INDIRECT AND DIRECT PEDAGOGICAL INTERACTION OF TEACHER WITH STUDENTS IN THE CONDITIONS OF ELECTRONIC LEARNING AND THEIR PERFORMANCE OF THE ROLES OF "E-TEACHER" AND "E-STUDENT"

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Abstract: The article presents the theoretical and empirical results of the study of the phenomenon "pedagogical interaction in e-learning". The direct pedagogical interaction of the e-teacher with e-students during e-learning was considered as mutual influence in the conditions of synchronous learning, and the indirect one – as mutual influence in the conditions of asynchronous learning. The pedagogical experiment was aimed at clarifying the attitude of various participants of the educational process, who perform the roles of e-teachers, e-students, e-teachers of elementary school, to direct and indirect pedagogical interaction during e-learning, which was organized both during the period of the spread of COVID-19 (1st period), and during the introduction of martial law on the territory of Ukraine as a result of Russian invasion (II period). According to the results of the pedagogical experiment, during the spread of COVID-19, e-students in asynchronous learning conditions felt psychological discomfort due to the lack of direct pedagogical interaction with the teacher. Also, the students had a slowdown in the pace of study material, a loss of motivation to study was observed. They constantly felt the desire to postpone the study of the educational material for later. During the introduction of martial law on the territory of Ukraine, e-students preferred synchronous learning. The presence of direct pedagogical interaction with others ('electronic teacher' and 'electronic students') had a positive effect on the psychological state of students, helped to maintain the pace of learning, learn new educational material faster and more efficiently, experience positive emotions, a sense of security, etc.

Keywords: behaviorism; cognitivism; experientialism; connectivism; e-learning models; pedagogical interaction; roles during e-learning.

1 Introduction

Interaction determines the existence and structural organization of any material system. It also reflects the processes of influence of various objects on each other, characterizes their mutual conditioning and being in a direct or indirect, external or internal connection or relationship [6; 7].

The concept of "pedagogical interaction" is widespread in the education system. According to Z. Kovalchuk [17], pedagogical interaction is a social phenomenon that manifests itself in the interaction of two subcultures - the teacher's (primarily, in official and general pedagogical terms) and the student's. According to the scientist, pedagogical interaction should be considered as active interpersonal communicative and perceptive relations between the teacher and students, which contribute to the development of cognitive motivation, cause an increase in the activity of the subjects of interaction, determines the emergence of emotional well-being, etc.

T. Miyer [22] explains pedagogical interaction as a process of direct or indirect influence of the subjects of the educational process on each other, which creates a relationship between them and the causality of their actions. Pedagogical interaction is implemented with the dominance of the developmental strategy of pedagogical influence, it is built as a system of mutual influences that contribute to the personal development of each of the participants in the interaction, and is manifested in communication.

Pedagogical interaction is manifested in subject-subject relations between the teacher and the student, which alternately change the position of the communicator, who informs (acts), to the position of the recipient, who actively perceives information. In this way, there is a mutual exchange of verbal and non-verbal signals; actions, operations, attitudes, emotional states, and conditions are created for the formation of individual experience based on the acquisition of new knowledge, skills, and abilities.

2 Materials and Methods

The construction of pedagogical interaction has certain features during the organization of e-learning, since the participants of the educational process have to perform new roles:

- In the absence of face-to-face communication [15],
- In the conditions of changes in social factors [25],
- With the use of various information and communication technologies, as well as computer, network, digital and specific mass media technologies, which provide the expansion of technological characteristics of information, communication technologies in the case of their use or are used as self-sufficient means (Fig. 1) [23].

It is about the roles of e-teacher, e-lecturer, e-student. Taking into account the above, the research was aimed at fulfilling the following tasks:

1. To investigate and summarize data on the peculiarities of the interaction of the teacher with students in various learning theories, in particular, in the theory of behaviorism, the theory of cognitivism, the theory of experientialism, the theory of connectivism, the theory of the adoption of information and communication technologies, the theory of the e-learning model within the framework of education for sustainable development.
2. To formulate the definition of the terms "direct pedagogical interaction during e-learning" and "mediated pedagogical interaction during e-learning" based on their correlation with synchronous and asynchronous learning, respectively.
3. To analyze scientific works and summarize data on the advantages and disadvantages of direct and indirect pedagogical interaction of 'electronic teacher' with 'electronic students' in the conditions of e-learning.
4. To conduct a pedagogical experiment to clarify and generalize data on the attitude of participants in the educational process (electronic lecturer, electronic students, electronic primary school teacher) to direct and indirect pedagogical interaction during e-learning organized in the time of the spread of COVID-19 (I period) and during the introduction of martial law on the territory of Ukraine as a result of the aggressive and criminal actions of Russia as an aggressor country (II period).

