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COGNITIVE STYLE OF A FUTURE IT SPECIALIST IN A TEAMWORK PROCESS

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Abstract. *Introduction.* Training future specialists in information technology to work in a team has a great potential both for solving educational problems in the higher education and for further development of graduates as professionals in the labour market. The efficiency of the teamwork is largely determined by the effectiveness of the distribution of roles in the team. The distribution of roles depends on the individual cognitive characteristics of each team member. Individual enlightening characteristics of the ways of perception and processing of information, the choice of ways to solve problems are associated with the cognitive style of the individual.

Aim. The present research aims to analyse the nature of the influence of the cognitive style of the personality of each member of the team on the results of solving a practice-oriented task in the field of information and communication technologies.

Methodology and research methods. The work used a systematic approach (N. A. Astashova, S. L. Melnikova, A. P. Tonkikh, L. N. Shilenkova, A. Burger, L. Naude, F. D. Fernandez, J. L. Arco-Tirado, M. Hervas-Torres); practice-oriented approach (E. F. Fefilova, D. Bednarek, M. Krulis, J. Yaghob); project approach (L. I. Savva, E. A. Gasanenko, K. E. Shakhmaeva); cognitive approach (J. B. Watson, G. A. Kimble, J. Anderson, B. M. Velichkovsky, J. Kelly, J. Bruner, J. J. Goodnow, G. A. Austin, M. A. Kholodnaya), in the frames of which general scientific and statistical methods were used. The works by M. A. Kholodnaya, J. Parker, J. D. Bain, H. A. Witkin, S. A. Moore, D. R. Goodenough, P. W. Cox constituted the theoretical and methodological basis of the study, on the basis of which the characteristics of students with different cognitive styles were studied.

The analysis of the dependence of the success rate of solving practice-oriented tasks by a team of students on the cognitive style of each member of this team was carried out. The success rate was calculated as the sum of the normalised values for each type of work. 250 undergraduate students of Nizhny Tagil State Socio-Pedagogical Institute (branch) of Russian State Vocational Pedagogical University and Nizhny Tagil Institute of Technology (branch) of Ural Federal University took part in the study.

The used research methods: questionnaires, testing, the method of expert assessments, ranking, scaling, rationing, content analysis of documents, methods of mathematical statistics in data processing, methods of analysis, synthesis, generalisation, comparison, abstraction when interpreting research results. The “Included Figures” test was used to determine the field dependence / field independence of the subjects. The main statistical calculations were performed using the nonparametric statistical method “Mann-Whitney U-test”. To confirm the reliable difference in the proportion of teams that successfully coped with the task, the Fisher criterion was applied.

The data sources are open source databases (websites of international and Russian government bodies), regulatory documents regulating the basics of training IT specialists, research by leading scientists in the field of cognitive personality style, statistical information.

Results. The authors developed the criteria to evaluate the results of solving a practice-oriented task by a team of future IT specialists and defined the concept of a success indicator. The authors demonstrated the importance of taking into account cognitive personality styles when forming a team of IT specialists. The dependence of the success rate of solving a practice-oriented task on the type of cognitive style of the participants of the task was revealed. It is established that the highest results of the success rate in solving a practice-oriented task were noted in those teams that included students with different cognitive personality styles of field dependence / field independence, with a predominant number of participants with a field-independent personality style. The findings indicate the need to take into account the cognitive styles of individuals when forming the composition of teams for IT projects.

Scientific novelty. The results of the study expand the scientific facts that cognitive styles are predictors of students' achievements in solving practical tasks in teamwork.

Practical significance. The data obtained can be used to develop a strategy for training future IT specialists aimed at improving the effectiveness of teamwork in higher education institutions. The proposed calculations of the success rate of solving practice-oriented tasks can be employed to evaluate the results of educational practices and final qualifying works.

Keywords: teamwork, specialists in information technology, cognitive style, field-dependent/field-independent style, practice-oriented learning, practice-oriented task.

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КОГНИТИВНЫЙ СТИЛЬ БУДУЩЕГО СПЕЦИАЛИСТА ИТ-СФЕРЫ В ПРОЦЕССЕ ОРГАНИЗАЦИИ КОМАНДНОЙ РАБОТЫ

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Аннотация. *Введение.* Обучение будущих специалистов ИТ-сферы работе в команде имеет большой потенциал для решения образовательных задач в системе высшего образования, дальнейшего становления выпускников как специалистов на рынке труда. Результативность деятельности команды во многом определяется эффективностью распределения ролей, которое зависит от индивидуальных познавательных характеристик

каждого члена команды (способов восприятия и обработки информации, выбора способа решения проблем), связанных с когнитивным стилем личности.

Цель статьи – анализ влияния когнитивного стиля личности каждого члена команды на результаты решения практико-ориентированной задачи в области информационно-коммуникационных технологий.

Методология и методика исследования. В работе применялись системный подход (Н. А. Асташова, С. Л. Мельникова, А. П. Тонких, Л. Н. Шиленкова, A. Burger, L. Naude, F. D. Fernandez, J. L. Arco-Tirado, M. Hervas-Torres); практико-ориентированный подход (E. F. Fefilova, D. Bednarek, M. Krulis, J. Yaghob); проектный подход, (L. I. Savva, E. A. Gasanenko, K. E. Shakhmaeva); когнитивный подход (J. B. Watson, G. A. Kimble, J. Anderson, B. M. Velichkovsky, J. Kelly, J. Bruner, J. J. Goodnow, G. A. Austin, M. A. Kholodnaya), в рамках которых использовались общенаучные и статистические методы. Теоретико-методологическую основу исследования составили работы M. A. Kholodnaya, J. Parker, J. D. Bain, H. A. Witkin, C. A. Moore, D. R. Goodenough, P. W. Cox, на основе которых были изучены особенности студентов с разными когнитивными стилями личности.

Проведен анализ зависимости показателя успешности решения практико-ориентированной задачи командой студентов от когнитивного стиля каждого члена этой команды. Показатель успешности рассчитывался как сумма нормированных значений за каждый вид работы. В исследовании приняли участие 250 студентов бакалавриата филиала Российского государственного профессионально-педагогического университета в г. Нижнем Тагиле и Нижнетагильского технологического института (филиала) Уральского федерального университета.

Были использованы следующие методы исследования: анкетирование, тестирование, метод экспертных оценок, ранжирование, шкалирование, нормирование, контент-анализ документов, методы математической статистики при обработке данных, методы анализа, синтеза, обобщения, сравнения, абстрагирования при интерпретации результатов исследования. Для определения полезависимости/поленезависимости испытуемых применялся тест «Включенные фигуры». Основные статистические расчеты производились с помощью непараметрического статистического метода «U-критерий Манна – Уитни». Для подтверждения достоверного отличия в доле команд, которые успешно справились с поставленной задачей, применялся критерий Фишера.

Источниками данных являются базы открытых источников (сайты международных и российских органов управления), нормативные документы, регламентирующие основы подготовки ИТ-специалистов, исследования ведущих ученых в области когнитивного стиля личности, информация статистического характера.

