

Challenges and Prospects of Scaffolding: Humanization and Individualization of Education in the Context of Industry 5.0

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Annotation. The article explores the current challenges of the modern educational process and the possibilities of using the subtechnology of scaffolding to overcome them. The main attention is paid to the humanization of education, which implies a reorientation of pedagogical activity from the social and applied sphere to the sphere of personal development. This requires the creation of an educational environment that stimulates the disclosure of the human essence of an individual in its entirety, not just as a social tool. The formalization of the gap between students and teachers, in particular in the context of digitalization, is another significant problem, as the digital divide changes the relationship between them. The problem of individualization of the personality in the context of the globalization of the educational process is studied. Individualization is carried out through self-development within the framework of self-education, self-study, and self-education, which allows a person to acquire specific knowledge, skills, and attitudes, overcoming socio-psychological forms of similarity. In the information society, this also includes information individualization as a mechanism for transferring and assimilating social experience. A significant decline in student motivation to learn is seen as a critical problem. Traditional teaching methods often do not meet the modern needs of students who are accustomed to fast and interactive information. Lack of practical application of knowledge, as well as changes in social values, cause a loss of interest in learning. Social networks and media create the illusion of quick success without significant effort, which also affects academic performance. The traditional approach to education does not take into account the individual needs of students and limits the opportunities to develop critical thinking, creativity, problem-solving, and teamwork skills. Scaffolding, which involves providing support to the student in the right amount and at the right time, can contribute to individualization and increase the efficiency of the educational process. The article emphasizes the potential of scaffolding in solving problems of interaction between student and teacher, optimizing the educational process, and providing an individualized approach. However, due to the limited number of studies, the full use of this subtechnology is still problematic. Further research may reveal the potential of scaffolding as a key way to integrate humanistic values into artificial intelligence technologies in education.

Keywords: educational environment, digitalization, digitalization, educational process, education, pedagogical competencies.

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Виклики та перспективи скаффолдингу: гуманізація та індивідуалізація освіти в умовах індустрії 5.0

Анотація. У статті досліджено актуальні виклики сучасного освітнього процесу та можливості використання субтехнології скаффолдингу для їх подолання. Основна увага приділяється гуманізації освіти, що передбачає переорієнтацію педагогічної діяльності з соціально-прикладної сфери на сферу розвитку особистості. Це вимагає створення освітнього середовища, яке стимулює розкриття людської сутності індивіда у всій її повноті. Досліджується проблема індивідуалізації особистості в умовах глобалізації освітнього процесу, що здійснюється через саморозвиток у рамках самоосвіти, самонавчання та самовиховання. В умовах інформаційного суспільства це включає також інформаційну індивідуалізацію як механізм передачі та засвоєння соціального досвіду. Зниження мотивації студентів до навчання розглядається як критична проблема. Традиційний підхід до освіти не враховує індивідуальні потреби студентів та обмежує розвиток навичок критичного мислення, креативності, вирішення проблем і командної роботи. Скаффолдинг, що передбачає надання підтримки учню в потрібний момент, може сприяти індивідуалізації та підвищенню ефективності навчального процесу. Стаття підкреслює потенціал скаффолдингу у вирішенні проблем взаємодії між учнем і викладачем, оптимізації освітнього процесу та забезпечення індивідуалізованого підходу. Однак, через обмежену кількість досліджень, повноцінне використання цієї субтехнології є проблематичним. Подальші дослідження можуть розкрити потенціал скаффолдингу як ключового способу інтеграції гуманістичних цінностей у технології штучного інтелекту в освіті.

Ключові слова: освітнє середовище, діджиталізація, цифровізація, навчальний процес, освіта, педагогічні компетенції.

Introduction

The project of the fourth industrial revolution, also known as Industry 4.0, has become a period that has combined the capabilities of various technological solutions, including artificial intelligence (AI), to maximize the automation of processes in all spheres of society. Digital technologies are penetrating all spheres of life, transforming the traditional areas of business, education, medicine, and culture [1, p.20]. One of the global goals of Industry 4.0 is the digital duplication of the material physical world. The field of education has also undergone significant changes under the influence of Industry 4.0, where two main trends can be clearly seen: first, the introduction of the characteristics inherent in Industry 4.0, and second, the need to support and develop the concept of individualized learning.

