Digital didactic products for "Generation Z" specialized education

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Annotation. The tasks of innovative didactic developments for the education of modern school and university students are actualized. The article analyzes the typological mental features of young people born in the XXI century – "Generation Z". Some general characteristic features of thinking that are massively inherent in "Generation Z" are revealed. The prevailing type of their consciousness and thinking is characterized by the concept of "clip". The features of the definition of "clip thinking" are considered, its negative aspects (fragmented, incomplete, uncritical) and positive aspects (rapidity, volume) are noted. It is concluded that there is a need for special approaches to the development of modern didactic tools for working with young people. The priority value of digital information technologies in solving educational problems of "Generation Z" is proved. The article deals with the conceptual issues of creating digital didactic products and their pedagogical use within the framework of certain digital didactic solutions. The complex technological and production nature of many digital didactic products and the necessity of partnership between pedagogical specialists and engineers for their creation is highlighted. The special role of natural science and technological specialized education for innovative and technological development is noted. Special attention is paid to the applied, scientific-model semantic context of creating digital didactic products for natural science and technological educational specializations.

1. Human potential for knowledge economy

The implementation of modern strategies for "growing" young research and engineering personnel for innovative and technological development as a socio-pedagogical problem in Russia today can be actualized in two interrelated educational and activity plans: professional education (University) and general education (school). The direct strategic relationship between the University and school educational levels is exemplified by the existence of a scientific and substantive specialization of secondary general education in the programs of secondary schools, which is represented there in the form of specialized areas of education for high school students. "Ori entation (specialization) education is an orientation of the educational program on a specific area of knowledge and (or) types of activities, determining its subject content, the prevailing types of educational activity of the student and requirements to results of mastering the educational program" [1]. The school specialization is the special complex of socially-pedagogic activities for educational orientation, psychological initiation, theoretical and practical preparation of senior pupils for obtaining higher education on certain professional orientation.
In accordance with the applicable Russian Federal State Educational Standard in the structure of secondary education it can be isolated two non-humanitarian educational specializations, in the context of the implementation of educational programs which are the main institutional socio-educational actions for pre-university training of future researchers in the field of natural and technical sciences and engineers – developers and the creators of technological innovation. These are educational specializations "technological" and "natural science". High school students who choose these specializations form the main potential talent pool for the country's future innovative and technological development. Formulation and solution of specific complex of tasks for educational work with high school students of "technological" and "natural science" specializations at the level of schooling and level of school-University educational-pedagogical and scientific-practical cooperation, is an essential condition for the formation and development of an effective knowledge economy in Russia, whose presence is now considered internationally as an indispensable factor for innovative-technological competitiveness of the state.

One of the most important aspects of assessing the effectiveness of the knowledge economy at the present stage and in the future should be the characteristic of the readiness of school graduates for higher education. The concept of readiness for higher education in this target context is much more complex and voluminous than knowledge preparation for University admission, preparation for entrance exams (Unified State Examination). The task of the modern pre-university school educational stage should be to prepare and comprehensively ensure the evolution of the educational transition of young people from school to the University world as a special reflection of the ideology of continuing education. The effectiveness of such a transition should be evaluated by different criteria: knowledge, activity-practical (functional, operational, instrumental), psychological, motivational, etc.

In contrast to the late Soviet period, the 80s of the XX century, and the first post-Soviet decades, today the popularity and prestige of natural science, engineering and technological education among young people in Russia is gradually increasing, in particular in connection with the National Technological Initiative (NTI) and other state innovation and technology strategies. However, the level of readiness of students for higher education in these areas, as shown by the analysis of University teaching practices, is quite low in many aspects today. To a large extent, this is precisely the result and echoes of periods of declining popularity of these areas of education and low consumer demand and competition for these specialties in many Russian universities in the late XX – early XXI century, including in pedagogical universities. Today's low level of school education in the field of natural-mathematical and technical-technological sciences, which are the basic core of training future scientists and engineers to implement the tasks of state innovation and technological strategies, is largely due to the insufficiently high scientific, content and professional-pedagogical competence of teachers working in the general education system, many of whom came to work in schools after higher education, having not received a sufficiently high-quality education in the post-Soviet period and/or not having an internal interest in their pedagogic profession. The qualitative aspect of the personnel and professional issue at all levels of education is one of the key aspects for ensuring absolutely all opportunities for innovative and technological development.