Результаты исследования. Были разработаны критерии для оценки результатов решения практико-ориентированной задачи командой будущих специалистов ИТ-сферы, определено понятие показателя успешности. Продемонстрирована важность учета когнитивных стилей личности при формировании команды ИТ-специалистов. Выявлена зависимость показателя успешности решения практико-ориентированной задачи от типа когнитивного стиля каждого участника команды. Установлено, что наиболее высокие результаты коэффициента успешности в решении практико-ориентированной задачи отмечаются в тех командах, в состав которых входили студенты с разными когнитивными стилями личности с преобладающим количеством поленезависимых участников. Полученные выводы указывают на необходимость учета когнитивных стилей личностей при формировании состава команд для выполнения ИТ-проектов.

Научная новизна. Результаты исследования расширяют научные факты о том, что когнитивные стили являются предикторами достижений студентов в решении практических задач в командной работе.

Практическая значимость. Полученные данные могут быть использованы для разработки стратегии подготовки будущих ИТ-специалистов, целью которой является повышение эффективности командной работы в высших учебных заведениях. Предложенные расчеты показателя успешности решения практико-ориентированных задач могут применяться для оценки результатов учебных практик и выпускных квалификационных работ.

Ключевые слова: работа в команде, специалисты информационных технологий, когнитивный стиль, полезависимый/поленезависимый стиль, практико-ориентированное обучение, практико-ориентированные задача.

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Introduction

Education is a process aimed at the exchange of experience between generations. Education helps us to form our own opinions and develop our own point of view on events in the world. Education should be accessible to every child without any restrictions. According to the Resolution adopted by the General Assembly on December 19, 2019, States are obliged to organise a safe, violence-free, inclusive and effective learning environment at all levels (preschool, primary, secondary and higher, including distance learning, technical and vocational)[1]. This work is impossible without improving teaching and learning methods aimed at developing the skills necessary to meet the individual and social needs of each individual[2].

Education for sustainable development is aimed at creating a better tomorrow for all people, and this work should begin today[3]. Under these

[1] Resolution adopted by the General Assembly on December 19, 2019. Education for sustainable development in the overall context of the 2030 Agenda for Sustainable Development. Available from: https://undocs.org/pdf?symbol=ru/A/RES/74/223 (In Russ.)

[2] 41st session of the General Conference of UNESCO. Education Commission Report (ED). Availa-ble from: https://www.un.org/unispal/wp-content/uploads/2021/11/UNESCO.41.C.71r_221121.pdf (In Russ.)

[3] UNESCO Roadmap for Implementing the Global Action Programme on Education for Sustainable Development. Available from: https://sustainabledevelopment.un.org/content/documents/1674unescoroadmap.pdf

conditions, special attention is paid to the research in the field of psychological and pedagogical sciences, in which cognitive features of personality are studied. According to T. M. Shamsutdinova, the cognitive characteristics of students are the basis for building the most adaptive learning models [1]. F. Haidu emphasises that success in the learning process will be achieved only in the process of coordinated joint work of all the subjects of the educational process. Such interaction is possible only if students are ready to adapt their communication and teaching styles according to the cognitive styles of the trainees [2]. In the study by S. A. Alharthi, G. E. Raptis, C. Katsini, I. Dolgov, L. E. Nakke, Z. Toups, much attention is paid to the dependence of the influence of cognitive styles on the effectiveness of the gaming activity of a team consisting at least of two people. The authors conclude that in the process of planning joint activities of trainees the influence of cognitive styles on the work capacity and workload of each participant should be taken into account [3].

Thus, the realisation of individual trajectories of students is impossible without taking into account their cognitive characteristics, including their personal cognitive style. Taking into account the cognitive style will allow the teachers to formulate correctly the task for each participant of the educational process.

Considering the features of students' training in the field of IT, we should mention the constant change of the requirements for the quality of software products and their safety. Any software product must be developed in a timely manner, taking into account the requirements of the customer and within a limited budget. Future IT specialists should be able to implement these requirements and find solutions to the tasks assigned to them. The complexity of software products leads to the fact that a large proportion of modern projects should be implemented by a team of specialists. Each member of the team performs certain functions: negotiates with a customer, designs a prototype of the interface of the future software product, describes functions, programmes, tests, etc. Teamwork involves the interaction of several participants with different individual characteristics. Such participants should be able to listen and hear each other, delegate authority and be responsible for the result.

The success of the team is defined as the cumulative contribution of the results of the work of each team member. A. N. Privalov, Yu. I. Bogatyreva, V. A. Romanov believe that this can be achieved if the members of a team are included in the full cycle of software production. That is why the authors emphasise the necessity of providing conditions for involving the group work in the process of training in higher educational institutions. In this case, the training of undergraduates in IT spheres will become more practice-oriented and gain additional resources to develop and consolidate teamwork skills and the level of

readiness of graduates for the upcoming professional activity [4]. The analysis of regulatory documents in the field of digital transformation in Russia as well as the analysis of research results presented in this field allow us to identify a contradiction between the increased requirements of the society to the level of information technology training of IT specialists and the insufficient orientation of the higher education system to implement these requirements. Hence, there is a need to study the ways of rational distribution of students into teams, taking into account their cognitive characteristics in order to obtain high results in solving problems and, as a consequence, the introduction of the criteria for evaluating the success of the team. The purpose of the article is to consider the nature of the influence of the cognitive personality style of each team member on the success rate of solving a practice-oriented task in the IT sphere.

To achieve this goal, the authors of the article formulated the following questions:

1. What is a practice-oriented task for IT undergraduates? What should serve to be the basis for evaluating the success of its solution?

2. How should the teachers distribute students into teams in order to achieve maximum success rates of solving practice-oriented tasks in the field of information and communication technologies?

In accordance with the goals and objectives of the study, the authors proposed a hypothesis based on the assumption that the indicators of solving a practice-oriented task by a team will be maximal if:

– the personal cognitive style of each of the members of the team is taken into account;

– the students with both a field-dependent and a field-independent personality style are included in a team, the number of the students with a field-independent personality style being prevailing.

The restrictions of the study was that the formation of the composition of the teams according to the cognitive style of students depended on the total number of the participants with a field-dependent or field-independent cognitive learning style taking part in the experiment in a given time period.

Literature Review

The direction of “cognitive psychology” began its development in the mid-20th century, as opposed to behaviourism, described in the study by J. B. Watson, G. A. Kimble [5]. According to J. B. Watson and G. A. Kimble, psychology should study only the external behaviour of a person, without focusing on mental activity. The prerequisites for the development of cognitive psychology were

G. Simon's research in the field of artificial intelligence [6], in particular, the idea that a person is a complex system with its own psychological processes. J. Anderson [7] argues that cognitive psychology "broke with behaviourism" because of advances in information theory, artificial intelligence, linguistics, and neuroscience. B. M. Velichkovsky [8] notes that the emergence of cognitive science as an interdisciplinary study of the patterns of human acquisition, preservation and use of knowledge is a phenomenon of the last few decades.