In the modern educational process, there are several key markers characteristic of the Fourth Industrial Revolution: active implementation of digital technologies (DTs), globalization, massification, cheapening, depersonalization, and reduction of human interaction. Examples of the implementation of these concepts include distance education, virtual classrooms, the use of massive open online courses (MOOCs), and others. All of these phenomena contribute to globalization - the creation of a single social space with a unified philosophy and system of values.

However, the process of globalization comes into conflict with the second important trend in the modern educational process - individualization. In the socio-philosophical discourse, individualization of education is not only about creating a personalized educational trajectory for each student, but also about the process of becoming an independent subject of activity, separation and autonomy. The main construct of individualization is the thesis about the uniqueness and originality of each person, about their potential talent, which needs to be revealed and developed through education.

Thus, a contradictory situation arises: on the one hand, education is influenced by the total introduction of digital technologies and globalization, and on the other hand, there is an increasing need to preserve individualization and autonomy. Experts agree that digital technologies will become a key means of transforming education into an individualized activity [2;3].

Having examined the main trends in education characteristic of Industry 4.0, we can conclude that these phenomena have an impact on other areas of society. Thus, scientists note that society is on the verge of the fifth industrial revolution. Speaking about globalization processes, S. Yahodzinsky, Vice-Rector of the European University for Educational and Methodological Work, notes: "at the beginning of the XXI century, the globalization of society is carried out by means of convergence of technologies. They are based on innovative communication technologies, in particular, artificial intelligence technologies" [4].

In the context of education in the future era of Industry 5.0, the task of creating and implementing individualization tools based on technologies focused on human interaction is being put forward. Educational institutions must not only meet the current needs of society but also anticipate and adapt to future challenges. Digital technologies, especially those focused on individualization and personalization of learning, are key tools to achieve these goals.

One of the most promising tools is a modern and progressive subtechnology of artificial intelligence - scaffolding. The term "scaffolding" was first introduced into the educational context during empirical research led by D. Bruner in 1976. In his work "The Role of Tutoring in Problem-solving", he describes this process as "one that allows a child or a beginner to solve a problem, complete a task, or achieve a goal that would be beyond their capabilities without assistance" [5].

It should be noted that today, the total number of sources covering aspects of the scaffolding subtechnology is relatively small. For example, researchers from the United States T. Luo, K. Arkout and P.S. Mulyanda focus on the use of scaffolding subtechnology in engineering education. The results of their research indicate a positive reaction of most students to the use of this subtechnology, although certain problems arose during its implementation, in particular those related to the COVID-19 pandemic [6].

N.H. Rahmat, N. Aripin, Z. Razlan, and Z. Khairuddin, in the course of online training of students in academic writing skills, found that many tasks that were previously considered difficult became easier due to the use of scaffolding in the educational process [7].

The work of researchers from the Netherlands and Iran, A.V. Haro, O. Naroozi, H. Biemans and M. Mulder, is devoted to a generalized analysis of the impact of scaffolding on improving subject-specific knowledge and developing argumentation competence in students of different levels (secondary and higher education). As a result, it was found that in higher education, 38% of studies show a significant impact on the acquisition of subject-specific knowledge, 53% on the development of knowledge in the field of argumentation, and 15% on argumentation-friendly behavior. In secondary education, 50% of the studies show a significant effect on the acquisition of subject-specific knowledge, and 30% on argumentation knowledge, while 20% of the studies found a partial effect on one of several measured indicators of argumentation knowledge [8].

The study by K. Mahan examines the problems faced by students studying in a non-native language. It is noted that the subtechnology of scaffolding has a positive effect on learning in such conditions, even with limited use of scaffolding strategies [9].

C. Puntambekar emphasizes the possibility of using such a type of subtechnology as distributed scaffolding [10].

In general, the subtechnology of scaffolding is that the adult "controls" those elements of the task that are initially beyond the student's capabilities, which allows the student to focus on performing only those parts of the task that are within his or her competence.

Scaffolding is actively used not only in the educational context, but also in biology, medicine, and programming. In psychology, this concept is also extremely widespread. One of the most popular works is a study that compares the subtechnology of scaffolding with "learning through discovery."

The purpose of this article is to study the impact of the subtechnology of scaffolding on the individualization of learning in the context of Industry 5.0. The objectives of the article include analyzing existing research on the use of scaffolding, evaluating its effectiveness, and developing recommendations for integrating this technology into the educational process.

