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Модульное обучение с двойной степенью дифференциации как условие достижения школьниками метапредметных результатов образовательной деятельности

Введение. Актуальность исследования обусловлена состоянием современной теории обучения, в которой не определены пути реализации индивидуализации и метапредметности в образовательной деятельности. Цель статьи заключается в раскрытии методологических основ построения технологии модульного обучения с двойной степенью дифференциации для формирования универсальных учебных действий как метапредметных результатов.

Методология и методы. Методологической основой исследования являются идеи и принципы технологического, системного, синергетического, индивидуального, когнитивного и метапредметного подходов. Они позволяют обосновать и обеспечить индивидуализацию и достижение метапредметных результатов образовательной деятельности школьников. В лонгитюдном экспериментальном исследовании для подтверждения теоретических выводов с 1990 г. участвовали 2075 обучающихся и 564 учителя общеобразовательных школ, 401 студент вузов педагогических направлений подготовки, 103 педагога высшей школы.

Результаты исследования. Основные результаты исследования состоят в раскрытии сущности модульного обучения с двойной степенью дифференциации как комплексной образовательной технологии для индивидуализации образовательной деятельности школьников и формирования в ней метапредметных результатов.

В исследовании зафиксированы эмпирические факты и тенденции, свидетельствующие о снижении тревожности школьников в обучении по факторам «страх ситуации проверки знания» (~ 55%), «страх самовыражения» (~ 31%); пребывания обучающихся в «нормальном» эмоциональном состоянии (~ 81%) при ровном, спокойном эмоциональном фоне урока (~ 68%) и повышенном (радостном) (~ 23%) при условии организации учебного занятия в режиме технологии; о положительной динамике владения методологическими умениями учителями при освоении технологии как системы (применение методов педагогического исследования ~ 52%; умение самостоятельно разработать самостоятельную анкету, тест, измерительное средство ~ 48%; способность обобщить результаты опытно-экспериментальной работы ~ 30%). Также разработано более 500 моделей инновационных уроков по достижению метапредметных результатов, 134 модуля с учетом когнитивного стиля, множество уровневых задач.

Научная новизна. Научная новизна исследования определяется обоснованием и разработкой дидактической системы, одновременно обусловливающей решение двух задач: достижения метапредметных результатов обучающимися в комфортной индивидуализированной образовательной среде. Результаты исследования разрабатывают дидактическую теорию образовательных технологий, метапредметности и индивидуализации.

Практическая значимость. Значимость результатов состоит в разработке технологии, полезной для модернизации процесса обучения в контексте развития индивидуальности и достижения метапредметных результатов в образовательной деятельности в общеобразовательных организациях, высшей школе, дополнительном профессиональном образовании.

Ключевые слова: технология обучения, уровневая дифференциация, когнитивный стиль, учебный модуль, универсальные учебные действия

Introduction. The relevance of the study is due to the state of modern learning theory, which does not define the ways of implementing individualization and metasubjectivity in educational activities. The purpose of the article is to reveal the methodological foundations for building a modular learning technology with a double degree of differentiation for the formation of universal learning activities as meta-subject results.

Methodology and methods. The methodological basis of the research is the ideas and principles of technological, systemic, synergistic, individual, cognitive and metasubject approaches. They make it possible to justify and ensure the individualization and achievement of meta-subject results of the educational activities of schoolchildren.

Results. The main results of the study consist in revealing the essence of modular education with a double degree of differentiation as a complex educational technology for individualizing the educational activities of schoolchildren and forming meta-subject results in it. The structure of the training module of the new format is also presented.

The empirical facts and trends were recorded by the study, indicating a decrease in schoolchildren's anxiety in learning by the factors "fear of a situation of testing knowledge" (– 55%), "fear of self-expression" (– 31%); staying in a "normal" emotional state (81%) with an even, calm emotional background of the lesson (68%) and an increased (joyful) state (23%), provided that the training session is organized in a technology mode; about the positive dynamics of teachers' possession of methodological skills when mastering technology as a system (application of methods of pedagogical research – 52%; the ability to independently develop an independent questionnaire, a test, a measuring tool – 48%; the ability to generalize the results of experimental work – 30%). Also, more than 500 models of innovative lessons for achieving metasubject results, 134 modules taking into account the cognitive style, and many level tasks have been developed.

Scientific novelty. The scientific novelty of the research is determined by the substantiation and development of a didactic system that simultaneously determines the solution of two problems: the achievement of meta-subject results by students in a comfortable individualized educational environment. The results of the research develop the didactic theory of educational technologies, metasubjectivity and individualization.

Practical significance. The significance of the results lies in the development of a technology which is useful for modernizing the learning process in the context of the development of individuality and the achievement of meta-subject results in educational activities in general educational organizations, higher education, and further vocational institutions.

Keywords: learning technology, level differentiation, cognitive style, learning module, universal learning activities

For Reference:
At the present stage of human development, numerous transformations are taking place in various spheres of life. The world community presents these transformations in the form of global processes. As a part of the Global Education Futures and Future Skills sessions, experts came to the conclusion that these processes mostly affect the technological sphere (digitalization of all spheres of life), social sphere (demographic changes and the formation of a network society), the techno-social sphere (globalization and environmental consciousness). All this leads to the acceleration of all life processes [26]. In this regard, the education sector must be ready to take on these challenges. It is important to use technological innovations in obtaining high educational results, to apply them in accordance with the individual characteristics of the individual.