J. Kelly [9] introduces the concept of "construct" – features of all cognitive processes. According to his theory, a person is a researcher of his/her past, present and future through constructs and the source of personal development is the environment and social environment. J. Bruner, J. J. Goodnow, G. A. Austin in 1956 [10] described the process of grouping things into classes and categories, paying attention to the sources of intelligent thinking. This date is considered the beginning of the formation of cognitive psychology. At the same time, J. Miller [11] published the paper "The Magical Number Seven, Plus or Minus Two", in which he described the features of short-term human memory.

U. Neisser [12] describes the processes of information transformation from the moment it hits the sensory receptor surfaces to its possible use in thinking processes. He argues that the constructive nature of our cognitive processes-perception, attention, memory, and thinking is a fundamental fact. Thus, cognitive psychology studies the main cognitive processes of the human psyche, which include sensations, perception, imagination, memory and thinking. J. S. Bruner points that the center of cognitive psychology is a comprehensive analysis of the processes of reflection of the external world and the complex and active perceptual activity that makes it possible to go beyond direct information and form the most complex processes of human cognitive activity [13]. Cognitive psychology is the scientific study of the thinking mind. Currently, the ideas of cognitive psychology are used in linguistics, hypnotherapy, education, and computer science.

One of the most important concepts of cognitive psychology is cognitive style. According to M. A. Kholodnaya [14], cognitive style includes the presence of individual-specific ways of perception, evaluation and interpretation of reality. A. I. Kibalchenko, V. T. Eksakusto in their research prove that the ccognitive style can be used as a characteristic of a person, who has certain ways to think, perceive and remember information for solving problems and tasks [15]. R. Sternberg [16] states that the basis of cognitive style is the psychology of choice and decision-making, personality preferences. Cognitive styles in the studies by N. N. Volkova and A. N. Guseva are recognised as limited by the means of their measurement, i.e. they are characterised by a rather "rigid" binding to the method of their diagnosis, which leads to obvious difficulties in generalising

the obtained empirical data and theoretical understanding of the results [17]. L. Zhang, R. J. Sternberg, S. Rayner talk about the difficulties in understanding the relationship of cognitive styles with other personality characteristics and attribute it to the growing number of individual styles. However, they note the need to create a unified model of cognitive styles and point to the significant application of the style approach in the field of training and education [18].

According to E. Cools and S. Rayner, such a model should be based on the data of multivariate analysis of cognitive personality styles [19]. C. Evans and M. Waring point out that the model will allow not only to take into account the needs of trainees, but also to identify optimal conditions for learning and developing the abilities of each person [20]. Empirical research in this field can bring invaluable benefits for the development of psychological and pedagogical sciences.

When organising the educational process, it is important to take into account the characteristics of the individual, including the cognitive style of his/her thinking. At the same time, the aim of training should be creating conditions for modelling the future professional activity of the graduate. Russia is currently focusing on the problems of digital transformation of business and education. The Russian information technology (further IT) industry is characterised by the rapid growth, as it is now a very competitive area. In this regard, the demand for qualified programmers, engineers, testers and other specialists in this field is increasing. As a result, the requirements for the quality of training of future graduates are changing. The professional activity of IT specialists is often associated with working on the long-term and complex projects to create automated systems that include a certain set of stages.

According to the interstate standard[1], which defines the stages of creating automated systems, it is possible to identify certain tasks of the subject area of the future IT specialist:

1. Generation of requirements and product concept development.
2. The design of the automated system.
3. Development and testing of an automated system.

To maximise students' involvement in the future professional activities, it is necessary to include practice-oriented tasks in the content of training. In the context of the organisation of the practice-oriented training, attention is paid to ensuring the unity of acquiring theoretical knowledge and practice it in fulfilling

[1] Federal State Unitary Enterprise "All-Russian Scientific Research Institute for Problems of Computer Engineering and Informatization" (FSUE ARSRIPCEI). Information technologies. Information-computing systems. Life cycle stages and steps, kinds and completeness of the documents. Available from: http://rugost.com/index.php?option=com_content&view=article&id=95:gost-34-601-90-avtomatizirovannye-sistemy-sta-dii-sozdaniya&catid=22&Itemid=53

the tasks of the professional activity. Therefore, a practice-oriented task involves the formulation of a problem related to the future professional activity and is intended to demonstrate the practical usefulness and significance of the theoretical material studied. According to N. A. Astashova S. L. Melnikova, A. P. Tonkikh, the integration of educational and practical activities in higher education will allow students to gain experience in a holistic system vision of professional activity, learn to act systematically, and solve new problems and tasks [21].

During the process of solving the tasks, students get a result that can be useful in their future professional activities. Success in solving the tasks reflects the effectiveness of students' activities. By definition of O. V. Birina, success is an integral assessment of the effectiveness of the result of one's own activities, which has received recognition from others, causing a person (the subject of activity) such an emotional state that expresses his/her personal positive attitude to the activity, allowing him/her to feel his/her own satisfaction [22]. L. N. Shilenkova notes that the success of the student depends on the goals of the teacher's pedagogical activity and is an indicator of the effectiveness of his/her work [23]. A. Burger, L. Naude reveal that successful students were associated with strong academic self-esteem, motivation, poise and effective learning behaviour [24]. According to the conclusions by F. D. Fernandez, J. L. Arco-Tirado, M. Hervas-Torres, an important evidence of success in training is the perseverance of the individual and perseverance in achieving goals. Therefore, the most important task of a teacher is to organise events aimed at developing such qualities of students as optimism, self-confidence, self-control, perseverance [25].

Success in solving practice-oriented tasks is usually associated with factors that can influence the process of obtaining the result. E. F. Fefilova refers to such facts the complexity of the formulation of the problem condition, the level of motivation of students, the ability to transfer theoretical knowledge, experience, funds to a specific situation, and the contradiction between the solution schemes and the problem condition [26].

In the context of the development of the IT sphere, most of the projects are performed in a team. Teamwork involves delegating the participants' authority, involvement in the work, and shared responsibility for the result [27]. L. I. Savva, E. A. Gasanenko, K. E. Shakhmaeva distinguish such signs of the team as maximum activity and responsibility for achieving the goal, awareness of the need for interaction and cooperation, cohesion and flexibility, creative attitude to joint activities, a combination of individual goals and experience of each team member [28]. At the same time, the team involves the interaction of individuals with different individual characteristics, which, of course, affects the success of the task. Therefore, in the process of training students it is necessary to organ-

ise such conditions that will allow students to gain experience in solving tasks, interacting in a team.