But personnel-competence, professional-ability – this is only one problematic facet of the modern complex of institutional education. Another problematic facet is related to the typological mental, psychological, and socio-cultural characteristics of the younger generation of school and university students. As modern research in the field of psychology, sociology, and pedagogical Sciences shows, today it is impossible not to take into account certain integral characteristics of the younger generation if we strive to ensure the effectiveness of modern education and solve the problems of forming human capital that can ensure a high level of innovative and technological development of the country.

One of the global trends in the modern organization of education at all levels in all countries of the world is informatization, digital technologization, mediatization of educational environments and pedagogical processes. These global technogenic and socio-cultural trends, as it turns out, have different specific features and manifestations for the formation of different age groups (generations), form different mental, psychological perceptions and behavioral responses. Special significance and special
promising opportunities for obtaining positive educational effects of the use of digital educational technologies can be expected in working with the audience of students of "Generation Z", which includes all current school students and most full-time students of higher education institutions, since both were born in the third Millennium. (All those born in the XXI century are integrally characteristically ranked as "Generation Z").

In accordance with the data of a number of modern scientific studies and the conclusions of scientists, for the education of young people, who today make up the entire audience of Russian school students and most university students aged about 20 years, understanding and pedagogical consideration of a number of typological generational features becomes extremely important for ensuring the success of educational processes of these students, since the nature of the mentality and social psychology of this generation significantly differ from similar characteristics of other, earlier generations [2; 3]. It turns out that the use of the same pedagogical techniques and approaches for different age communities – generations – of students, the same didactic components of the educational environment today can not provide the desired educational effects. In other words, to organize effective educational processes with young people, it will no longer be possible to use only the arsenal of old pedagogical approaches, tools and means that have long been proven and previously worked well for the education of older generations, and it is necessary to create new ones that are more suitable for working with "Generation Z".

2. "Clip thinking" as an attribute of "Generation Z"
"Generation Z", or Centennials (from the English "centennial") – today's young people who not only live in the era of global informatization and digital technologization, but also were born during it. They live in the environment of these technologies from birth and naturally use them widely and fearlessly, including for educational purposes. ("Generation Z" has another meaningful symbolic name – "Digital Natives"). This generation is characterized by a special typology of "digitized" consciousness and thinking. The definition that today typologically generalizes the activity of representatives of the "Generation Z" community is "clip thinking (clip consciousness)". "The English word "clip" in translation into Russian has the following meanings: "segment", "text fragment", "newspaper clipping" or "excerpt from a movie" [4]. Previous generations do not have such type of thinking as a characteristic globalized, unifying feature of the generation. The effectiveness and success of pedagogical and educational actions is directly related to the nature, form and content of students' thought processes. Without a qualitative comprehension of the thinking characteristics of a certain target audience of students and without the adaptation of pedagogical tools and approaches to working with it, positive educational effects cannot be obtained.

In the modern scientific world, there is no unified interpretation and strict treatment of the concept of "clip thinking", but there are a number of its contextual representations and interpretations. Analyzing various scientific sources, we can identify the main characteristics and distinctive properties of "clip thinking", which are noted by most researchers [3-9]. Among them:

- the ability to perceive sufficiently large technologized information flows (electronic, audio and video information);
- the habit of consuming large amounts of fragmentary, "patchwork" information;
- quick perception (mental processing) of scattered information fragments in the information flow, the ability to quickly switch between them;
- development of visual perception of information, high speed of perception of images (not deep, essential, but superficial, external);
- predominance of concrete thinking over abstract, preference for non-textual, imaginative information;
- relatively high level of user development of information (digital, computer, multimedia) technologies;
- ability to navigate the constantly changing information technology space;
• virtualization of consciousness, the ability to "flow" from a real environment to a virtual one and back;
• lack of development of reflective, analytical, critical thinking plans, weak capacity to analyze, to make a conclusions;
• difficulties in integral perception and logical understanding of objects, phenomena, events and their relationships;
• trustfulness to the information received, accepting it on faith, lack of reflection on its correctness, truth, and justice;
• weak abilities of self-organization and self-control, lack of psychological concentration and attention;
• vocabulary minimalism and speech limitations.

