THE ROLE OF INNOVATIVE TECHNOLOGIES IN SUPPORTING THE EDUCATIONAL PROCESS IN HIGHER EDUCATION INSTITUTIONS OF UKRAINE IN THE CONDITIONS OF WAR

[a]VALENTYNA KUPCHYSHYNA, [b]TETIANA KUDIARSKA, [c]LYUDMYLA MATSUK, [d]OLENA HOMONIUK, [e]MARIANA LEVKO, [f]NADIIA LAZAROVYCH

[a,f]National Academy of the State Border Service of Ukraine named after Bohdan Khmelnytskyi, 46, Shevchenko Str., Khmelnytskyi, Ukraine
[b,c]Vasyl Stefanyk Precarpathian National University, 57, Shevchenko Str., Ivano-Frankivsk, Ukraine
[d]Khmelnytskyi National University, 11, Instytuts'ka Str., Khmelnytskyi, Ukraine
[e]Hetman Petro Sahaidachnyi National Army Academy, 32, Heroes of Maidan Str., Lviv, Ukraine
email: [a]valentino68_68@ukr.net, [b]tetianakudiarska@ukr.net, [c]liudmila.matsuk@pnu.edu.ua, [d]elena_gomonyuk29@ukr.net, [e]ucpmaryana@yahoo.com, [f]nadiia.lazarovych@pnu.edu.ua

Abstract: The article represents an attempt to comprehend the influence of war on higher education landscape in Ukraine and find the ways to mitigate negative impact, in particular, based on comparison with the experience of war period in Syria. The application of multidisciplinary approach allowed investigating the most recent and innovative trends in higher education implying borrowing of best practices from the business world (predominantly, IT development) and projecting them on the sphere of higher education in its current conditions in wartime Ukraine.

Keywords: higher education; education process; war in Ukraine; Agile; Extreme Pedagogy; Kolb cycle; innovative technologies.

1 Introduction

The Universal Declaration of Human Rights, which was drafted just after World War II, ensures that everyone has the right to an inclusive education. But in a humanitarian emergency, that right is readily infringed upon, or abandoned altogether. This is particularly valid for war-torn nations. Given that education is essential to promoting long-lasting peace, the loss of education brought on by conflict can have disastrous results. Future generations will lose out on the advantages that education offers in terms of equality, money, health, and psychological well-being if there is a lapse in education brought on by emergencies. This perpetuates the poverty cycle.

The war in Ukraine has put the education system in front of very serious challenges. In the front-line territories, face-to-face training became impossible both due to constant shelling and the destruction of infrastructure. According to the Ministry of Education and Science of Ukraine, a total of 3,151 educational institutions were damaged by bombings and shelling in Ukraine. Of them, 440 were completely destroyed [19].

However, even in the far rear, face-to-face teaching poses a danger to students and teachers, due to the increasing frequency of long-range missile and drone attacks. In particular, during one year of the war, 5 educational institutions were damaged by rocket attacks in Khmelnytskyi region, which is located in more than 1000 km from the front line [10].

A recent column published by the Centre for Economic Policy and Research indicates that "one aspect that has received little attention so far is the effect of conflict on academic achievement" [16]. While the CEPR focuses on high school pupils in this instance, all students - including those pursuing higher education - are affected by the same factors that contribute to war's negative impact on educational achievement. The fact that teenagers and young people are particularly affected by conflict is one of the main causes of this. The younger they are, the less means of expressing the dread, worry, and melancholy that are typical emotional responses to conflict. Students' performance is negatively impacted by a lack of psychological support, particularly for those who require extra help with learning even in non-conflict situations.

According to experts, the lengthening of hostilities is changing how we should approach education in conflict areas. Nowadays, several conflicts have been going on for ten years or more: Burkina Faso, Afghanistan, Somalia, South Sudan, the Democratic Republic of the Congo, and Syria. The length of time a crisis, such as a conflict, persists increases the complexity of the emergency. When it comes to priority, education frequently comes in last when it comes to matters like roads, running water, and sanitation in many nations that have entered peacetime [2]. Actually, this concerns many areas in Ukraine now.

In the meanwhile, education has the power to change lives by giving students access to knowledge and helping them acquire the abilities to question, evaluate, and convey that knowledge. This is essential to establishing enduring peace. The abilities that education fosters may inspire people and society to resist injustice, despotism, and injustice. They may then make room for discussion, democracy, and change. As a result, the contribution of cutting-edge technology to the pedagogical process in higher education assumes paramount importance.