The following contradictions are especially evident in modern education:

- the massive scale education and the necessity to take into account the psychophysiological and individual personality characteristics of students; lack of appropriate educational technologies to implement individualized learning;
- the state requirements to achieve meta-subject results in learning and lack of pedagogical mechanisms to fulfil this requirement; lack of specific educational technologies to develop the meta-subject component, i.e. universal learning activities (ULA).

Despite the fact that the principles of individualization, variability, meta-disciplinarity (transdisciplinarity) are becoming more significant in the Russian education, the real teaching practices only start trying to resolve the above-mentioned contradictions.

The current stage of development of the Russian education is obviously characterized by a “technological boom”. Its evidence is intensive growth in various educational processes, called “educational (pedagogical, teaching, learning) technologies”. However, not all of them can be called so. It is explained by the diverse approaches to understanding the essence of an educational technology. This phenomenon is understood as a branch of science, as a pedagogical system and as an instrumental component of the teacher’s activity.

It is evident that, from the viewpoint of methodology, these are fundamentally different pedagogical phenomena. In our study, we rely on the definition of the educational technology (meaning “teaching technology”) [1]: it is a specific sequence (not necessarily strictly ordered) of procedures and activities that together constitute an integral didactic system, implementation of which leads to the achievement of the guaranteed training and academic goals in pedagogical practice.

In this case, the educational technology as an integral didactic system allows one to take into account psycho physiological and individual personality characteristics of students to the fullest extent possible and to meet the requirement of developing the universal learning activities of students as a meta-subject component.

There are some prerequisites in the form of theoretical ideas, concepts, and theories in modern pedagogical science to develop such technologies (L.V. Bayborodova (subject-oriented technologies), G.K. Selevko (a scientific description of more than 500 educational technologies), V.P. Bespal’ko (technology of nature-aligned and culture-specific teaching), etc.). However, among them, there are no clearly defined technology algorithms and
programs for realizing truly individualized learning in modern school effectively forming the universal learning activities on a massive scale.

In regard to the above, the research problem can be formulated as follows: what are the essential characteristics of an educational technology providing truly individualized education in the modern school of mass nature and facilitating achievement of the meta-subject outcomes of the educational activity?

The following assumptions are suggested as a hypothesis of the study:

Development of the teaching technology in the form of clear algorithms and instructions to implement truly individualized learning in a secondary school environment achieving meta-subject outcomes is possible when the following psychological and pedagogical conditions are created:

- the conceptual framework of the teaching technology is defined, which takes into account top-priority trends in modern education development: individualization, variability, meta-disciplinarity;
- the essential characteristics (purpose, principles) of teaching technologies are determined; they integrate into a comprehensive learning technology capable of solving two basic educational tasks: providing individualized learning and forming the meta-subject component, i.e. universal learning activities (ULAs);
- based on the developed concept, the teaching technologies are designed for private didactics;
- the developed technologies are tested and their effectiveness / ineffectiveness is diagnosed with regard to providing individualized learning and formation of the meta-subject component of the students' learning activity.

Thus, the study aims at providing a theoretical justification to and developing a comprehensive teaching technology, testing it in the Russian school practice; it should ensure that psychophysiological and individual personality characteristics of students are taken into account and meta-subject learning outcomes are achieved.

**Literature Review**

The problem of individualization and differentiation in the educational process is considered in the works of domestic and foreign researchers.

V.M. Monakhov considers individual capabilities and the training level of students to be the main criteria for differentiation of education, and, accordingly, he describes the following kinds of differentiated instruction: general (basic level of knowledge), academic (higher, advanced level of knowledge), vocational-oriented education (basic level + applied knowledge) [3]. This scientist's ideas seem to be important for us in the context of developing different variants of the differentiation technology.

A.A. Ostapenko makes an emphasis on the unity of integration and differentiation in the teaching processes. A fundamentally important idea expressed in his work is the idea of a reasonable balance between the processes of integration and differentiation in learning [5].

L.I. Grytsenko believes that individualization should be understood in the modern sense as facilitating the development of a unique combination of qualities of each student with different levels of their development, representing an integral identity of each student’s personality [2]. This idea is of key priority for our research.

I.M. Osmolovskaya describes the essence of individualization as a limiting case of
differentiation (individualization as taking into account the individual characteristics of each student and the limit which differentiation aims for) [4].

One of the principal methodological foundations of our research is the theory of technologization of education [8]. These scientists define the characteristics and structure of the teaching technologies [6], their classification [7], the concept of personified didactic systems [9], and the priorities of the technology approach in modern education. The ideas which are essential to us are the development of a student’s personality in learning activities and the development of subject-specific educational technologies [10].

The theories on the psychodynamic aspect of the learning process and the cognitive styles of learners are important in the context of our research [11; 12] as we take into account the ideas of the cognitive approach and the cognitive differentiation in the process of teaching [13;14]. A distinctive feature of the modern research is a strong tendency towards an integral study of individuality and assigning a more significant role to a person in building the relationship with the surrounding world. It is a person’s individuality that recent theories on style constructs are increasingly coherent with.

The theory of a meta-subject approach in education and training is being currently developed. [17]. In the studies of these scientists, the signs and structure of learning technologies, their classification [15], the concept of personalized didactic systems and the priorities of the technological approach in modern education are approved [16]. However, in the study, we rely on the authors’ understanding of these phenomena and the technology for achieving meta-subject educational results [18; 19].

The review of the foreign literature on individualization in teaching has shown the relevance of this problem for scientists of different countries. It should be noted that at present the scientists are searching ways of transition to and realization of a new educational paradigm which is called a person-centered approach.