Results

To begin with, let's characterize the challenges faced by the modern educational process of society and try to determine how the subtechnology of scaffolding can help in this case. It is important to note that this study does not claim to cover all possible options; this article is a generalization of the vector of potential use of scaffolding in educational processes.

Thus, the first problematic area is the humanization of education, which involves reorienting the meaning and priorities of pedagogical work from the social and applied sphere (implementation of educational standards, assistance in choosing a profession, socialization) to the existential and human sphere. The public consciousness should form an attitude to the educational institution as a specially organized space where an individual receives incentives and prerequisites for the unfolding of his or her human nature in its entirety, and not just as a social tool. An important criterion of humanization is human-centeredness [7; 8].

Another problem is the formalization of the gap between students and teachers. The teacher's readiness to conduct a professional dialogue with students in the context of digitalization is an important condition for subject-subject interaction. However, there is often a gap in the digital skills of students and teachers, which changes the relationship between them. Education cannot be systematic, consistent, and of high quality without a teacher as a subject of educational activity. The teacher guides students in the semantic and content purpose of the discipline, analyzing the latest achievements of science and practice; teaches a systematic vision of processes and phenomena in the discipline taught, helps to overcome spontaneity, chaos, and disorder in the educational process, professionally evaluates and monitors the achieved learning outcomes.

The problem of individualization in the context of the globalization of the educational process is that individualization is realized through the specification of a person and his or her transformation into an individuality that differs from other people. Individualization is carried out with the maximum activity of the person, which includes self-development in three pedagogical functions: self-education, self-study, and self-education. In the course of these three processes, a person acquires specific knowledge, skills, and attitudes, overcoming the socio-psychological forms of social conformity that are characteristic of Industry 4.0.

In the information society, individualization occurs not only in the system of traditional social relations and interactions but also in the information reality, where a new kind of culture is formed - information culture [10]. Information reality changes the specifics of the entire socialization process. Information individualization is understood as a mechanism for the transfer and assimilation of social experience in the context of the information reality created by information technologies of the information society.

It is also worth noting the decline in students' motivation to study. In today's environment, there is a significant decline in student motivation to learn. Young people are losing interest in knowledge, which may be due to new approaches to learning and changes in social values. The main motivation of most students is to obtain a diploma rather than to gain knowledge, which negatively affects the quality of education.

This decline in motivation can be explained by several factors. First, traditional teaching methods often do not meet the modern needs of students who are accustomed to fast and interactive information. The lack of practical application of the knowledge gained also plays an important role in reducing interest in learning. Many students do not see a direct connection between what they are learning and how it can be applied in real life.

Second, changes in social values also affect student motivation. In a society where the main criterion for success is often material achievement and status, many young people believe that obtaining a diploma is a sufficient condition for success, regardless of the level of knowledge and skills. This leads to students focusing on the formal completion of their studies rather than deep learning.

In addition, social networks and media have a major impact on student motivation, creating the illusion of quick success without significant effort. This increases the unwillingness to spend time on in-depth study and self-development. As a result, students are more likely to look for easy ways to get a diploma, which affects their academic performance and professional training [9].

There is also a problem today with the traditional approach to education, which is based on the transfer of knowledge from teacher to student and does not always meet modern requirements. Modern educational processes should focus on the development of competencies, independence, and creative activity of students. However, the system of motivating teachers to use innovative technologies remains weak. The traditional approach, based on passive learning, often does not take into account the needs and characteristics of a modern student. In this system, the main emphasis is on lectures and theoretical classes, which leads to formal learning without proper understanding and the ability to apply knowledge in practice. The lack of interactivity and active involvement of students in the learning process reduces their motivation and interest in learning.

Disadvantages of the traditional approach:

1. Lack of individualization. The traditional approach does not take into account the individual characteristics and needs of each student. All students receive the same amount of information and perform the same tasks, which does not allow them to reach their full potential. This leads to the fact that more gifted students do not receive enough incentives for development, and students with learning difficulties do not receive the necessary support.

2. Limited opportunities for skill development. The educational process in the traditional system is focused on the transfer of knowledge rather than the development of skills. This limits students' ability to develop critical thinking, creativity, problem-solving and teamwork skills. In today's world, these skills are essential for a successful career and personal development.