2 Materials and Methods

The research process involved the use of general scientific methods of analysis and synthesis, classification, comparison, and generalization. The research is based on an interdisciplinary approach. Also, the theoretical and methodological basis of the study includes the Agile paradigm and elements of process analysis.

3 Results and Discussion

Generations born within a culture of wartime worry, dread, and relocation lose their sense of normalcy as a result of living through such times. These impacts may last the entirety of their lives. Research on how students at different educational levels are affected by war shows that mental health disorders rise by at least 17% during these times. This increases the risk of severe psychological strain, traumatic experiences, extreme frustration, shocks, and violent crises, all of which impede normal development [3].

Nonetheless, recent real-world experience - particularly in Syria - attests to the possibility of developing and even improving higher education amid times of conflict. Higher education was more affected by the Syrian crisis than other educational levels, according to Dillabough et al. [6] and Milton [19]. This resulted in assaults on structures, professionals, and students, as well as decreased access, quality, and equity of higher education. Conversely, increased security measures, campus militarization, and the merging of state politics and university administration have all contributed to the politicization of higher education. In a more nuanced approach, el Hafi [8] pointed out that although universities are important agents of social change, higher education in areas controlled by the opposition has a number of difficulties. In other words, by "[acting] as a beacon of inclusion, equity, justice, and tolerance, and educate a new generation of citizens committed to social justice and solidarity", education in Syria can be seen as a tool for liberation and social transformation rather than just a victim of the conflict. This helps to promote peace [1].

Higher education confronts several direct and/or indirect problems in situations influenced by conflict. Physical devastation, population displacement [21, 22], mental health, lack of international recognition, lack of financial support from the international community, the role of armed groups, and the methodological difficulties of conducting research in war-torn environments can all be categorized under these main themes.

Shaban [27] emphasizes that in order to supervise and contribute to the transformation of the current higher education system, it is imperative to establish an efficient networking, communication, and development strategy with international organizations. This is based on the findings pertaining to the difficulties Northern Syria's higher education faces as well as the needs that arise

from this research. This should boost the industry's efforts to raise the bar for both research and instruction, make certification and recognition easier, and supply much-needed funding. In order to establish connections with foreign partners and facilitate access to academic resources, colleges must improve their media presence and their English language instruction. Along with giving their students the abilities and information that employers want, they should also strive to comprehend the demands of the labor market better. Scholarship programs have to be created in response to the heightened financial requirements of conflict-affected individuals. Universities in Northern Syria must create communication channels in order to unite under a formal canopy, create an official governing body to oversee and oversee higher education in NS, and serve as a common gateway to the global Northern Syria academic community [27].

Back in 2016, M. Sansom emphasized: “after more than seven years of conflict, Syrian higher education continues to function. This observation defies expectations that higher education suffers more than other educational levels during conflict and contradicts media depictions that Syrian higher education collapsed during conflict” [26, p. 38]. However, Sansom discovered through interviewing Syrian scholars and students that although the system managed to survive on a quantitative level for a variety of reasons, major qualitative changes have destroyed equity and quality in higher education in Syria and strengthened control over campuses as a tool for regime security.

Evidently, the task of preserving and all the more so developing higher education during war is extremely difficult. But the ‘good news’ is that some experience of rapid reorientation of education towards online format was carried out during COVID-19 pandemic, and there are quite efficient technologies in this field.

Ukraine has also accumulated experience in the use of innovative technologies of distance and blended education, which can be successfully used today during the war. It should be noted that recently, blended learning has become particularly relevant in the world, which is explained both by the society’ need for special technologies and forms of education, and by the development of information technologies, which makes it possible to consider the distance aspect of blended learning as a special autonomous technology with its own characteristics, standards, and conceptual apparatus.

In the process of blended learning, both online learning and teacher-assisted learning are equally important. Researchers from the Clayton Christensen Institute have identified the parameters of blended learning that improve the quality of education:

- Personalization;
- Mastery based learning;
- Creating an environment of high achievements;
- Personal responsibility of students for their own educational results [30].

Statistics show that blended learning is becoming more and more popular. The global market for blended learning was estimated to be worth USD 20.2 billion in 2022 and is expected to increase to USD 49.6 billion by 2032, with a compound annual growth rate (CAGR) of 10.50% expected to occur between 2023 and 2032. The main factors boosting market growth are the growing use of digitalization and flexible, accessible educational methods (see Figure 1).