In September 2014, an international conference called “Rethinking Teaching and Learning in the 21st Century” was held in South Africa; it was devoted to determining new approaches to learning and teaching in the new century. Professor Sitwalalmenda in her article notes that such theories as behaviorism, cognitivism and constructivism had a significant impact on education in the twentieth century [20]. The author believes that all of these theories underlie the specific pedagogical question: are direct learning approaches, such as demonstration, narration, description, and explanation, equally valuable for students compared to the problem identification method? The latter involves bringing the student closer to the “proximal development zone” to optimize learning. The scientist challenges his colleagues to search for a teaching and learning theory for the 21st century, considering the possibility that, in a new paradigm, these three perspectives could complement each other, and taking into account the distinct individual characteristics of schoolchildren of the information society.

Ananda Mahto has a similar point of view [21]. Comparing different learning theories, the author comes to the conclusion that no theory is wrong or right, but each contributes to understanding individual differences of students and the ways they can be taken into account in the learning process. Many of his conclusions are based on his own teaching experience. Thus, behaviourism reduces students to beings with no free will. On the other hand, the students make decisions based on things that they value, and values are different for each individual. It is these values that condition the individual behavior of a child and the unique characteristics of his learning activity. From the point of view of cognitive psychology, it is important to teach age-appropriate skills and concepts. It is equally important that the lessons are not under-stimulating, as this ultimately reduces a
child’s motivation to learn. Analyzing the significance of the social cognitive theories for individualization and differentiation in learning, Ananda Mahto emphasizes the importance of the fact that the pedagogical goals should conform to the learning goals of students. He believes that the effectiveness of training will increase if the students are self-motivated, socially conscious, resourceful and resilient to setbacks. To teach students these skills, the teacher should be able to model relevant learning situations well. The author does not fully support the use of punishments or awards in the classroom. He considers that it is important to create an environment in which the students are engaged and have some ownership of their education. The scientist admits that not all students can reach the same level of self-efficacy. The reason for this, according to him, is that the teaching methods do not take into account students as individuals and the solution is in making the learning process more individualized and differentiated.

Foreign scientists try to develop different ways of effective learning based on individualization and differentiation in learning. Chris Kyriacou describes individualized learning programs for students, which continue for several hours or days [22]. The main advantage of such individualized programs is that they make it possible for students to work at their own pace and at their own level. This aspect actualizes the importance of the compliance of the learning tempo with the student’s level to maximize the instruction quality. The author identifies three main types of individualized programs commonly used in schools: project activities, computer training programs, and schemes structuring the material in the form of maps and booklets. Chris Kyriacou identifies risks of possible difficulties for students when they perform independent tasks and suggests a new kind of teacher-student relationship to overcome the difficulties.

On Becoming an Effective Teacher presents the final unpublished writings of Rogers and it has not only unique historical value but also a vital message for today’s educational crises [23]. It can be considered as a prescription against violence in our schools. It documents the research results of four highly relevant, independent studies which comprise the biggest collection of data ever accumulated on student individuality. This comprehensive research was accomplished over a twenty-year period in 42 U.S. States and in other countries including the UK, Germany, Brazil, Canada, Israel, and Mexico. The research suggests that teachers and schools can significantly improve their effectiveness through programs focusing on facilitative interpersonal relationships. The results show that teachers who either naturally have, or are trained to have empathy, genuineness (congruence), and who prize their students (positive regard) create an important level of trust in the classroom and exert significant positive effects on student outcomes including achievement scores and interpersonal functioning. The dialogues between Rogers and Lyon offer a unique and timeless perspective on teaching, counselling and learning. This book is among the most thorough and rigorous research ever accomplished on the significance and potential of a person-centered approach to teaching and learning.

Timothy G. Wingate, Jennifer L. Tomes used a person-centered approach to explore individual differences in academic performance [24]. Their findings identify conscientiousness, intellectual ability, motivation, and anxiety as the strongest predictors of academic performance and academic variability.

The study by L. Coertjens et al. aims at investigating the variability of students’ approaches across three learning environments [25]. A sequential explanatory mixed-method design is used to relate these approaches to students’ general study orientations and their context-specific perceptions of the learning environment. A total of 148 students took part in
the investigation on the course-specific approaches they adopt. The scientists observed significant positive association between perceived interest and relevance and change in organized studying. Perceptions of receiving peer support were also positively associated with the deeper approach to learning and organized studying.

Students encounter different difficulties in the process of learning – cognitive, emotional, personal, social and functional; they may arise for various reasons [27]. Teachers know about their learning difficulties; however, they do not know what the nature of the difficulties is, and what they arise from. Insufficient awareness of teachers of the learning difficulties of students is associated with two main reasons: 1) teachers find it a challenge to ask students about their learning difficulties; 2) when asked directly about their learning difficulties students struggle to express these difficulties explicitly and clearly [28]. These facts demonstrate the importance of enabling students to describe their difficulties and encourage students to actively participate in their own learning process. This approach is based on the belief that it can make the learning experience more valuable for students, increasing their engagement in learning [29]. Moreover, the students’ opinion of the classroom climate and their participation in the classroom enables teachers to get rich and profound information about the teaching processes and thereby adapt the educational environment to their needs [30]. It is obvious that one should build real and mutual trust between students and teachers, encouraging students to express themselves so that they can openly state their opinion [31]. Often, when asked directly about their learning difficulties, students try their best to word them clearly, and as a result, teachers try to adequately resolve these difficulties [32; 33].