This study focuses attention on such a cognitive style of a personality as field dependence / field independence. Henry Witkin when studying individual differences in behaviour in space first described the style [29]. It turned out that the field-dependent personality hardly overcomes the influence of the external field, while the field-independent perceive their spatial position without the existing context. Studies that are more recent have examined the relationship between the style and learning characteristics. M. A. Kholodnaya asserts that every person thinks within the framework of his/her cognitive style, considering his/her inherent form of understanding what is happening to be the only possible and "true" one. On the one hand, the concept of cognitive style allows us to identify individual differences of people in the processes of information processing, and on the other – to consider the peculiarities of the organisation of their cognitive sphere [30]. J. Parker and J. D. Bain discuss the need for compatibility of cognitive styles of teachers and students. The best results were obtained in those groups in which the teacher and the student had the same cognitive style [31]. S. F. Sergeev presents differentiation of abilities, depending on the style of "field dependence / field dependence" [32]. The author believes that taking into account these abilities is necessary for modelling the conditions of the educational environment that are optimal for each student. H. A. Witkin, C. A. Moore, D. R. Goodenough, P. W. Cox argue that cognitive style is responsible not only for the difference in the ways of intellectual activity of the individual, but also has an impact on interpersonal interaction and ways of human perception of events [33].

Analysing the results of these studies, we concluded that students, who are more dependent on working in a team, are able to listen to their interlocutors, and perceive information through visual sensations. Proprioceptive feelings are dominant in students with a field-independent style of thinking, and these students are quickly included in the learning process as active participants, more accurately process information and make decisions based on the experience. The purpose of this study was to determine the relationship between the way of dividing students into teams (taking into account the participants' cognitive style of field dependence / field independence, without taking into account the participants' cognitive style of field dependence / field independence) and the success of solving practice-oriented tasks in the training of a future IT specialist.

Methodology, Materials and Methods

The study was conducted, taking into account:

– a systematic approach that allows to consider the conditions of training the undergraduates of IT spheres from different points of view (N. A. Astashova, S. L. Melnikova, A. P. Fine, L. N. Shilenkova, A. Burger, L. Naude, F. D. Fernandez, J. L. Arco-Tirado, M. Hervas-Torres);

– a practice-oriented approach that ensures the unity of the theoretical and practical knowledge of the students, as well as their experience of work (E. F. Fefilova, D. Bednarek, M. Krulis, J. Yaghob);

– a project approach involving the study of approaches to solving a problem by a student or a group of students (L. I. Savva, E. A. Gasanenko, K. E. Shakhmaeva);

– a cognitive approach that allows to focus on taking into account the individual characteristics of each personality when organising teamwork (J. B. Watson, G. A. Kimble, J. Anderson, B. M. Velichkovsky, J. Kelly, J. Bruner, J. J. Goodnow, G. A. Austin, M. A. Kholodnaya).

The theoretical and methodological basis of the study was the works by M. A. Kholodnaya, J. Parker, J. D. Bain, H. A. Witkin, S. A. Moore, D. R. Goodenough, P. W. Cox, which describe the features of the process of personality activity depending on its cognitive style. To determine the field dependence / field independence of the subjects the "Included Figures" test was used. To confirm or refute the hypothesis of the study the "Mann-Whitney *U*-test" and the Fisher criterion were applied.

The study was conducted on a sample (*N=250*) of undergraduate students of the Faculty of Natural Science, Mathematics and Computer Science of Nizhny Tagil State Social-Pedagogical Institute – Branch of Russian State Vocational-Pedagogical University and the students of Nizhny Tagil Technological Institute – Branch of Ural Federal University from 2017 to 2020 academic year. The representativeness of the sample was achieved by selecting several age groups of higher education respondents, and the difference of one year between each group allowed getting an idea of a wider range of age structure.

The study was conducted in two stages. The first stage included the analyses of the cognitive style of the future IT specialist. We used the "Included Shapes" test, suggested by H. A. Witkin [33], studied the correspondence of the "field-dependent / field-independent" style to one of the bipolar values.

The test "Included Shapes" was performed as follows. We asked the students to select a simple shape within a complex one and evaluated the time each student spent searching for a simple shape and analysed the mistakes they made during the task. The "field dependence / field independence" index was calculated using the formula (1):

$$I = \frac{N}{t}$$

where: I – the index of "field dependence / field independence",

t – the total time spent by the student on completing the test,

N – the number of correct decisions.

If the value of the index I exceeds 2,5, then the student is characterised by a field-independent style, otherwise – a field-dependent style.

At the second stage, the students were asked to solve practice-oriented tasks selected according to the goals of training IT specialists. The purpose of such tasks is to perform activities related to the design, development and maintenance of software tools, taking into account the needs of the organisation or the requirements of the customer. It is assumed that a team of students should solve this task for two years of study at the university in such disciplines as "Design of information systems", "Software engineering", "Subject-oriented information systems", "Information management", as well as during industrial practice of the students.

Results

To check the equality of the initial conditions of the experiment, each student was asked to answer a test on theoretical material and solve a practice-oriented task. As a result, it was found that the third-year students of the two educational institutions have approximately the same level of competence in the field of subject training disciplines.

At the first stage of the study, the cognitive style of thinking of the students was determined. We determined the cognitive style of thinking of the third-year students – the field-dependent style (FD) and the field-independent style (FIND) – by means of the "Included Figures" test. The results are shown in Table 1 and Figures 1–2.

According to the results of the study, the majority of students have a field-independent cognitive style, which is typical for future IT professionals due to the specifics of this type of activity.

The students were divided into groups of five. In Nizhny Tagil Technological Institute, the distribution of the students into the groups was carried out without taking into account their cognitive style. Basically, they were assigned to teams at their will. In Nizhny Tagil State Social-Pedagogical Institute, the distribution of the students into teams was carried out taking into account the cognitive style of each student. The teams were formed in such a way that students with different cognitive styles worked in the same team.

Table 1

Defining the cognitive style of third-year students

Таблица 1

Определение когнитивного стиля студентов 3 курса

Higher educational institution / Высшее учебное заведение	2017-2018 academic year / 2017-2018 учебный год		2018-2019 academic year / 2018-2019 учебный год	
	FD/ ПЗ (полезависмый)	FIND/ ПНЗ (полезависимый)	FD/ ПЗ (полезависмый)	FIND/ ПНЗ (полезависимый)
Nizhny Tagil Technological Institute / Нижнетагильский технологический институт	10	40	12	38
Nizhny Tagil State Social-Pedagogical Institute / Нижнетагильский государственный социально педагогический институт	22	53	15	60