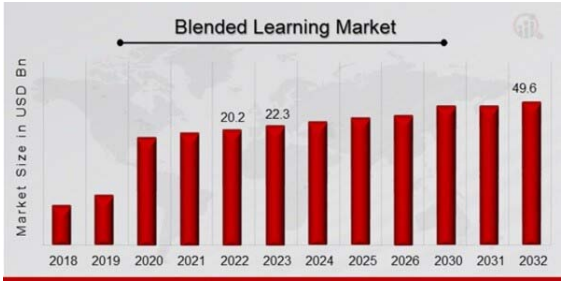

Figure 1. Blended learning market dynamics [5]

Immersion technologies such as augmented reality (AR) and virtual reality (VR) are finding their way into blended learning more and more. Especially in skill-based instruction, these technologies provide learners realistic and engaging experiences. By interacting with virtual reality (VR), students may improve their practical skills in a risk-free environment. AR projects digital data onto the physical environment, providing contextual learning opportunities. Incorporating VR and AR into blended learning systems not only enhances student engagement but also makes experiential learning - particularly in manufacturing, healthcare, and technical training - more feasible.

The blended learning model helps improve the quality of the educational process at a university, ensuring the development of the student as a subject of self-educational activity and shaping his readiness for self-development in the future. This means that one of the main tasks of a teacher when introducing a blended learning model into educational reality is the selection of the most productive information and communication technologies, programs, applications that allow optimal integration of classroom and electronic components into a single system [12; 13; 23].

Moreover, the share of online component in blended learning gradually grow. According to Word Economic Forum, “online learning is an important tool helping to close the widening global skills gap” [31]. The upward trend in online learning is evident in Figure 2 below, showing the demand for online learning in Coursera – s of 2021, it continued to outpace pre-pandemic levels.

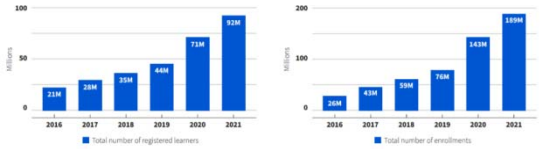

Figure 2. The upward trend in Coursera online learning [31]

Thus, moving towards more dissemination of online learning in Ukraine during the war does not mean any deterioration of higher education quality but instead indicates correspondence to global trends and should not be the cause for fears. At the same time, however, concerns are justified, since relying on wrong grounds and education technologies can really harm Ukrainian higher education.

Among the priority measures for the development and implementation of new educational models, it is necessary to highlight the advanced preparation of teachers for their use according to the principle of “learning in a learning environment”, motivation of teachers through conscious inclusion in the development of a new generation of electronic educational resources and mandatory practical acquaintance with the best experience of leading universities. This will remove concerns and reduce the degree of psychological barriers when perceiving new electronic resources and services. In this case, the dominant type of educational activity becomes the student’s independent work.

Meanwhile, the organization of online learning cannot be effective only with the opportunities provided by educational platforms, if they are not combined with other teaching methods. The modern learning environment requires flexibility, searching for new approaches that combine classroom teaching methods with online tools. Before the pandemic, Kolb model was used in classroom teaching. However, during the period of quarantine restrictions, a number of American universities began to use this model in blended learning. The results of online learning using the Moodle platform in combination with the Kolb model were obtained, and the results of student performance during classroom and online learning using this model were compared. Discussion of exam results with students showed that in the case of a combination of online learning and the Kolb model, students need independent work to understand the results of their learning, especially at the stage of observation and analysis of their experience. According to them, online learning provides

them with such opportunities [18]. At the same time, the gradual logical development of abstraction of concepts and the construction of knowledge is carried out on the basis of independent activity, which is currently recognized as important in the higher education system.

Ideally, online learning should begin with an experience or replication of a real-life situation. Also, there should be an alternation of learning phases: experience - observation - conceptualization - experimentation. Unfortunately, at the moment, the vast majority of online educational programs in Ukraine are structured in such a way that students first study theory and then perform practical exercises.

In Kolb's model, one cannot learn by simply observing or reading. To learn effectively, an individual or team must experience or learn through experience.

Of course, ideally, for online content the same requirements should be applied that are usually used in teaching aids and textbooks (independent review, department approval). However, in wartime conditions this is by no means always possible. Therefore, the Kolb method, which involves maximum individualization of the educational process and is based on the use of the student's personal experience, represents the most optimal model in distance and blended learning in wartime.