The study by J. C. Kaufman, R. A. Beghetto, C. Watson aimed at investigating creative metacognition [34]. They examined the question whether students’ self-ratings corresponded with the opinion of the external raters. 242 students completed three performance tasks (visual, verbal, and scientific task). Immediately following each task, students were asked to judge whether their resulting product was creative at the mini-c level (i.e., creative to the self, but not others) and little-c level (i.e., recognized as creative by others). External raters also scored the creativity of each completed task. Results suggest that students were able to differentiate their performance on different creative domains (i.e., visual, verbal, scientific) and across different levels of quality (i.e., mini-c and little-c). In addition, their self-ratings were also predictive of creativity scores as assigned by expert raters. The specific patterns of the relationships between students’ self-ratings and creativity are discussed in the article.

Despite the diversity in educational practices developed by science, individualization of teaching causes teachers difficulties. Thus, Courcier analyzes the practice of personalized learning which is a ‘new’ teaching and learning style in the Five Year Strategy for Children and Learners launched by the Department for Education and Skills (DFES) for England in 2004 [35]. Personalized learning, in Courcier’ view, seems to be the collection of ideal old and new approaches used to promote the creation of ideal classes and schools.

Thus, the review of the domestic and foreign studies has shown the existence of the above-stated problem of determining the essential characteristics of a teaching technology in the form of clear algorithms and instructions to adopt a truly individualized learning format in the modern secondary school of mass nature and to achieve the most effective meta-subject results.

On the whole, according to the degree of scientific development of the issue, designing a technology to implement truly individualized schooling and achieve effective meta-subject outcomes in learning requires a further search for solutions.
The leading methodological approaches to the problem of the research are technological, systematic, synergistic, personified, cognitive and meta-subject ones.

The technological approach is the cornerstone one. It defines the main idea of the research – justification, development and testing of the teaching technology that allows taking into account psycho-physiological and individual personality characteristics of students and students’ achievement of the meta-subject results.

The systematic approach ensures the integrity of the developed technology as a didactic system. It makes it possible to ‘fuse’ the principles and elements of three teaching technologies into a single conglomerate: these are the technology of level differentiation, the technology of individualization based on the learner’s cognitive style, the modular technology.

The synergistic approach acts in the integrated technology system as the one co-opting the potential of the systematic method and expanding it in regard to complex nonequilibrium dynamic educational systems, which are each of the technologies integrated as one teaching technology. In addition, personalities of the learner and the teacher, united by pedagogical interaction within the integrated technology, are also self-organizing systems influencing the process of the technology implementation.

The individualized approach reflects the essence of double differentiation modular training technology as a technology focused on working with the person’s originality, developing it and creating didactic conditions to manifest personal individuality [36; 37].

The cognitive approach emphasizes the fact that the technology takes into account the type of the learner’s cognitive strategy in learning. It reflects the significant role of the psychological aspect of cognition in the learning process.

The meta-subject (meta-disciplinary) approach is represented as the principle of designing the didactic process in a comprehensive technology, highlighting its focus on compliance with the requirements of formation of the ULAs and the basic competencies, and availability of the resources to achieve that.

The following theoretical and empirical methods were used to carry out the research:

- the comparative analysis of theoretical concepts of individualized, differentiated, personified, meta-subject education in general secondary school;
- the synthesis of the theoretical ideas of three learning technologies (the level differentiation technology, the technology of individualization based on the learner’s cognitive style, and the modular training technology) into a system of concepts describing the essence, principles and pedagogical mechanisms of the integrated technology;
- theoretical modelling of the principal learning tools of the integrated technology – variants of a modernized training module of double differentiation implemented along the following criteria: the level of training/learning ability and the cognitive style;
- the psychological and pedagogical experiment to test the effectiveness of the integrated technology in teaching practice;
- R. Philips’ diagnostic test [38], adapted to the learning process for 7-9 grade students, R. Kondash’s scale of anxiety [38];
• the teacher self-assessment questionnaire of methodological culture [39]. The assessment is conducted in the following way: teachers are asked to answer the questions evaluating the level of their knowledge, skills and personal qualities on a scale from one to nine: the highest level is 9 points and 1 point means very low. The points are summed, and the level of the methodological culture is assessed in accordance with the questionnaire key as follows: very low (10-18), low (19-27), below average (28-36), slightly below average (37-45), average 46-54), slightly above average (55-63), above average (64-72), high (73-81), very high (82-90);
• designing a set of criteria and their indicators to determine the level of competency (or its components – ULAs) along three levels. Readiness for independent educational activity, the nature of the activity (reproductive, constructive, creative), the content of the activities stated the federal state educational standards were used as generalized criteria to determine the levels [40];
• a statistical method of processing the mathematical data of a multi-stage experiment – the sign test.

The study involved 2 075 students and 564 teachers of secondary schools of the Russian Federation, 401 students studying at pedagogical departments of Russian universities, 103 university teachers. The experiment was carried out in stages, each stage solving a specific research task. There were three stages of the research defined in accordance with the backbone research goal:

Stage I (1990–2009): theoretical and experimental research on the problems of implementing particular educational technologies in the teaching practice at schools and universities: the technology of level differentiation, the cognitive style differentiation technology, and the modular training technology;

Stage II (2010–2013): generating and developing an idea of applying the three technologies in unity as one, and as a result of their consolidation, designing a new integrated didactic system;

Stage III (2014–2020): monitoring the effectiveness of the double differentiation modular training technology in achieving the meta-subject results.

