characterized by the integration of

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certain ideas or provisions contained in a book or communicated by another person into one's own knowledge system" (Matyushkin, 1972, p. 49). After reading and understanding a microtext, readers develop a concept, which is integrated into their worldview based on the associative bond established by the readers themselves, between the new concept of part III and the existing knowledge.

Our study shows that texts from university textbooks represent four logical types of microtexts (let us use ⇒ and ⇐ to denote logical connections and → to denote the associative bond):

type A (III ⇒ *therefore, as a result, for example, namely* IV). This is the most common type of microtexts; in some macrotexts up to 100% microtexts fall into this category. There are several subtypes of type A microtexts that can be distinguished: physical cause ⇒ result, argument⇒ conclusion, basis⇒ consequence, goal⇒ consequence, condition⇒ consequence, compromise (anti-reason) ⇒ consequence, general⇒ specific (or example), new concept⇒ development of the new concept. Each of these types has its own sentence connectors, such as: *therefore, it follows, as a result, after that, this causes, this leads to, this means, so, for example*;

type B (in Russian Б) – an associative type without internal logical connections, when the microtext recites certain characteristics or actions connected only by a common topic (I → II → III → IV→ V);

type C (in Russian В) (II ⇐ *this is because; the reason for this is* III);

type D (in Russian Г) (III ⇐ *this is because; this is confirmed by* IV).

However, one of the specific features of microtext structure is the accentuation of part III by a certain attribute (vocabulary, sentence structure, voice, tense, modality, verbal mood, animateness/inanimateness of the subject, semantics of the predicate, and other characteristics of predicative items). The author unconsciously, intuitively accentuates the core sentence both lexically and grammatically. This contrast attracts the reader's spontaneous attention and controls the work of long-term memory: the contrast serves as a signal for the formation of the associative bond between the new and existing knowledge, attracting spontaneous attention to this particular sentence and a new, unexpected concept (new word), which makes its first appearance in this sentence.

Let us examine some examples of the above microtext types. Since technical texts from university textbooks are rather sophisticated due to the abundance of specific terms and complex content, in educational purposes it is recommendable to use popular scientific texts that describe certain devices or technologies. The following examples are taken from Umyarov's (2008) article "Great Silk Way: Whirlwinds in Wells" published in Tekhnika Molodezhi No. 8. In the examples, italics indicate sentences corresponding to logical part III of the microtext, in which a new concept is introduced and serves as a basis for the integration of the microtext's content into the reader's existing worldview. The new concept introduced in logical part III is written in bold font, with keywords presented in capital letters. Square brackets indicate sentence connectors which could be inserted into the microtext to explicate logical connections between the central sentence and the preceding and subsequent sentences.

Type A (III ⇒ IV): "One of the main advantages of the Great Silk Way, the ultimate engineering and transport construction, were the wells. *In order to increase, modernly speaking, the payload of caravans, engineers* ***DID EVERYTHING to make sure that pack animals didn't have to carry*** [accentuated by us – N.A.] *huge reserves of drinking water, apart from a minimum amount required for*

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one passage. [NAMELY] They dug wells along the way 12-15 km from each other, each well storing enough water for a caravan of 150-200 camels" (Umyarov, 2008).

In this microtext, several types of accentuation are represented: the core sentence features animate subjects (*engineers, animals*), a verbal adverb phrase (*modernly speaking*), a negation (*DIDN'T have to carry*), active voice, active constructions (*did, didn't carry*), a clause of purpose, and an adverbial of purpose. There are no such characteristics in the first and last sentences.

Type A (III ⇒ IV): "In the conical or tabernacular vault of the well ... there were radial canals covered with ceramic veneer, or the ceramic veneer itself was a set of parts with ready-made sections of radial canals. ***Being heated by the sun****, the veneer* ***TRASFERRED a part of its thermal ENERGY TO THE AIR INSIDE THE CANAL*** [accentuated by us – N.A.]. [AS A RESULT,] There was a convection current of hot air inside the canal. Hot air currents were hurled into the central part of the vault. But what was the origin of the whirling motion inside the well building?" (Umyarov, 2008).

In this microtext, the core sentence has a verbal adverb phrase (*Being heated by the sun*), whereas the other sentences don't have such grammatical forms.

Type B (I → II → III → IV→ V): "3,000 years ago in Minusinsk Hollow in Siberia, an extremely sophisticated irrigation system was created, which has been working properly to this day after some minor renovation. On the island of Crete, remains of a clock mechanism have been found, which is surprisingly precise even for our time. Ancient Rome boasted complex water supply and sewer systems, while in Paris people in the 15th century still poured dishwater right onto the city street! So, were our ancestors really that primitive in their thoughts and actions?!" (Umyarov, 2008).

This microtext recites separate **facts**, which are **connected** by an associative bond rather than causal relationships. The core sentence is not accentuated. In some cases, like in this microtext, the final sentence serves as a conclusion. Alternatively, the topic can be introduced in the first sentence: "Aluminum is widely used in engineering. First example. Second example. Third example. Fourth example. It should be emphasized that the core sentence in this case has no causal relationships with the preceding or subsequent sentences.