If the current community of school and university students, automatically classified as "Generation Z" by date of birth, is typologically regarded as "clip thinking" bearer (which, based on various studies, can be done quite logically and reasonably), then in the context of the tasks of "growing" future personnel for research, engineering, technical and pedagogical technological spheres, the issues of creating elements of an innovative complex of didactic support are being actualized, both to work with students, and working with high school students. Designing elements of such a complex should take into account the different characteristic features of "clip thinking".

3. Didactic products of the new pedagogical nature

The problems of ensuring the quality of modern general and higher education in the target projection of "Generation Z" cannot be effectively solved without the creation of new information-technologized, multimedia didactic products. For this generation of students, as for none of the previous ones, visualization of scientific knowledge (all kinds of objects, processes, phenomena, events, etc.) will play a significant not only didactic, but also psychological, motivational, interesting role. This is the peculiarity of "clip thinking", integrally inherent in "Generation Z", that the perception and understanding of knowledge (in a broad sense) by students without visual images can be significantly difficult, and neither interest, nor thinking, cognitive, creative and other important personal abilities may not be developed. This thesis, in fact, defines a new conceptual didactic setting for modern general and higher education, a new nature of pedagogical actions – understanding and taking into account the psychological and mental characteristics of the target audience of students when designing modern didactic solutions and products.

Always recognized as a didactically significant factor of visual-figurativeness in teaching in the global digital era, it is acquiring a new qualitative embodiment in the form of Digital Didactic Products (DDP) and various options for their educational, didactic application – Digital Didactic Solutions (DDS). Moreover, in relation to some existing DDP, the concept of a DDS is a meaningfully open applied category – the same DDP can be included and involved in different digital didactic solutions, while the number of different digital didactic solutions for using a certain DDP is potentially unlimited. This not only leaves, but also encourages the possibility of creative use of the DDP by various pedagogical specialists.

The development of a DDP is a special educational and technological and at the same time production problem. This problem has two initial development and production components. The first is ideological and conceptual, scientific and informative pedagogical (actually, didactic), the second is engineering and technological, technical (production and product). A digital didactic product is also an engineering and technological product. Feature and the problem of its creation is that the didactic aspect of the development of such products will be provided by some people, and technological ones more often by others, because the developers of didactics, generally speaking, have not and will have not, in the mass, special engineering-technological, programming knowledge needed for creation of most digital products. Thus, the task of didactic digitalization of modern and future education passes into another
problem-activity plane, namely, the organization of innovative-activity educational and technological partnership of teachers-didactics with development engineers, programmers.

Practical examples of such innovative and active partnership of scientific and pedagogical specialists and engineers to create a DDP already exist. In particular, in 2018-2020 in Krasnoyarsk, scientific and pedagogical specialists of KSPU named after V.P. Astafiev (Department of Technology and Entrepreneurship and Department of English) in partnership with representatives of high-tech business (Krasnoyarsk Techno Service company) within the framework of the NTI project "Smart Education-interactive learning using virtual reality technologies", didactic development and technical creation of a digital didactic product for learning a foreign language (English) was carried out. This DDP uses virtual reality (VR) technologies to create a simulated educational environment that initiates virtual immersion of the student in special communication spaces with animated visual images and multimedia components. In a technical sense, this DDP is a rather complex technological object that cannot be created independently by an ordinary pedagogical specialists.

To use the described DDP in real pedagogical practice, a didactic solution for the infrastructure organization of the educational space in the classroom has been developed. This solution is implemented by creating a computer-multimedia complex with working tools and places for the teacher and students in the classroom.

The server part of the complex is implemented as a three-tier architecture [10]: client application – application server + speech recognition and synthesis server – DBMS. The application server is implemented on the Odoo platform and provides the main functionality of the solution, a software interface for a mobile VR application, as well as a web-based learning administration platform that provides the following functions:

- Creating and editing didactic situations.
- Create and edit graph in the learning process.
- Analysis of the results of students’ tasks.
- Administration of access to the service.

PostgreSQL is used as a DBMS, providing high speed, flexibility and scalability of the solution. The client application is a browser or a VR application.

The model scheme of the classroom for using the DDP is described in [10]. The auditorium is equipped with a projector and an interactive whiteboard. The teacher's workplace has a local server. Tablet computers and stand-alone VR helmets are available at the students' places. Tablets are used for visualizing educational material and completing tasks. The teacher can use a Windows laptop for work, these permits to connect to a variety of laboratory equipment and use other software tools.