Theoretical foundations of the study

Let us take a closer look at the basic concepts of the research. Individualization in learning is taking into account diverse characteristics of each student when choosing for them specific didactic components in the didactic process. The didactic components are understood as goals, content, methods and techniques, tools, forms of organization of academic and cognitive activities; they should necessarily comply with the educational standards. If groups of students, but not each individual, are taken into account when choosing the didactic components, then we can speak of differentiation in learning. Depending on the number of different components, one can identify the degree of individualization (differentiation) in learning. The more diverse components there are, the higher the degree is. We understand individualized learning as implementation of the didactic process with some degree of individualization (differentiation) in conditions of mass secondary education. Thus, individualized learning is not individual learning, but it is learning in conditions when a class-and-lesson system is maintained but its didactic substructures are "reorganized" and "modernized" to a certain degree.
According to the principle of educating and developing learning, we believe that any educational technology should necessarily contain educating and developing elements. But the priority is “a purposeful process of organizing the students’ activities aimed at mastering knowledge, skills, competencies, acquiring experience, developing abilities, acquiring the experience of applying knowledge in everyday life, and developing students’ motivation for lifelong education” [41]. The above definition reflects the developmental aspect of learning and characterizes the modern education as continual. In this regard, the priority in general secondary education should be given to achieving the meta-subject results, one of the components of which is universal learning activities – ULAs (along with philosophical, general scientific, generally valid notions and a system of values). Therefore, educational technologies ought to take this requirement into account and ensure the development of 4 groups of ULAs (personal, learning and cognitive, regulatory and reflexive activities). The relevance of their development is also determined by the increased share of independent work in the learning process. The meta-subject problem is relatively new in the Russian education, although there have been some serious studies in this scientific field: metasubject approach [16]; meta-subject content and results of education [17]; meta-objects as a means of forming reflective thinking in schoolchildren [15]; metasubjectivity as a didactic principle [18].

The authors understand the phenomenon of meta-disciplinarity as a multi-aspect phenomenon to develop students’ meta-knowledge, meta-activities (ULAs, fundamental for the basic competencies), students’ value system. Meta-disciplinarity is aimed at overcoming the lack of unity of the scientific worldview of the learners and helping them to achieve a high level of theoretical thinking, acquire knowledge about knowledge (methodological culture), and develop the willingness to solve educational and life problems which have a high degree of uncertainty [19].

Thus, a modern educational technology is a didactic system containing all its components from regularities and principles to the guaranteed result. An educational technology is scientifically predictable and justified, it takes into account the requirement of maximum adaptability to psychological and individual personality characteristics of learners, and necessarily creates conditions for ULA development.

The technology of double differentiation in modular training takes into account psychophysiological and individual personality characteristics of students, at the same time achieving the meta-subject outcomes in learning. Further, we will describe the essence of this complex technology.

Modular training does not only implement the idea of level differentiation, as it does in its traditional version [42; 43], but it also takes into account the learner’s cognitive strategy (the cognitive style according to the classification by G.A. Berulava and M.N. Berulava [13]. In other words, the authors' technology means applying three educational technologies taken as a unified whole; they are the technology of level differentiation, the modular training technology, the technology of individualization based on the student's cognitive style – the cognitive style technology. Training in this case is organized according to the model represented in Fig.1, where IT, IE, IA, DT, DE, and DA are the 6 cognitive styles defined by G.A.Berulava and M.N. Berulava: the integral-theoretical style, the integral-emotional style, the integral-activity style, the differential-theoretical style, the differential-emotional style, and the differential-activity style respectively.

Differentiated instruction within the framework of modular training is implemented along two lines: 1) level of training / learning ability and 2) cognitive style. That is the reason why it is called the double differentiation technology.
A cognitive style is understood as an individual way of perceiving, understanding (internalization) and processing external information entering the human brain. The names of cognitive styles speak "for themselves" and are associated with more preferable and psychologically comfortable learning technologies for a particular cognitive style.

![Diagram of a modular program on the topic of a subject course](image)

**Figure 1** Model of a modular program on the topic of a subject course

The main objectives and principles of the technologies integrated as a whole one are as follows:
- the level differentiation technology: the goal is to take into account similar abilities and cognitive needs of particular groups of students, create pedagogical conditions for each student to be involved in activities in their zone of proximal development; the principles are the following: an open list of learning goals is prepared for students indicating the criteria of achievement of each goal; each student has a right to choose the level of achievement of the learning goals (not below standard); the learning process provides conditions for mutual assistance and independent work and takes into account each student’s individual pace of work; diagnostic control (incoming, current, final) is provided continuously monitoring students’ academic achievements;
the style differentiation technology: the goal is to create the most psychologically comfortable conditions for students which means taking into account individual psychological characteristics of each student and creating conditions for self-realization in learning; the principles are: diagnosing the cognitive styles; based on this, defining individual cognitive strategies; selecting an individual learning and self-learning technology facilitating the mental and personal development of each student to the fullest degree;

the modular training technology: the goal is developing self-education and self-development skills; the principles are dividing the material into sections (units, topics) and algorithmizing the learning activity in accordance with the instructions; designing modular programs, where modules, in turn, consist of learning units (LU), as well as determining the didactic goals (of topics, of the module and its learning units: comprehensive, integrated and specific goals); indicating the ULAs developed within each learning units; acquisition of the educational content in the process of the completed cycle of mostly independent work with a module which includes the educational content, a goal action plan and a methodological guide upon achieving the planned results; the teacher’s role is that of a consultant but not an information carrier.