3. Low level of student engagement. The traditional approach to learning often leads to a low level of student engagement. They are passive listeners who only receive information without actively discussing and applying it. This negatively affects the level of learning and overall motivation to learn.

As we have already noted, the use of the scaffolding subtechnology implies that the student is provided with the exact amount of help at the time when it is needed, and this amount decreases as the material is mastered. The technology is completely customer-centered. Despite the fact that formally, in the process of the relationship between the subtechnology and the learner, the latter remains the object of activity, due to the orientation and constant monitoring of the current level of his/her competencies, reactions and support only when and to the extent necessary, scaffolding can be considered a kind of human-centered subtechnology.

Scaffolding can effectively contribute to solving problems of interaction between the teacher and the student, as it provides support and assistance exactly when and to the extent needed. The use of this sub-technology allows you to optimize the interaction between the student and the teacher, focusing on solving the most pressing problems faced by students. The

student does not feel neglected, even if they are in a large social group, as scaffolding provides a personalized approach to learning. This makes education more individualized and effective.

From all of the above, we can conclude that the subtechnology of scaffolding has significant potential that contribute to the autonomy of the individual and the development of students' individuality. However, due to the limited number of studies in this area, it is not yet possible to state this confidently. Most of the analyzed works reflect the experience of using scaffolding in the local educational environment. There are practically no studies that examine the impact of scaffolding on education as a global social institution. However, we believe that this sub-technology has significant potential and, if enough further research is conducted, can become one of the key ways to integrate humanistic values into artificial intelligence technologies in education.

Let us further consider the position that not all stages of the implementation of the subtechnology of scaffolding in modern education can be fully realized. To do this, let's define the main stages of implementation of the scaffolding subtechnology in the educational process (Table 1).

Table 1

The main stages of implementing scaffolding subtechnology in the educational process

No. of stage	The name of the stage	Brief description
1	Collecting and systematizing information about the student	The modern student is a complex, multifaceted, and dynamic individual. For the effective use of the subtechnology of scaffolding, it is necessary to take into account some key features. These include the current level of training, learning ability, and psychological state. Entrance testing and regular monitoring activities provide the opportunity for adequate and timely correction of support methods, which contributes to individualization and increase the effectiveness of the learning process.
2	Fixing requirements for the level of competencies	To learn through scaffolding, a clear understanding of the final set of competencies is required. The set of "21st-century skills" is taken into account. Capturing the full set of knowledge and skills is necessary to adjust the assistance in the learning process. The endpoint may vary, but it should always be clear to both the student and the persons providing and supervising the training.
3	Fixing the way of conducting educational activities	The organization of the learning process is a complex issue. It is important to have information about the duration of training, the possibility of changing the terms, the method of training (full-time or distance), and forms of training (lectures or practical classes, individually or in a group). It is important to record the environmental conditions in which the educational process takes place and its key features.

Let's take a closer look at each of the stages. The first stage is the collection and systematization of information about the student. A modern student is a complex, multifaceted,

and dynamic personality. For the effective application of the scaffolding subtechnology, it is important to identify some key features that may be indicative of further work. Among them is the current level of training. Almost all studies, both domestic and foreign, emphasize the importance of the quality of the entrance test. The final success of the learning process largely depends on a qualitative assessment of the student's existing competencies and a properly constructed learning strategy. In addition, ongoing monitoring activities are required throughout the training to ensure adequate and timely correction of support methods.

An important aspect that must also be taken into account is the ability to learn, i.e. the ability to perceive, process, and reproduce the information received. It is also important to understand the student's psychological state while studying, as modern education requires constant involvement, activity, interaction, and communication. All this may lead to the need to ensure the student's psychological stability and, accordingly, its continuous assessment.

The second important stage is to fix the requirements for the level of competencies of the student after graduation. If teaching any discipline or set of disciplines is planned to be carried out using the sub-technology of scaffolding, it is necessary to have a clear understanding of what set of competencies a student should have at the end of their studies. This includes not only basic knowledge of the subject but also broad competencies that are critical for the modern world. Fixing the competencies is critical because it allows for effective correction and adaptation of the learning process. Clearly defined final competencies allow you to build an educational trajectory in such a way that each student can achieve the required level of training. It also provides the ability to assess student progress at different stages of learning and make timely adjustments to teaching methods.