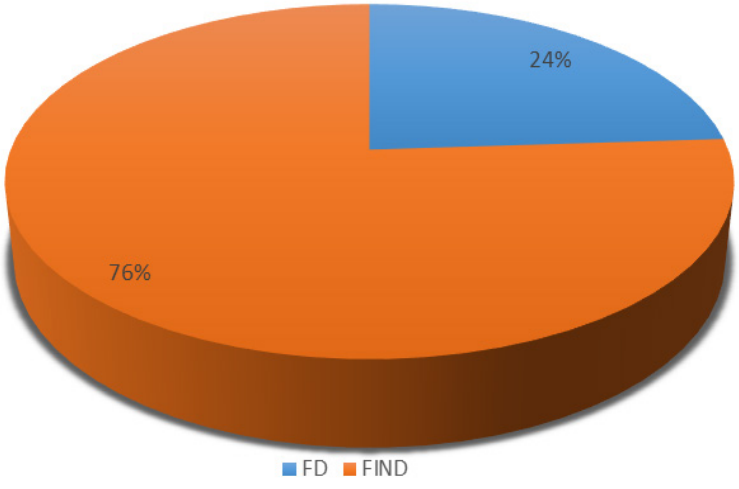

Fig. 1. Percentage ratio of the number of students with the field-dependent cognitive style in relation to the field-independent cognitive style

Рис. 1. Процентное соотношение числа студентов с полезависимым стилем по отношению к студентам с поленезависимым когнитивным стилем

The task was formulated as follows: “You need to develop a software product that will be used to solve the problems of digital transformation of business and education, and to find ways to inform the public about the results of your work. Describe the sequence of your actions”. To assess the success in solving this task, the indicators presented in Table 2 were developed.

Table 2

Indicators of success in solving a practice-oriented task

Таблица 2

Показатели успешности решения практико-ориентированной задачи

Type of activity (component of activity) / Вид деятельности (компонент деятельности)	Evaluation criteria and indicators / Критерии и показатели оценки	Solution level (scores from 0 to 2) / Уровень решения (баллы от 0 до 2)
1. Creating product requirements, developing a concept / Формирование требований к продукту, разработка концепции		
1.1. Study of market needs in Russia / Изучение потребностей рынка в РФ	The needs of the modern market are listed. The relevance of the developed product is determined / Перечислены потребности современной рынка. Определена актуальность разрабатываемого продукта	
1.2. Interaction and/or Participation in a workshop with customers / Взаимодействие и/или Участие в воркшопе с заказчиками	Specific detailed requirements for the product under development are obtained from a workshop with customers (user requirements, quality attributes, external interfaces, restrictions) / Конкретные детальные требования к разрабатываемому продукту получены из воркшопа с заказчиками (пользовательские требования, атрибуты качества, внешние интерфейсы, ограничения)	
1.3. The objective of the project / Формулировка цели проекта	The goal of the project is formulated in terms of SMART – the goal must be specific, measurable, achievable, agreed, and defined by deadlines / Сформулирована цель проекта в терминах SMART – цель должна быть конкретной, измеримой, достижимой, согласованной, определенной по срокам	
2. The design of the software product / Проектирование программного продукта		
2.1. The design of the software product / Планирование работы по проекту	The main stages of work on the project are highlighted and their duration is indicated and visualised in the form of a Gantt chart. The assessment of resource compositions and work relationships is given, and the types	

	of relationships between tasks (start-start, finish-start) are justified. The main actions for modifying the calendar plan are outlined. The most optimal option is proposed, taking into account the goal, the ratio of the total duration of work and the amount of resources used / Выделены основные этапы работы по проекту и обозначена их продолжительность и визуализированы в виде диаграммы Ганта. Дана оценка ресурсных составов и взаимосвязи работ, обоснованы типы связей между задачами (старт-старт, финиш-старт). Обозначены основные действия по модификации календарного плана. Предложен наиболее оптимальный вариант с учетом поставленной цели, соотношения общей продолжительности выполнения работ и объемом используемых ресурсов	
2.2. Construction of the key diagrams for visualisation of the features of the software product / Построение основных диаграмм для визуализации особенностей программного продукта	The choice of design methodology is justified, taking into account the requirements for the software product, the necessary diagrams are constructed, and the application features of each diagram are indicated. The diagrams fully reflect the static structure of the solution being developed, functional aspects, and details of the programme implementation / Обоснован выбор методологии проектирования с учетом требований к программному продукту, построены необходимые диаграммы, обозначены особенности применения каждой диаграммы. Диаграммы в полной мере отражают статическую структуру разрабатываемого решения, функциональные аспекты и подробности реализации программы	
2.3. The risk calculation / Расчет рисков	The risks that may arise during the project implementation are indicated, and their ranks are indicated. For each risk, measures to prevent consequences are indicated / Обозначены риски, которые могут возникнуть в процессе реализации проекта, указаны их ранги. Для каждого риска обозначены меры по предотвращению последствий	
2.4. The calculation of resources / Расчет ресурсов	The main resources that are necessary for the project implementation are described, and their cost is indicated. Options for reducing the volume or cost of resources are offered. The final presented estimate is optimal / Описаны основные ресурсы, которые необходимы для реализации проекта, обозначена их стоимость. Предложены варианты сокращения объема или стоимости ресурсов. Итоговая представленная смета является оптимальной	

3. Software product development / Разработка программного продукта		
3.1. The choice of development tools / Выбор средств разработки	A comparative characteristic of development tools is performed; all possible options are taken into account. The rationale for the choice of development tools is consistent with the requirements for the system being developed and the planned project implementation dates / Выполнена сравнительная характеристика средств разработки, учтены все возможные варианты. Обоснование выбора средств разработки согласовано с требованиями к разрабатываемой системе, планируемыми сроками реализации проекта	
3.2. Software product development / Разработка программного продукта	All the functions planned in the previous stages have been implemented. The algorithms used are described. The applied algorithms are optimal from the point of view of minimal use of computing resources, unambiguous / Реализованы все функции, запланированные на предыдущих этапах. Описаны применяемые алгоритмы. Применяемые алгоритмы являются оптимальными с точки зрения минимальности использования вычислительных ресурсов, однозначными	
3.3. Development of the software product interface / Разработка интерфейса программного продукта	A visually attractive interface has been developed that eliminates unintentional user errors. The amount of information entered by the user through the interface is minimal. The user interface is designed to meet modern standards / Разработан визуально привлекательный интерфейс, применение которого исключает непреднамеренные ошибки пользователя. Объем вводимой информации со стороны пользователя посредством интерфейса является минимальным. Пользовательский интерфейс разработан с учетом современных стандартов	
4. Testing of the software product / Тестирование программного продукта		
4.1. The choice of test methods / Выбор методов тестирования	The choice of testing methods for this software product is justified. The choice was made taking into account several criteria (effectiveness, ability of the test to evolve, cost of the test, etc.) / Обоснован выбор методов тестирования данного программного продукта. Выбор осуществлен с учетом нескольких критериев (эффективность, способность теста к эволюции, стоимость проведения теста и т.д.)	