At the same time, the integrated technology of double differentiation modular training has the following basic principles:

the principle of individuality and subjectivity (determining individual cognitive goals matching with the ULAs); continuous diagnostic monitoring in the process of learning; transformation of the teacher’s role – ‘adaptation’ of the educational process to the individual psychological characteristics of students; differentiating the learning content and the nature of the learning activity into three complexity levels; voluntary tuning of a student towards internalizing the learning content and achieving success in learning; organizing mainly independent learning of the educational material (up to 60% of the study time);

the principle of complementarity (designing a system of training modules, different in structure (taking into account the logic of material introduction – linear and ‘spider’ training, inductive and deductive cognition methods), different in the scale of their of theoretical, emotional and dynamic components);

the principle of integration and integrity (designing modular programs, promoting intrasubject, inter-subject and meta-subject links in accordance with the content of the major subject).

The main goal of the technology is to create psychologically comfortable learning conditions for each student, taking into account their individuality and based on the double differentiation training module coordinating the whole learning and cognitive activity [44]. The complementary objectives are: a) developing personal independence and responsibility for the learning process and its results; b) developing organizational skills competencies of students including readiness to define personally-relevant learning goals; c) developing information competence and the corresponding universal learning activities of students; d) developing students’ imagination, creativity and research culture [45]. The technology has a new form of an educational module, which helps to significantly modernize the known kinds of a multifunction information unit (Table 1) and implement double differentiation [46]. The detailed description of the integrated technology, its algorithms and stages is given in the articles by one of the authors [47; 48].
The structure of a learning module of double differentiation

**Module № (M 1, M 2, ….). Topic of the module. Module Type** (complete, abridged, advanced). **Differentiation Level** (Level 1 – minimum, Level 2 – ordinary, Level 3 – advanced). **IDG (integrative didactic goal)** specifying the ULAs formed

### Table 1

<table>
<thead>
<tr>
<th>Cognitive Style</th>
<th>The learning material specifying the tasks</th>
<th>Cognitive Style</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTEGRAL</td>
<td>Guideline for learning the subject content</td>
<td>DIFFERENTIAL</td>
</tr>
<tr>
<td>Content of the learning material ITIEID</td>
<td>Content of the learning material DTDEDA</td>
<td>Guideline for learning the subject content</td>
</tr>
</tbody>
</table>

**LU № 1.** (type of the learning unit). **Specific didactic goal (SDG):** ... (description of the SDG). **ULAs, formed in this learning unit**

<table>
<thead>
<tr>
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<th>ITIEIA</th>
<th>DTDEDA</th>
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</tbody>
</table>

**LU № 2.** (type of the learning unit). **Specific didactic goal (SDG):** ... (description of the SDG). **ULAs, formed in this learning unit**

<table>
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</tbody>
</table>

**LU № N.** (type of the learning unit). **Specific didactic goal (SDG):** ... (description of the SDG). **ULAs, formed in this learning unit**

<table>
<thead>
<tr>
<th></th>
<th>ITIEIA</th>
<th>DTDEDA</th>
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</table>

**LU № N+1.** Summarizing. **SDG: Filling in the checklist. Evaluating knowledge.**

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<thead>
<tr>
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<th>IT, IE, IA</th>
<th>DT, DE, DA</th>
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<tbody>
<tr>
<td></td>
<td>IT, IE, IA</td>
<td>DT, DE, DA</td>
</tr>
</tbody>
</table>

**The checklist. Knowledge evaluation**

<table>
<thead>
<tr>
<th>The learning unit, Task</th>
<th>Questions</th>
<th>Total Points</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>LU 1. Task</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LU 2. Task</td>
<td></td>
<td></td>
</tr>
<tr>
<td>... Task</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LU N. Task</td>
<td></td>
<td></td>
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<tr>
<td>Grade</td>
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</tbody>
</table>


**LU № N+2.** Home assignment

Grade. Differentiated home assignment: ...

Write down the home assignment in the assignment book depending on the result of your work in class.
Results

Concepts of modular training technology of double differentiation

- The teaching technology, which is the result of integration or “blending” of educational technologies, stands as a didactic system of a higher order in relation to each technology included in its conglomerate and is capable of strengthening the educational effects achieved by each of the particular technologies.
- The modular training technology can act as a coordinating technology in relation to other technologies involved in its field. As a result, it performs not only its own educational functions but also significantly facilitates implementation of the main objectives of the technologies it is comprised of. As for the level differentiation technology, it is taking into consideration similar abilities and similar cognitive needs of groups of students, creating the pedagogical conditions providing involvement of each student in the activities corresponding to their zone of proximal development. As for the cognitive style technology (individualization based on the cognitive style of the student), it is creating the most psychologically comfortable conditions for each student: taking into account the individual psychological characteristics of each individual and creating conditions for self-realization in learning.
- The technology takes into account the priority trends in the development of the modern education (individualization, variability, meta-disciplinarity) and promotes individualized learning achieving the meta-subject outcomes.
- The transition to individualized learning is highly resource-consuming, hence requiring a long transition period. This conclusion is based on a fundamental difference between mass education (“one for all”) and an individualized didactic process (“each according to his individuality”).
- Individualized learning is not identical to individual learning. It is much richer in essence and fundamentally different in the content and forms of organization, preserving individual, group and collective activities as mutually reinforcing ones.

Justification of the technology possibilities to achieve the meta-subject educational outcomes

We will describe the UALs formed (on the example of the basic general education level: [39]) and the resources of the integrated technology.