An important tool in the implementation of distance learning using the Kolb method is the project method. Project activities in distance learning not only facilitate the assimilation of educational material, but also provide new opportunities. The project method, as existing experience shows, creates motivation among students to study an academic discipline [17; 33]. Consequently, the use of the project method as a distance educational technology implies that the created content is an implementation of this method.

Zen et al. (2022) [33] aimed to analyze the effect of Project-Based Online Learning (PBOL) and student engagement on academic achievement. A mixed-method convergent parallel design was utilized in the study. Interviews, observational studies, and documentation forms are used to gather qualitative data; questionnaires and portfolios are used to collect quantitative data. The findings demonstrated that, thanks to the experience they acquired via project-based learning, students' opinions on applying the PBOL technique and student involvement improved their academic performance to become new entrepreneurs. Furthermore, according to the authors, this approach could foster an enjoyable learning environment that influences students' engagement levels. Thus, this method can perform a dual function during war - in addition to purely educational results, it can help reduce stress levels in students, improve communication and mutual support.

As it is known, different regions of Ukraine are affected by military operations to significantly different degrees. Accordingly, students may have different access to a computer and gadgets - in particular, in some regions the power supply is extremely unstable due to constant enemy attacks on the energy infrastructure. Therefore, it seems appropriate to apply the paradigm used in the training and work of distributed teams.

In business today, distributed Scrum teams in particular are popular. The name "distributed Scrum team" speaks for itself. This is a Scrum team in which all or some members work remotely. To succeed, a distributed Scrum team needs to discover new approaches to implementing Scrum. Situational collaboration and informal communication are limited, so remote teams need to be more disciplined about their Scrum rituals and create more opportunities for networking and collaboration.

Increasingly more companies are using teams in which at least some employees work remotely. For them, the Scrum methodology is becoming the basis for more effective collaboration. Additionally, Scrum principles include adaptability. It helps teams adapt to changing conditions and user requirements, and remote teams more confidently take advantage of Agile, continuously learn and improve.

All forms of remote work require effective collaboration tools. Using Agile planning tools, Agile teams collect stories and requirements, report and manage issues, and track progress and quality of work. Distributed teams should have something like a virtual whiteboard, which can be used to get an idea of the project stages and the sequence of their implementation [29]. In Western countries (especially in the USA), agile teaching-learning methodology (ATLM) and eXtremePedagogy (XP) are gradually becoming increasingly used. Moreover, research has revealed the general homogeneity and universality of approaches, their applicability to various disciplines, regardless of the practical orientation of the disciplines [4]. An analysis of the values of various educational methodologies based on Agile allows seeing that the methodology can be easily adapted to solve specific educational problems in universities with virtually no changes to the central ideas of the methodology expressed in the Agile Manifesto [11].

Extreme Pedagogy is an educational approach, a teaching concept that focuses on the needs of the student. The authors of the first description of the concept note that the idea arose from observations made during a course where they used the Extreme Programming (XP) method, one of the traditional Agile development methods, for educational purposes. Students worked in teams and were required to apply Extreme Programming techniques to complete basic course assignments. Students had to engage in pair programming, submit tasks for review using the short release method, that is, constantly release relatively small updates to the program being developed, and engage in a "planning game" based on predicting several options for the development of a product at once. The course applied five core XP ideas that were closest to Agile teaching and overall values.

The first idea is interaction between teacher and student. It was implemented in three versions: in class, the teacher asks students and initiates discussions of issues with them; outside of class, the teacher meets with students for consultations; in addition, the teacher communicates with students using electronic means of communication (e-mail, university services, etc.).

The second idea is goal-oriented learning. In the program of extreme pedagogy, it was decided to implement this principle as follows. The lesson material is structured to best suit the goals and objectives that were determined in advance at the beginning of each lesson, the teacher explains to the students the purpose and objectives of the current lesson. After students complete the assignments, a short control event is carried out, the main task of which is to assess how successfully the goals and objectives announced by the teacher at the beginning of the lesson were achieved.

The third idea is paired learning: two students complete a class project or homework assignment in the form of work closely copied from pair programming practice. When one student directly performs the task, the second observes the "colleague", suggests ways to improve, alternative ways to solve the problem, and corrects mistakes. Periodically, they change places - the one performing the task becomes the 'inspector' and vice versa.