The basic version of the DDP provides for the use of an autonomous GEAR-VR helmet with a Samsung Galaxy S7 and higher smartphone running Android OS. The developed training content consists of simulations linked to the topic being studied. Simulation scenarios involve performing simple tasks with the possibility of dialogues.

The software allows the teacher to fully control the student's tablet, up to the point of blocking their work. The ability to recognize handwritten text allows students to write an answer and thus there is no need to use methods for selecting the correct answer from the suggested list.

The test approbation of this DDP showed a high sensitivity and interest of young people (students) to high-tech didactic developments, psychological comfort of using them, while older generations perceive digital didactic innovations with a lower level of psychological comfort, up to their rejection by representatives of the most senior age groups, in particular, teachers.

4. Pedagogical features of natural science and technological specialization in the digital epoch

The target audience of students who choose natural science and technological specializations for their education at school, and then come to similar specialization in higher education institutions, will in the future be the core of innovative and technological development in the country and in the world. Ensuring
high-level development of their thinking, scientific knowledge and creative potential should be considered today as one of the most important strategic state tasks. In this regard, taking into account the above-described typological mental and psychological features of "Generation Z" as a whole, it is necessary to identify new educational focuses and design special pedagogical approaches and tools that will allow them to get the desired educational effects in working with current and future school and university students.

Considering the category of "clip thinking" as a general mental and psychological attribute of "Generation Z", we can conclude about the special role of visualized and multimedia information for the mental activity of representatives of "Generation Z" and use this understanding to design the content of educational environments and to construct educational environments for "Generation Z".

The main "minus" of "clip thinking" persons is the lack of development of their abilities to complete, generalizing, and not to fragmented perception of the world – its objects, information, and knowledge. In relation to the natural science and technology spheres, this "minus" threatens the inability of practical application of theoretical scientific knowledge, information obtained in the educational process, since all real research and engineering and technological problems represent a special complex integrity, interrelation and interdependence of various scientific aspects. Real research and engineering projects, in fact, are always interdisciplinary and multi-subject and do not have, in contrast to the educational process, ready-made solutions. The lack of development of analytical, critical, and reflexive thinking plans of a person has a very negative impact on their creative abilities. And it is impossible to become a scientist or engineer without developed analytical and creative abilities.

In today's educational work with students of natural science and technology specializations, special emphasis should be placed on the practical applicability of specialized (and generally speaking all) scientific knowledge, its functionality, and its applied role. This thesis is not a pedagogical novel – a true teacher always speaks about the applied nature of knowledge and always reminds students of this. The emphasis on specialized knowledge in this context is made, since they form the professional and competence basis, the professional potential of the future specialist. However, in the modern school educational reality, there are few practical plans for applying theoretical knowledge at all, and many teachers do not even include these plans in the educational activities of school students.

The digital technological era significantly expands modern pedagogical opportunities and develops didactic tools. For "Generation Z", many applied contexts for applying scientific knowledge can be shown and proposed in a quasi-real model representation (virtual or augmented reality). With the help of digital technological capabilities, in particular, scientific model thinking of students can be formed. Scientific and technical modeling are the main modern tools for scientists to learn and master the world around them and for engineers to create technical and technological products. Model representations of reality for "Generation Z" can be said to be in many ways even natural, since they have grown up and continue to live in the environment of computer-gaming environments and immersion in them, where everything exists in a model-like form.

In order to form students' scientific model thinking in practice, it is necessary to develop and create special digital didactic products in the context of certain aspects of scientific problems. To create a DDP, for example, in the context of physical and technical problems, the necessary stages of developing and creating a DDP at the scientific and pedagogical development level will be: physical and mathematical modeling and didactic modeling. At the engineering and technological level it will be computer modeling, simulation, hardware and software modeling, etc.

Creating a DDP for educational work with "Generation Z" in natural science and technology educational specializations today is considered as not only an important, but also a necessary component of modern systems for working with school and university students. An important conceptual facet of the use of DDP in modern educational practices is the aspect of developing students' interest in science, engineering, their cognitive and creative activity. Through visual and other multimedia components of virtual and augmented realities, it is easier to form a scientific understanding and develop analytical and creative abilities of young people, to spur their interest in science and engineering. But as mentioned
above, creating high-quality and really useful digital didactic products is not an easy process, in general, it requires the cooperation of different specialists.

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