It is also important to take into account a set of so-called "21st-century skills" that a student must master. These include critical thinking, creativity, collaboration, communication, information and media literacy, adaptability, and problem-solving skills. These skills are essential for the successful integration of a graduate into modern society and the professional environment. It is important to note that the requirements for the final competencies may change over time, due to the development of technology and changing market needs. Therefore, the "endpoint" of learning should be flexible, allowing one to adapt the educational process to new challenges. This means that both students and teachers should have a clear idea of the final goals, but be ready to adjust them in accordance with new knowledge and conditions.

To effectively implement this stage, it is necessary to implement a systematic approach to assessing the student's initial level of knowledge and skills, as well as to monitor their progress. This may include a variety of diagnostic techniques, testing, individual and group projects, self-assessment, and external assessment. The results of these assessments should be used to adjust curricula and teaching methods, thus ensuring that the educational process meets the needs of each student.

The last step is to fix the way educational activities are conducted. Organizing the learning process is a rather complex issue that requires a comprehensive approach and detailed planning. To do this, you need to have information about the chosen duration of training and the possibility of changing these terms. One of the key aspects is to determine the mode of training. It can be full-time study, distance learning, or blended learning. Each of these methods has its advantages and disadvantages and also requires a different approach to organizing the learning process. The choice of learning method depends on many factors, including the availability of technology, the specifics of the curriculum, and the individual needs of students.

It is also important to determine the forms of training. These can include lectures, practical classes, seminars, laboratory work, individual consultations, and group projects. The choice of the form of classes depends on the content of the curriculum and learning objectives. For example, lectures are effective for imparting theoretical knowledge, while practical classes and labs allow students to apply this knowledge in practice.

Another important aspect is the organization of training: individually or in a group. Individualized learning allows you to take into account the characteristics and needs of each student, while group learning promotes the development of communication skills and the ability to work in a team. A combination of these approaches can be the most effective, as it allows you to combine the advantages of both methods.

At this stage, it is also worth noting the importance of recording the environmental conditions in which the educational process takes place and its key features. This includes physical conditions (lighting, temperature, access to technology), as well as the psychological climate (atmosphere in the group, interaction between students and teachers). Environmental conditions can have a significant impact on learning efficiency and student motivation.

In the context of the events of recent years, flexibility of the educational process is also an important condition. This means the ability to adapt the curriculum and methods to changing conditions and student needs. For example, in the event of an emergency, such as a pandemic or martial law, the educational process should be able to quickly switch to distance learning. Flexibility also implies the ability to adjust the terms of study and the amount of workload depending on the individual needs of students.

From the above steps to implement the subtechnology of scaffolding in educational activities, we can identify certain shortcomings in the conduct of educational activities that seriously affect the full use of scaffolding opportunities. One of the most important shortcomings is the lack of information about students. The psychological state of the student and his or her living conditions are not taken into account or monitored almost anywhere. We can also note the almost complete absence of assessment of the student's level of initial knowledge. Most often, teaching is conducted according to one approved program without the possibility of individualization.

Thus, we can conclude that the subtechnology of scaffolding seems to be very promising for use in individualizing the educational process, which is one of the main modern challenges to education. However, insufficient research (especially in our country) makes its full use virtually impossible at present.

Conclusions

The analysis of the impact of the scaffolding subtechnology on the individualization of learning in the context of Industry 5.0 has shown that this subtechnology is a promising tool for improving the efficiency of the educational process and promoting student autonomy. However, additional research is needed to fully utilize this technology, taking into account all aspects of student-teacher interaction and educational conditions. Further development and adaptation of this sub-technology to modern conditions may be the key to successful humanization and individualization of education in the future.

In order to fully integrate the sub-technology of scaffolding into the educational process, several key aspects need to be taken into account. First of all, it is the development of infrastructure and access to the necessary technological resources. It is also important to provide systematic training for teachers, including training in the latest techniques and technologies. Providing psychological support to students during their studies is another important factor. Teachers and administrators must be able to respond quickly to changing learning environments and adapt their approaches to meet the needs of students.

Further research should focus on the effectiveness of the subtechnology of scaffolding in various educational areas. This could include both quantitative and qualitative research methods to gain a more complete picture of the impact of this technology on students' learning outcomes and personal development. It is also important to explore the possibilities of integrating scaffolding with other innovative methods and technologies, such as gamification,

adaptive learning, and the use of artificial intelligence. This will allow us to create more comprehensive and effective educational programs that meet the needs of modern society.

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