4.2. Implementation of testing methods / Реализация методов тестирования	During testing, the results of processing all possible combinations of source data were checked, taking into account the time of their receipt, the duration and priority of processing, the dynamics of memory usage and interaction with other programmes. All the necessary test cases have been compiled. Conclusions based on the test results reflect the reasons for the deviation of the results of the real programme from the specified reference values, as well as possible ways to eliminate shortcomings / В процессе тестирования были проверены результаты обработки всех возможных комбинаций исходных данных с учетом времени их поступления, длительности и приоритетности обработки, динамики использования памяти и взаимодействия с другими программами. Составлены все необходимые тест-кейсы. Выводы по результатам тестирования отражают причины отклонения результатов функционирования реальной программы от заданных эталонных значений, а также возможные способы устранения недочетов	
5. Implementation and maintenance of the software product / Внедрение и сопровождение программного продукта		
5.1. Development of a software product presentation / Разработка презентации программного продукта	A visual presentation of the software product that meets the style requirements has been created. The content of the presentation clearly defines the problems that will be solved by means of the developed software product, justifies the advantages of using the presented solution, and uses visual means of presenting information / Создана наглядная, удовлетворяющая стилевым требованиям презентация программного продукта. В содержании презентации четко определены проблемы, которые будут решены средствами разработанного программного продукта, обоснованы преимущества использования представляемого решения, использованы визуальные средства представления информации	
5.2. Informing users about the features of the software product / Информирование пользователей о возможностях программного продукта	There are publications that reflect various aspects of the developed software solution. The concept of an advertising campaign is considered and presented, reflecting its purpose, idea, style, main advertising arguments, and means of advertising distribution. Consulting of	

	potential users is organised / Имеются публикации, отражающие различные аспекты разработанного программного решения. Продумана и представлена концепция проведения рекламной кампании, отражающая ее цель, идею, стиль, главные рекламные аргументы, средства распространения рекламы. Организовано консультирование потенциальных пользователей	
5.3. Search for funding sources / Поиск источников финансирования	The analysis of open pomegranate competitions, which meet the requirements of the developed software product, is performed. An application for the competition has been issued. The prospect of participation in the competition was evaluated / Выполнен анализ открытых гранатовых конкурсов, требованиям которых удовлетворяет разработанный программный продукт. Оформлена заявка на конкурс. Оценена перспектива участия в конкурсе	

The indicator of success in solving the problem is the efficiency coefficient proposed by V. P. Bespalko k_{suc} [34]. The k_{suc} coefficient can be normalised from 0 to 1 and is correlated with the rating system of assessment. The value of the coefficient is used to judge the completion of the learning process. If the k_{suc} value exceeds 0,7, then the practice-oriented task can be considered solved. If the coefficient value is in the range 0,9-1, the task is solved successfully.

To quantify the results of each level of performance of the activity component, we define a numerical value: 0 points – this criterion is not implemented, 1 – the criterion is not fully implemented or mistakes were made, 2 – the criterion is fully implemented. The maximum number of points a team can get is 30 points. Then the ratio of the number of points and success indicators can be as follows:

– 27-30 (0,9-1) – the task has been successfully solved, all activities have been implemented, the product is ready for implementation or has already been implemented, students understand the value of the received solution and objectively evaluate the result;

– 24-26 (0,8-0,9) – the problem is solved, but there are shortcomings, errors, but students understand the value and significance of the obtained solution and know how to improve the result;

– 21-23 (0,7-0,8) – the problem is not completely solved, only certain activities are implemented, the student can explain the algorithm of performing only individual actions, in the process of evaluating the final result they experience difficulties;

–15-21 (0,5-0,7) – the team made a lot of mistakes in solving the problem, the student does not understand the significance of the result and cannot and/or wants to evaluate the results;

– less than 15 (less than 0,5) – the team failed to complete the task.

Further, from 2017 to 2020 academic year, monitoring of the students' activities in solving a practice-oriented task in teamwork had been carried out. Each course had been observed for two years that coincided with the training of students in the third and fourth years. Table 3 shows the distribution of the students by bipolar values of the "field-dependent / field-independent" style of cognition, the amount of points received by each team as a result of solving the problem. Points for solving the problem were awarded by a group of experts consisting of teachers of the Department of Information Technology, employers, customers of the software product, as well as practice managers from the organisation.

Table 3

Distribution of students in teams, the number of points scored

Таблица 3

Распределение студентов по командам, количество набранных баллов

Number in order / Номер по порядку	Time to monitor the team's work on the project / Время наблюдения за работой команды над проектом	Team numbers / Номера команд	The number of students in a team with a field-dependent cognitive style / Количество студентов в команде с полезависимым когнитивным стилем	The number of students in a team with a field-independent cognitive style / Количество студентов в команде с поленезависимым когнитивным стилем	The number of points gained based on the result of solving the task according to the command number / Количество баллов, набранное по итогу решения задачи соответственно номеру команды
Group 1. Students of Nizhny Tagil Technological Institute (without taking into account the cognitive style of students) / Группа 1. Студенты НТИ (ф) УрФУ (без учета когнитивного стиля студентов)					
1	2017-2018 ac.year, 2018-2019 ac. year	1.1	3	2	19
2		1.2, 1.3	2	3	23, 17
3		1.4, 1.5, 1.6	1	4	27, 24, 22
4		1.7, 1.8, 1.9, 1.10	0	5	21, 18, 16, 16

Number in order / Номер по порядку	Time to monitor the team's work on the project / Время наблюдения за работой команды над проектом	Team numbers / Номера команд	The number of students in a team with a field-dependent cognitive style / Количество студентов в команде с полезависимым когнитивным стилем	The number of students in a team with a field-independent cognitive style / Количество студентов в команде с полеизависимым когнитивным стилем	The number of points gained based on the result of solving the task according to the command number / Количество баллов, набранное по итогу решения задачи соответственно номеру команды
5	2018-2019 ac.year, 2019-2020 ac. year	1.11, 1.12	3	2	17, 14
6		1.13, 1.14	2	3	23, 25
7		1.15, 1.16	1	4	23, 22
8		1.17, 1.18, 1.19, 1.20	0	5	19, 24, 17, 17
Average:					20,2
Group 2. Students of Nizhny Tagil State Social-Pedagogical Institute (based on the students' cognitive style) / Группа 2. Студенты НТГСПИ (ф) РГППУ (на основе учета когнитивного стиля студентов)					
1	2017-2018 ac.year, 2018-2019 ac. year	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7	2	3	25, 19, 27, 29, 20, 22, 18
2		2.8, 2.9, 2.10, 2.11, 2.12, 2.13, 2.14, 2.15,	1	4	21, 21, 27, 23, 19, 16, 22, 22
3	2018-2019 ac.year, 2019-2020 ac. year	2.16, 2.17, 2.18, 2.19, 2.20, 2.21, 2.22, 2.23, 2, 24, 2.25, 2.26, 2.27, 2.28, 2.29, 2.30	1	4	28, 27, 18, 20, 27, 29, 23, 27, 26, 21, 22, 22, 23, 24, 22
Average:					23

Figures 2 and 3 show the deviation of the number of points scored by each team of the students from the threshold values.