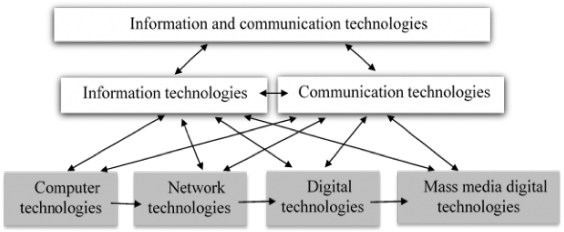

Figure 1. An essence of information and communication technologies [23]

Various methods were used in the research: theoretical (analysis, arrangement, systematization, generalization) and empirical (observation, questionnaires, interviews). The pedagogical experiment involved 16 lecturers and 350 students of the Faculty of Pedagogical Education of the Borys Grinchenko Kyiv University (Ukraine), as well as 12 lecturers of the Municipal Institution "Kirovograd Regional In-Service Teacher Training Institute named after Vasyl Sukhomlynsky" (Ukraine) and 240

primary school teachers who studied on advanced training courses.

3 Results and Discussion

Analysis of theories of learning in the context of teacher interaction with students

According to the theory of behaviorism [30; 32] the interaction of the one who teaches (the teacher, lecturer; hereinafter – the teacher) with those who study (pupils, students, teachers in post-graduate pedagogical education institutions (hereinafter – the students), is built on the basis of imitating the actions of the former, involves external motivation to training, passive assimilation of a certain amount of knowledge. In the process of interaction, considerable attention is paid to repetition, which, in turn, contributes to the consolidation of the student's correct behavioral reactions to a certain educational content, since the knowledge he has learned determines the repertoire of behavioral reactions to the stimuli of the educational environment.

In the theory of cognitivism, the teacher's interaction with students acquires other characteristics. The interaction unfolds in an educational environment, in which conditions are specially created for the discovery of subjectively new knowledge by students and their active assimilation and conscious inclusion in pre-existing knowledge structures [30]. The teacher's interaction with the students is aimed at promoting the active acquisition of knowledge, is built on the students' internal motivation for their acquisition, and involves the formulation of the goal of the educational activity by each student. According to the theory of cognitivism, interaction is organized on the basis of the teacher's use of various cognitive strategies, in particular, the schematization of learning, analogical reasoning, algorithmic problem solving, the introduction of classifications [4], and the use of digital tools.

According to the theory of constructivism, students actively construct an idea of reality, connecting new information with the knowledge they have learned before [8]. To facilitate the process of construction, the interaction of the teacher with students is organized in accordance with the principles (the principle of spatial contiguity, the principle of coherence, the principle of modality and the principle of redundancy to strengthen the learning process) and constructivist strategies (situational learning to solve heuristic problems, cognitive learning based on personal choice, social negotiations for monitoring the researched processes) [4]). The process of interaction is organized by the teacher using information resources, cognitive tools, tools for activating communication and interaction, social (contextual) support and involves the use of multimedia, virtual reality (VR), etc. [18]. The act of interaction during education focuses on social situations, which directly affect students, their motivation and everyday life [34].

The basis of the theory of experientialism provides for the observance of the cycle of stages of experience (stage of concrete experience; stage of observation, reflection and abstract conceptualization; stage of testing in new situations). The teacher's interaction with students is aimed at creating conditions for active formation of personal experience by students. The teacher-facilitator directs the interaction and motives of students to the successful completion of all stages of the educational cycle [16].

The basis of the theory of connectivism is conveyed by the thesis "a person learns throughout his life". In accordance with his cognitive requests, an individual seeks to acquire new knowledge, form new professional skills, obtain the necessary experience as a result of: interaction with the teacher; it also implies obtaining access to the necessary information on the use of VR technologies [31]. Having gained access to the necessary information, a person simultaneously performs various functions, including educating himself, with the involvement of previously analyzed information and selected necessary data.