The fourth idea is frequent intermediate control of students' knowledge. The final grade is averaged over all grades received for the course, and the form of intermediate control can be any, for example, assignments for a project carried out as part of the course. Regular intermediate control of students' knowledge corresponds to the idea of frequent releases in extreme programming. Also, regular monitoring helps to provide feedback when teaching a discipline, since even when students have not done anything on the project, they are put in a position in which they must report something to the teacher.

The fifth idea - simplicity - means that teachers should convey the material in the simplest and most understandable way so that students can easily understand the material. Difficulties begin when the teacher cannot assess the students' ability to perceive the material or overestimates their capabilities, in which case the topic becomes inaccessible to students' understanding. To solve this problem, frequent monitoring and support of constant interaction between the teacher and students is used [24].

The developers of the concept did not create any universal program of disciplines for this methodology, but formulated three fundamental principles of their teaching: learning by continuous doing, learning by continuous collaboration, learning by continuous testing. Learning by continuous doing should replace the practices of "surface learning", in which the student simply tries to memorize ideas, to the practices of "deep learning", when knowledge is created in the process of action [32]. To achieve this, the authors of the concept propose to involve students in the process of solving real practical problems. In addition to solving cases, they should try to discuss various problems, complete projects, and also engage in mutual learning.

Another approach, called "The Agile teaching-learning methodology" (ATLM), was developed back in 2004 and represented a literal adaptation of the Agile methodology to teaching. Although at the time of development the methodology was used only for teaching students majoring in computer science, the author of the methodology argued that the methodology could be applied to other academic disciplines.

The methodology is built from two parts: recommendations for teachers and students. The structure of the ATLM educational program is more rigorous than that of Extreme Pedagogy. In ATLM, the main goal is for students to gain "working" knowledge, that is, knowledge that the student can apply immediately after completing the course to develop his own project. The author, describing methodology, notes that it has three key aspects: flexibility, extreme, and independent study.

Flexibility refers to the ability of a course to change by adapting to the needs of different students, even changing the structure of the course to help students stay in tune with the material. This can be achieved through ongoing communication, including beyond scheduled consultation hours; the teacher must constantly respond to students' requests and explain to them the details of the work.

The idea behind the extreme is that if a tool used in a course works well, it should be implemented to its fullest extent all the time. For example, if feedback is useful, it becomes a mandatory and constantly used tool in the educational program; the same applies to project work, performing laboratory experiments, and certain methods of organizing independent work. According to the method' author, in order to determine the usefulness of a discipline, it is necessary to develop a tool for assessing the effectiveness of educational methods [15].

The idea of independence means that the course should teach students to learn, and not just memorize course materials.

The student cycle corresponds to the "active learning methodology" [24], which consists of several steps. The first step is a classroom lesson (it can also be carried out online). This is followed by independent completion of tasks that apply the knowledge gained in lectures. According to the requirements developed for the assignments, the student needs not only knowledge, but also creativity, which will ensure competition between works and will help in the desire to create a more interesting solution to the problem.

The third step of the student cycle is independent learning, to which assignments should push students. For example, they will contain requirements for the project that cannot be achieved using the data obtained in the lecture session. It is assumed that the next step, the exchange of student knowledge, will allow students to work better independently. This step - sharing knowledge in the classroom or online - involves providing platforms and opportunities for students to learn from each other; it is an important component of the "classical learning pyramid" [24].

Many researchers [14; 15] consider monitoring of students and teachers to be a necessary part of the educational process, thanks to which it is possible to adapt the Agile methodology to it. Student progress can be assessed by small tests, the results of which should be communicated to students as soon as possible. Such work will help identify difficulties and weaknesses, and will allow students to understand what knowledge the course will test.

Overall, integrated conceptual framework for Agile in Teaching and Learning is presented in Figure 3.

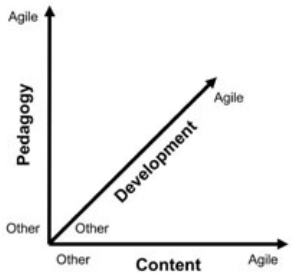

Figure 3. Integrated conceptual framework for Agile in Teaching and Learning [28]

Relevant developments, tools, and best practices from the business world can be used to transform student groups in remote learning environments into distributed learning teams using appropriate teaching methods.