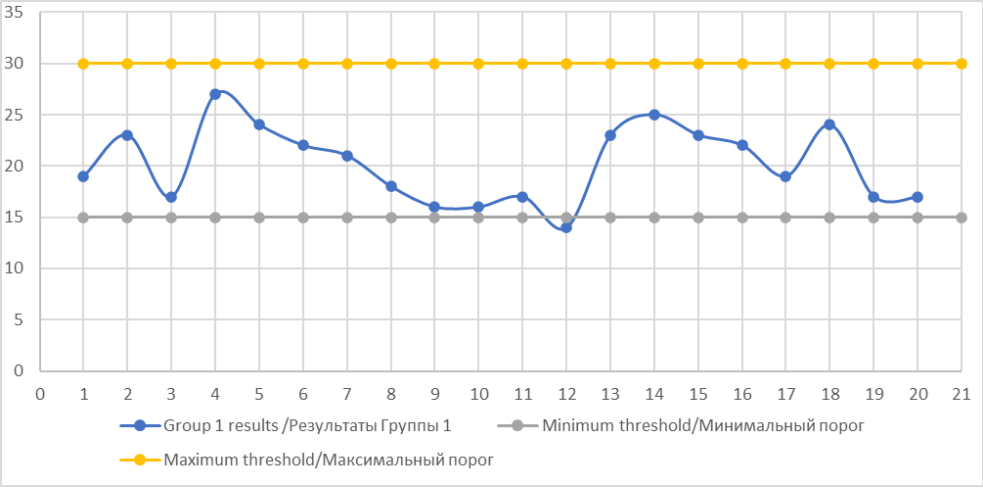

Fig. 2. Deviation of students' scores from the threshold values in Group 1

Рис. 2. Отклонение набранных студентами баллов от пороговых значений в Группе 1

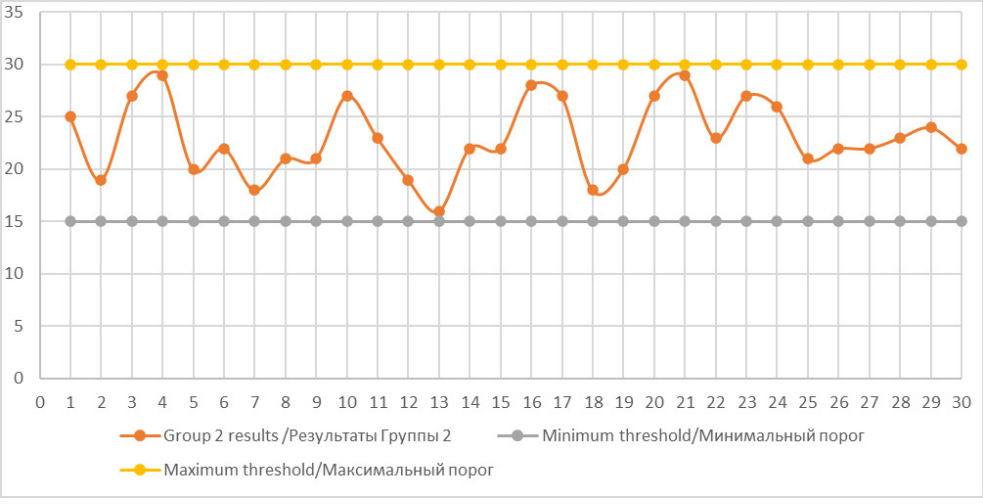

Fig. 3. Deviation of the number of points scored by each team of students from the threshold value in Group 2

Рис. 3. Отклонение набранных студентами баллов от пороговых значений в Группе 2

We see that two teams (2.4. and 2.21.) received the maximum score for solving the task. The first team investigated the possibility of holding an international intellectual game on programming in the institute. They developed a website for information support of the game, a database of questions, and presented the project estimate. In 2019, this team won the "Your Initiative" grant to implement its idea. The second team dealt with encryption of information. Based on the results of the work, a patent was issued for the developed information system for automating the processes of secure data storage and transmission. Some teams did not cope with the task. Therefore, teachers need to re-analyse the results obtained for each indicator, determine the reason for this result, and possibly make some changes to the methodology of the taught disciplines.

We experimentally tested the following hypotheses:

H_0 – there is no difference in the results of solving the task in the compared samples (it does not exceed the individual statistical spread);

H_1 – students of the second group have higher results in solving the problem (the difference exceeds the statistical spread).

The Mann-Whitney *U*-test can be used to verify the validity of differences between two independent traits by trait levels. The number of students in the groups varies, but if you calculate the average values of the number of points scored in the groups, they will be equal to χ_1=20,2 and χ_2=23 points, which gives grounds for the hypothesis H_1. *U*-criterion allows us to test it, since the conditions for the applicability of the method are met. As a result of calculations, the following values were obtained: U_{exp}=186, U_{cr}=216.

According to the results obtained by $U_{exp} < U_{cr}$, therefore the H_1 hypothesis is accepted, i.e. the decision results are better in those teams where students with different cognitive styles were present.

Table 4 shows the average values for each team.

Table 4

The average value of indicators for teams with different numbers of FD and FIND students

Таблица 4

Среднее значение показателей для команд с разной численностью ПЗ и ПНЗ студентов с ПЗ и ПНЗ

Distribution number / Номер распределения	FD / ПЗ (полезависимый)	FIND / ПНЗ (поленезависимый)	Average result / Средний результат	Success rate / Показатель успешности
1	0	5	18,5	0,62
2	1	4	23,14	0,77
3	2	3	22,55	0,75
4	3	2	16,67	0,56

We see that the lowest scores are typical for teams that are dominated by students with the same cognitive style.

Let us analyse the obtained indicators in the control and experimental groups from the point of view of success. We will count the maximum number of points (30) received by the team per unit. Calculations show that in the first group, the average success rate is equal to *0,7*, and in the second – *0,8*. Figures 4 and 5 show the values of the success rate for each team. We assume that the proportion of teams that coped with a practice-oriented task in the first group does not statistically differ from the proportion of teams that successfully solved the problem in the second group, that is, we will test the hypothesis H_0. To test the hypothesis, we will use the Fisher criterion, designed to compare two samples by a given parameter. The team coped with the task if the success rate $k \geq 0{,}7$.

Counting the number of teams in both groups, we obtained that $\varphi_{ex} = 1.95$. For the significance of $p \leq 0.05$, $\varphi_{cr} = 1.64$. Thus, $\varphi_{ex} > \varphi_{cr}$, i.e. the hypothesis H_0 can be rejected. We can observe a significant difference in the proportion of teams that have coped with the task.