- Make choices and take responsibility for decisions.
- The technology resources: The level differentiation suggests three variants of learning objectives. A student can choose a goal for himself (with the help of the teacher if necessary).
  - Independently draw up an algorithm for solving the problem, choose a solution method taking into account the available resources and own capabilities, draw up an action plan (plan for implementing the intended solution algorithm).
  - The technology resource: the module as the main means of organizing the learning activities allows independent planning of the ways of achieving the goals stated in the training module as ULAs, depending on the chosen differentiation level and the type of cognitive style. The module also suggests various alternative ways of solving academic and cognitive problems (at least two alternatives for the integral and differential styles). The tasks for all style types are available to a student, so he can, if desired, try another way of performing the task, offered for the opposite style type or for some of the sub-styles (theoretical, activity, emotional ones).
• Explain the reasons for achieving (or vice versa) the results of activities, assess the experience gained, be able to find positive in the situation that has occurred, make adjustments to activities based on new circumstances, identified errors.

The technology resource: the planned results are indicated as the integral goal of the lesson at the beginning of the module, the specific goals for each learning unit within the module, and description of the ULAs formed within the given learning unit. A student, on this basis, has a possibility to constantly monitor the degree of achievement of the result. In addition, the right answer is usually given for each task so that a student can verify the completed task and, if necessary, make adjustments.

• Give an adequate assessment of the situation and propose a plan to change it.

The technology resource: the training module provides the correct answer to the learning task. At the end of the lesson, it is advisable to organize “experience exchange” between groups of students who have diametrically opposed cognitive styles to prevent students from getting stuck on only one type of cognitive strategy and to demonstrate the strengths of another cognitive style. At the same time, a student has a possibility to see the strengths of another cognitive strategy, an alternative way to solve the same problem, and learns self-control and self-evaluation.

• Master the methods of self-control, self-motivation and reflection.

The technology resource: the module suggests a stage-by-stage self-evaluation by students of their learning results by means of the accumulated points, which are shown in the final checklist. The teacher can check the accuracy and objectivity of this assessment at any time. Students can also mutually evaluate each other’s success. The course of work with the module and the final result are easily tracked by means of the final checklist reflecting the student’s activity throughout the entire course of work with the module. The teacher can give a qualitative assessment of the student's activity in any form which is pedagogically and psychologically appropriate at this moment from the educational and motivating points of view.

• Establish an essential feature of the classification, grounds for generalization and comparison, criteria for the analysis; identify cause-and-effect relationships in the study of phenomena and processes; draw conclusions using deductive and inductive reasoning, reasoning by analogy, formulate hypotheses about relationships.

The technology resource: The learning units of a module provide for both independent and collective search for patterns, especially at the advanced level of differentiation. Modular training involves all students, taking into account their abilities and individual interests by coordinating the content of the module with the learner’s cognitive strategy. For example, the educational material offered to students, who have a differential cognitive strategy, deals mostly with inductive logic, and for students with the opposing type – the integral style – deductive reasoning works in the tasks offered. Accordingly, this develops the ability to build logical reasoning, make inferences and generalizations. The tasks suggested determine either inductive or deductive reasoning in accordance with the student's cognitive style. An obligatory element of this technology is discussing the strategies employed by different students or groups of students having similar cognitive styles at the end of the lesson, as a rule. In this case, students have an opportunity to see the strengths of another cognitive strategy and logic.

• Select, analyze, systematize and interpret information of various types and forms of presentation; independently choose the optimal form of information presentation and illustrate the tasks to be solved with simple diagrams, diagrams, other graphics and their combinations.
The technology resource: The cognitive strategies are connected with the phenomenon of the cognitive style, as well as the student’s leading modality. Working with the module, the teacher can track the activity of each student during a lesson; the module content takes into account the interests and preferences in learning, the cognitive strategy and the cognitive style of each student (perception and representation of information). Working with the module, students of the integral cognitive style are most often asked to start with an integral structural-logical scheme, a drawing, the whole of a situation. Then they analyze particular details of the situation, its elements. Students having a differential cognitive strategy are, as a rule, first offered to work with a text, to study elements of the situation, and then to create, construct, or study the whole concept that generalizes the previous knowledge or activity. The result and achievement exchange takes place, as a rule, at the end the lesson.

- Understand and use the advantages of team and individual work in solving a specific problem; accept the goal of joint activities, collectively build actions to achieve it distribute roles, agree, discuss the process and result of joint work.

The technology resource: working with the module, despite its primary focus on independent activity, suggests different types of interaction of students with each other and with the teacher.

- Express your point of view in oral and written texts; compare their judgments with the judgments of other participants in the dialogue, discover the difference and similarity of positions.

The technology resource: Planning and regulating one’s learning and cognitive activities are carried out in accordance with the guidelines contained in the training module. Written speech skills are developed as students perform the tasks suggested to complete the learning elements of the module. Oral speech skills are developed constantly, as a student, reading the texts of the module, deals with samples of literary speech. The exchange of results and achievements obtained by means of different cognitive strategies takes place, as a rule, in the final part of the lesson, where a possibility to produce monologic speech is offered.

- Apply various methods, tools and queries when searching and selecting information or data from sources, taking into account the proposed learning task and specified criteria.

The technology resource: while performing the module’s learning tasks students often have to access the Internet sources, various study books and resources, they should be able to work with a computer and use various software products (for example, the XMind program to design mind maps)

*Specification of the generalized modular training technology of double differentiation for private didactics*

On the basis of the developed concepts of the technology, there have been designed private didactics teaching technologies. A few series of training modules on school subjects have been published [45].