In particular, researchers pay attention to the phenomenon of "shared understanding" in team interaction [29]. The concept of "shared understanding" is relatively new: it appeared in works examining various aspects of teamwork at the turn of the 20th and 21st centuries. The analysis of definitions revealed two main aspects of shared understanding: agreement on existing knowledge and coordination of actions on this basis. Research shows that shared understanding is closely related to the shared mental models by "bases" of meaning shared by team members. To achieve effective work, team members must have two main elements of common understanding: agreement on the results (goals) and agreement on the means to achieve them. Researchers agree that developing shared understanding has a positive impact on team performance, promoting the development of a team's "common language" and more efficient use of resources. The development of shared understanding in a team is influenced by several groups of factors: individual personal factors, external factors (physical and socio-psychological), and communication features of team members [29]. At the same time, high quality communication and high-quality communication channels between participants, as well as their active questioning of each other, contribute to the development of shared understanding. The development of such understanding is facilitated by projects based on case studies, as well as individualization of tasks for students in a group in accordance with the roles of team members according to the Belbin classification (Resource Investigator, Teamworker and Co-ordinator (the Social roles); Plant, Monitor Evaluator and Specialist (the Thinking roles), and Shaper, Implementer and Completer Finisher (the Action or Task roles)). Regular assessments can help understanding what gaps exist in the team. One should not only evaluate the productivity of individual team members, but also monitor how they work together. Responsibilities can be redistributed depending on students' behavior and personality types. Team building games are a great way to interact with team members and evaluate how effectively they work together.

Experience shows that the availability of software and hardware (infrastructure) does not guarantee the successful implementation of innovative training projects during war; a more important role is played by the presence of a correct and optimally organized management system for the entire project. Of particular importance is the stability of the system under conditions of negative external influences, such as failures in the operation of communication channels and server equipment. Experts emphasize that one of the optimal solutions is to separate the functions of the system, at least educational and administrative. In this case, subsystems must have not only independent channels for exchanging information with remote objects (subjects) of the system, but also several parallel

channels, including physically separated ones [7]. It is, of course, impossible to obtain a complete separation of functions. For example, the operation of the administrative system requires information (at least statistical information), which is available only in the educational part. The question arises of choosing the optimal number of intersystem "gateways", their mode of operation and optimizing the quantity and content of transmitted information. The number of "gateways" and the content of the exchange strongly depend on the structure of both subsystems, on the flow of documents, data, control actions, etc. All of the above, in turn, depends on the characteristics of the tasks being solved, the goals of the system, external conditions, etc. Thus, the task arises of developing a distributed educational system that ensures uninterrupted functioning in the event of negative external influences, as a special information and communication environment with elements of self-adaptation.

It is advisable to analyze the functioning of such a distributed educational system on the basis of models of varying degrees of approximation to the idealized one. Models can be presented in the form of structural and functional diagrams, with detail, as a rule, in IDEF0 and IDEF3 notations, but specific objects and functions introduced additionally can be used.

The most effective are systems with an intermediate level of integration, combining several management and training technologies included in a distributed and diversified information environment. The combination of technologies makes it possible to reduce the impact of a number of factors that negatively affect the effectiveness of a distributed educational system. In particular, the presence of pre-created alternative learning paths makes it possible to quickly respond to changes. The experience of building military communication systems and systems that support critical civilian infrastructure shows that the most stable structures are those that have at least three parallel channels of information exchange between subjects and objects of the educational process [7]. Apparent redundancy does not play a noticeable role, since at each moment a limited set of nodes and connections of the model operates.

Unfortunately, at the moment in Ukraine there is no such approach to building an educational landscape, even in the front-line territories. Meanwhile, the need for this is critical to maintaining the viability of the education system. Unfortunately, Ukrainian authors propose predominantly 'extensive' and not 'intensive' measures, incline to the position of 'problem avoidance' instead of problem solving: "international academic mobility", "cooperation between Ukrainian and foreign higher education institutions", "improve the territorial organization of higher education in Ukraine, in particular, to relocate higher education institutions from areas where active hostilities are taking place to large cities", and the like [9].

Of course, the introduction of such teaching methods requires training of teachers for their implementation in the educational process. Fast and effective teacher training can be carried out within the framework of the triple helix model, where the state (Ministry of Education and Science) would act as an organizer of the process, business - as a coach (meaning those business players who have implemented successful Agile models in their companies), and higher education institutions is a platform for implementation.

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Primary Paper Section: A

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