Fig. 4. Indicators of success in solving a practice-oriented task for each team in Group 1

Рис. 4. Показатели успешности решения практико-ориентированной задачи для каждой команды в Группе 1

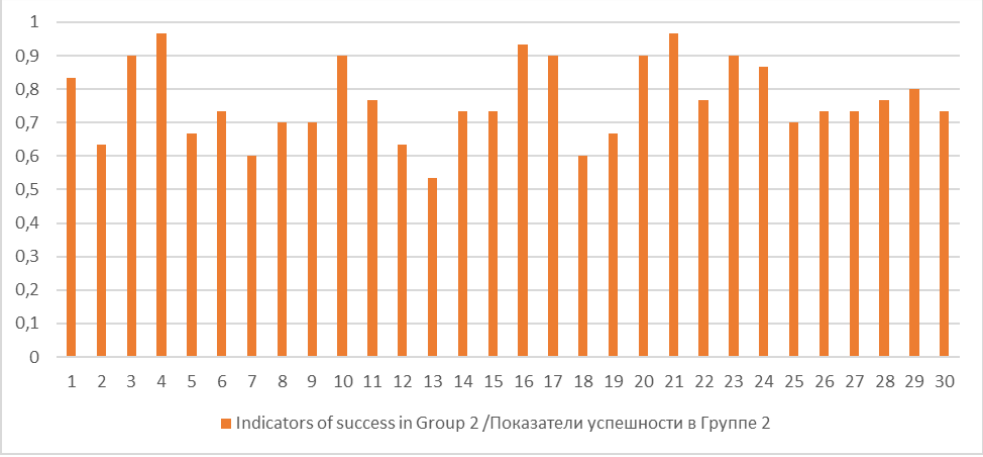

Fig. 5. Indicators of success in solving a practice-oriented task for each team in Group 2

Рис. 5. Показатели успешности решения практико-ориентированной задачи для каждой команды в Группе 2

Discussion

Cognitive style includes the presence of individual-specific ways of perception, evaluation and interpretation of reality in a person. Taking into account the student's cognitive style allows not only to determine the ways of his/her behaviour in the educational environment, but also to simulate ideal conditions for his activity.

Considering the specifics of the professional activity of an IT specialist, it can be argued that it is associated with the solution of such tasks as the formation of requirements and the definition of the product concept, design, development and testing of an automated system[1]. At the same time, as D. Bednarek, M. Krulis, J. Yaghob point, future specialists should be able to identify the ways to improve the performance of software products, and not neglect the study of technological problems [35]. The complexity of the requirements for software products leads to the fact that most of the projects are carried out in a team. A team is a collaboration of different people. From the point of view of the cogni-

[1] Ministry of Education and Science of the Russian Federation (2017, september) Federal State Educational Standard of Higher Education – Bachelor in the direction of training 09.03.03 "Applied Informatics approved". Available from: http://fgosvo.ru/uploadfiles/FGOS%20VO%203++/Bak/090303_B_3_17102017.pdf (In Russ.)

tive load, the team achieves the success if the task is solved and each member of the team experiences success from the work done, what is demonstrated in the study by C. Lange, J. Costley, M. Fanguy [36]. Taking into account the individual characteristics of each team member, in particular, the cognitive style of "field dependence / field independence", will allow teachers to form teams that are able to successfully solve the tasks of professional activity and get a positive result at the same time.

The results of the study demonstrated that most of the IT future professionals have a field-independent cognitive style. These students can structure schemes, transform text and are successful in their studies, but they have some difficulties in getting information from the society. Therefore, they will have difficulties in performing such activities as interacting and/or participating in workshops with customers, informing users about the capabilities of the software product, etc. The students with a field-dependent cognitive style are more successful in this sphere. They can get information from other people and participate in social interactions. In addition, field-dependent students focus on external factors, including the rules governing the implementation of a particular stage of activity, such as standards in the field of technical documentation, etc. Therefore, in order to solve successfully a practice-oriented task, it is necessary to team students with different cognitive styles. This was established at the first stage of the experiment.

The results of the second stage of the experiment showed higher performance of solving a practice-oriented task in the teams whose participants belong to different bipolar values of the cognitive style "field dependence / field independence". At the same time, teams dominated by a larger number of field-dependent students also turned out to be non-competitive. This can be explained by the fact that the solution of most of the blocks of practice-oriented tasks implies the ability to identify individual elements of the subject area and establish relationships between them (planning project work, building basic diagrams, calculating risks, calculating resources, selecting development tools and directly the development itself, etc.). In such teams, there was an insufficient amount of human resources needed to solve a practice-oriented task.

In addition, the results of the experiment allow us to conclude that the best option for solving a practice-oriented task in the field of IT is a team with a predominant number of students with a field-independent cognitive style and mandatory presence of students with a field-dependent cognitive style (1 FD student + 4 FIND or 2 FD student + 3 FIND). Such an association of students allows getting a significant practical result, approval from the customer, teachers and/or employers, which is a significant incentive to self-development of the future IT specialist.

In addition, the results of the study showed that there is a significant difference in the proportion of teams of the control and experimental groups who coped with the practice-oriented task.

Results

The study assumed that the conditions outlined below were met.

1. Studying the ratio of the way of dividing students into teams takes a long period, because it involves monitoring the performance of students over several years of study.

2. Conducting the research requires adjusting the work programmes of disciplines taking into consideration their interdisciplinary connections, since it involves solving a practice-oriented task within several courses (information systems design, software engineering, subject-oriented information systems, information management, and industrial practice of students).

3. Conduction of research requires a lot of work on the organisation of the educational process, as it supposes the involvement of teachers of several academic disciplines, managers of production practices, customers of software products in monitoring the success of solving a practice-oriented task.

4. Continuous development of the IT sphere entails changes in the requirements for the quality of training of specialists. This, in turn, leads to changes in the content of practice-oriented tasks and adjustments to the criteria for evaluating the success of the solution.

5. Students can successfully solve a practice-oriented task if the team is interested in the positive result of its work. The task of teachers is to constantly monitor the work of students, assist them and make necessary changes.

Conclusion

In the context of the digital transformation of the society, universities should be ready to train IT specialists who are competitive in the market of professions. They should be able to work in a team, quickly and efficiently solve the tasks assigned to them. These tasks should be practice-oriented, that is, formulated taking into account the specifics of future professional activity. An important role in the formulation of such a task is played by the decomposition of the task content into separate actions at each stage of the software product production lifecycle. The introduction of points to assess the quality of each completed action will allow teachers to evaluate the results of training future specialists both at individual stages of work and in general.

In modern conditions, most of the IT projects are carried out in teams. Accordingly, the bachelors of IT areas should be ready for teamwork. The distribu-

tion of students into teams should be carried out taking into account their cognitive characteristics, namely the cognitive style of the individual. In this case, team members will be able to rationally distribute tasks and delegate authority.

Good results in solving practice-oriented tasks are shown by teams that include students with different cognitive styles of field dependence / field independence. The highest success rates of solving a practice-oriented task are noted in teams with more students with a field-independent personality style. This can be explained by the fact that most of the types of professional activities embedded in the structure of solving the problem are focused on students with a field-independent style. However, in the structure of the task there are also activities in which students with a field-dependent cognitive style are more successful, which necessitates their presence in the team.

Thus, the hypothesis presented at the beginning of the study about the influence of the cognitive style of each team member on the results of the local solution of a practice-oriented task was confirmed. The conclusions obtained in the article can be useful for studying ways to improve the effectiveness of teamwork in higher education institutions.

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