Type C (II ⇐ III): "This is documented in the notes of Arab travelers at the time of the Khilafat (7th century). The authors of the notes claim that Chinese engineers were responsible for the creation of the wells. *This was probably true:* [THIS IS BECAUSE] *modern China, just as in ancient times, still* ***prefers rational and profitable COMMERCIAL EXPANSION*** [accentuated by us – N.A.] *over political and military measures in their relationships with the neighboring countries*. Construction of roads, albeit on foreign soil, was a part of such rational expansion. But let us not jump to conclusions regarding the authorship, thus ignoring the engineering capabilities of other ancient nations" (Umyarov, 2008).

In this microtext, the core sentence is accentuated using the modality of possibility (the word "*probably*"), comparison (*just as in ancient times*), and asyndeton.

Type D (III ⇐ IV): "Unfortunately, sparse description of the conical or tabernacular vault of the well does not provide a clear picture of its structural properties. Lack of information is compensated by speculation. *Just take a look at the slight* ***surprise of the Arabs****: ceramic veneer* ***was expensive in those times as well, but builders IGNORED THESE EXPENSES****, adding the veneer to each well.* [THIS IS

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BECAUSE] This was done for a reason: clay can be molded into any shape, and then burnt to get a finished piece that would withstand the most harsh environmental conditions for years to come" (Umyarov, 2008).

The core sentence of this microtext is accentuated by asyndeton and coordinating conjunction between the parts of a compound sentence as well as by using an animate subject. The rest of the sentences do not have these properties.

Based on the examined theoretical provisions and results of the experimental study of microtext understanding, we have developed an algorithm of working with microtexts in order to enhance the heuristic and communicative competence of students and facilitate their reflection on their own educational activities.

The algorithm includes four groups of exercises: 1) analyzing logical and psychological patterns in the structure and content of a microtext and comparing them with the specific features of creative thinking and design thinking; 2) summarizing the main idea of a microtext; 3) filling the gaps in a microtext; 4) finding and correcting errors in the composition of a microtext in order to make it as close as possible to a perfect model A, B, C, or D.

The first group of exercises – analyzing logical and psychological patterns in the structure and content of a microtext – makes it possible to compare these patterns with the specific features of creative thinking and the innovative methodology for solving complex problems – design thinking. These exercises not only provide insight into the stages of the process of resolving a problem situation, but also allow students to come up with their own guidelines for managing their educational process when solving a creative problem. At this stage, it is advisable that students watch the reality show "Design Thinking: Beyond the Bounds of Possibility" and analyze training stages, comparing them with the process of resolving a problem situation and explaining the psychological reasons for the inclusion of certain tasks and training stages. It is also possible to use the history of scientific discoveries for the sake of comparison – the discovery of Archimedes, for example. Creative tasks can also be used at this stage, such as writing an essay or preparing a report on the history of any discovery or innovation, in which students would analyze the creative process of researchers, creators, and developers of scientific or business solutions based on diaries, memoirs, or historical research. Alternatively, students may describe an experience of their own or of their friends, relatives, etc. The main purpose of these tasks is to analyze the psychological patterns and logic of finding a solution, pointing out universal patterns in each individual case.

The second group of exercises involves summarizing the main idea of a microtext in the form of a new sentence composed on the basis of the existing sentences, which should reflect the internal logical connections between the content of the sentences. The algorithm of summarizing the main idea resembles the natural way of thinking and helps students better comprehend the flow of their thought. In type A microtexts, the main idea is represented by logical connection III $\Rightarrow$ IV, in type C microtexts – II $\Leftarrow$ III, in type D microtexts – III $\Leftarrow$ IV. Information from the other sentences can be added when necessary. For type B microtexts, this algorithm does not work: the main idea can be contained in the first or last sentence if they are general in nature, or in a newly composed sentence that unites or recites the content of all (or some) other sentences of the microtext.

The third group includes exercises that task students with filling the gaps using appropriate connectors, adding missing sentences (by choosing one of the proposed options), or writing an ending to a

microtext based on the A, B, C, D microtext development models discussed above. These exercises facilitate creative thinking and require a high degree of understanding of the author's logic reflected in the microtext. These exercises are aimed at developing the reflection capabilities of students.

The fourth group of exercises involves finding and correcting errors in the composition and presentation of a microtext. Errors appear in actual texts because authors are guided not only by logic, but also by intuition – due to the fact that microtexts reflect the process of resolving a problem situation, in which parts II and IV correspond to the maximum activity of logical-conceptual thinking, and parts III correspond to the maximum activity of intuitive-creative thinking. By understanding the specifics of this process and using perfect A, B, C, D models to analyze microtexts, students should be able to detect errors and correct them, thus making the microtext easier to understand. The types of errors and the principles of correcting them are discussed in our previous publications (Anisina, 2016).

7. Conclusion

Implementation of this set of exercises makes it possible not only to develop competencies and skills of creating logically sound and comprehensive microtexts in students, but also to realize the pedagogical potential of an academic-scientific text and to facilitate the development of heuristic competence and reflection on creative thinking. Comparison of the process of creating and understanding text with the actual creative process (gaining new knowledge in science or creating an innovation) and with business training in design thinking enhances the creative capabilities of students. Furthermore, this type of learning can be based on texts relating to the students' field of expertise, which enhances their interest, motivation, and, consequently, the efficiency of pedagogical communication.

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