Monitoring the dynamics of student's anxiety in the learning process (Phillips and Kondash’s scale of anxiety) have provided proof of a comfortable psychological atmosphere as a consequence of individualized learning on the basis of the modular training technology of double differentiation. It turned out that the students did not experience any increased anxiety in the process of innovative learning. The results show that there was a decrease in the higher than usual or high levels of anxiety for all anxiety factors being monitored. The most evident decrease in anxiety rates was observed for the factors: “fear of the situation of checking knowledge” (–55%), “fear of self-expression” (–31%), “fear of not
meeting the others’ expectations” (−28%). There was a significant percentage of students who showed decreased anxiety in relation to a possibility of achieving academic success. The analysis of the emotional state of each student has made it possible to conclude that it is most often characterized as “normal” (81%) (the average data for experimental classes), the emotional background of the lesson – as “quiet, calm” (68%), elevated (joy, satisfaction – 23%), unstable (7%) and decreased (2%).

The development of the methodological competence of teachers in regard to the modular training technology of double differentiation and applying it in the educational practice was carried out through the all-Russian professional development course for teachers during 11 years (from 2006 to 2017), the course on the problem of applying the described technology through distance educational courses (Moscow, First of September Pedagogical University), and participation of teachers in experimental work. The assessment of development was based on the technique called “Self-evaluation of the teacher's methodological culture”. The data obtained from 237 school teachers reflect a general increase in the methodological competence of the experimenting teacher. At the same time, the degree of proficiency in the pedagogical research methods has changed to a greater extent (52% of respondents); the ability to design one’s own questionnaire, or test (48%); the ability to generalize the results of the experiment (30%), write an article (25%), report at a scientific seminar or conference (21%).

The teachers, participants of the experiment, have developed and introduced into the teaching practice the didactic materials of a new generation in the form of double differentiation modules in natural sciences (physics, geography, technology, basics of project activity, and etc.) within the framework of the innovative sites of the Volga-Vyatka Regional Scientific and Educational Center of the Russian Academy of Education. On the total, over the course of the experiment, more than 500 models of innovative lessons were developed to achieve the meta-subject outcomes, 134 new generation training modules and many level tasks with integrated content were designed, etc. On the basis of the experiment, the teachers have published over 60 articles, student textbooks (modules), collections of multi-level tasks and tasks offering integrated content.

The above concepts and the results of the empirical research are the starting point in the development of an integrated system of the personified educational process in an educational institution. The author's technology determines the organization and content of all the components of the corresponding didactic process of a new format. At present, the developed technology is still being tested in the teaching practice at the general education school. The future research prospects are to introduce the stated ideas and personified technologies in higher education institutions.

The experiments are still being carried out to confirm the effectiveness of the modular training technology of double differentiation in developing the meta-subject components – ULAs, and, accordingly, the basic competencies. For the sake of clarity, it should be mentioned that we consider ULAs as constituents of the basic competencies. Thus, the competency of “willingness to work independently” includes the ULAs numbered 1–5 (see the numbers above). ULAs numbered 6, 8 and 12 make the basis of the educational and cognitive competency; for the information competency these are ULAs numbered 7, 11, and ULA 9, 10 is the basis for the communicative competency. To monitor this aspect, we used a set of criteria and indicators to define three levels of development of one or another competency. The sign test has shown a clear improvement of universal learning skills as components of the students’ basic and professional competencies.
Thus the following results have been achieved in the course of the research:

• 5 modular training constructs of double differentiation have been designed as an integrated teaching technology;
• the experiments have confirmed that the technology creates a possibility to individualize the educational activity of students and achieve the meta-subject outcomes;
• the foundations of the modular training technology of double differentiation have been specified for private didactics, and the structure of the training module of a new format, which takes into account the requirement to implement double differentiation, has been demonstrated;
• it has been proved that the teacher’s methodological competence is developed when the modular training technology of double differentiation is applied in teaching.

The analysis of the works of Russian and foreign studies showed that scientists have developed a technological approach to learning [2], private learning technologies – organizing and designing pedagogical activities have been developed [9]; technologies of individualization of learning and self-learning [4], which create conditions for the development of a personality, taking into account its metaneeds [36]. A sufficient number of theories about the cognitive aspect of the learning process [11] and the cognitive styles of students [13] have been published. The authors give ideas about metasubjectivity [14] and a metasubject approach in education and training [16]. But, despite this rather deep study of the theoretical foundations of the need for individualized learning and the requirements of metasubjectivity in the conducted studies, pedagogical mechanisms have not been developed in the form of learning technologies for the implementation of the didactic process with the conditions indicated above. Our study is aimed at the development of technological support for the desired training format.

Conclusion

Thus, we have created a teaching technology in the form of clear algorithms and instructions to implement truly individualized education in general secondary school of mass nature and to help students effectively achieve the meta-subject academic outcomes.

The article can be used to modernize the learning process in general education institutions of any type, as well as in higher education institutions. The approach creates the conditions to develop subjectivity and individuality in learning, as well as to achieve the meta-subject objectives which are the basic general culture (universal) competences.

REFERENCES

23. Wingate, T., Tomes, J. Who’s getting the grades and who’s keeping them? A person-centered approach to academic performance and performance variability. Learning and Individual Differences, 2017, vol. 56(S), pp. 175–182. DOI: 10.1016/j.lindiff.2015.05.004


44. Korshunova, O.V. Modular technology with level-style differentiation as an instrumental foundation of rural schoolteachers’ didactic system. *Proceedings of Petrozavodsk State University*, 2014, no. 5(142), pp. 31–37. (In Russ.)


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