A certain level of development of society is reflected in a certain theory of the construction of the educational process and the interaction of the teacher with students. The education of the digital and network society takes place in new, timeless and boundless web spaces, based on new learning models, forms, methods, means and virtual educational environments that are constantly changing. Both the teacher and the student in timeless and boundless web spaces perform other roles, namely: the role of an electronic teacher and the role of an electronic student. In these roles, they interact with each other differently, perceive the educational process in e-learning, perform tasks, and understand the learning outcomes.

It is worth noting that e-learning as a basis for the deployment of teacher-student interaction is also undergoing changes. There has been a radical change in the teachers' and students' understanding of the e-learning essence. Their attitude towards e-learning as a modern method, means and form of education, organized on the basis of interaction of participants in the educational process, preceded the attitude towards e-learning as an online folder used to store educational materials.

In Table 1, we organized the definitions of the concept of "e-learning" proposed by various scientists and analyzed their content in the context of the presence/absence of a direct or indirect indication of the interaction of participants in the educational process.

Table 1: The presence / absence of a direct or indirect reference to the interaction of the teacher with students in the content of the definitions of the concept of "e-learning"

Year	Author / source	Contents of the definition of the concept of "e-learning"	Instruction on teacher interaction with student
2002	M. Paulsen [26]	an interactive learning method in which learning content is delivered online	indirect – through the use of the term "interactive"
2006	R. Mason & F. Rennie [21]	a strategic way of lifelong learning and an effective way of spreading higher education	indirect – through the use of the terms "method of learning" and "higher education"
2010	P. Resta & M. Patru [27]	a teaching method that uses online communication through interaction between teachers and students with appropriately designed learning materials and content	direct
2014	D. Nguyen & T. Nguyen [24]	an online learning method for some formal education programs managed by a learning management system (LMS) to enable interaction, collaboration, and meeting the learning needs of learners anywhere, anytime	direct
2016	E. Masie [20]	a learning process that is prepared, delivered, and managed using various ICT tools locally or globally	indirect – through the use of the terms "prepared" and "managed"

The analysis of the data in Table 1 proves that during the 21st century, scientists revealed the essence of the concept of "e-learning" and directly or indirectly indicated the interaction of the teacher with students. Our study was aimed at identifying the advantages and disadvantages of the teacher's interaction with students in the e-learning environment.

Potentially the most effective are three styles of e-learning [10]: 1) exercises with automatic and appropriate feedback; 2) a combination of independent study and joint study; 3) use simulation to improve skills.

The theory of adoption of information and communication technologies explains the teacher's attitude to the use of information and communication technologies as a result of establishing the following causal relationships: antecedents - beliefs - attitudes - behavioral intentions - actual behavior in the organizational context [35].

In the study [10] it was established that the motivation for technology adoption mediates the following relationships:

- constructivist beliefs – behavioral intentions;
- subjective norms - behavioral intentions;
- technological complexity – behavioral intentions;
- technological complexity – perceived ease of use;
- subjective norms - perceived usefulness.

It was also established that among university teachers the following is observed [10]: 1) motivation to use tools is positively related to the perceived usefulness of the e-learning system; 2) motivation to use the tools is positively related to the ease of use of the e-learning system; 3) motivation to use tools is positively related to behavioral intentions in the e-learning system. That is, ICT adoption motivation has a positive effect on perceived usefulness, perceived ease of use, and behavioral intentions, suggesting that university teachers who are aware of their motivations tend to view e-learning systems as worthwhile and easy to use. Perceived usefulness measures the educator's subjective opinion about whether information systems will improve learning effectiveness. Perceived ease of use measures the degree to which the teacher and students believe that the implementation of information systems will be effortless. Both belief variables directly influence attitudes, and attitudes, in turn, influence teacher and student behavioral intentions.

Among university teachers, subjective norms are positively related to the motivation to instrumental use of the e-learning system and to behavioral intentions in the e-learning system. That is, subjective norms regarding the use of the e-learning system have a positive effect on the behavioral intentions of university teachers and on their introduction of e-learning in their educational practice [10].

The theory of e-learning model for sustainable development [36] consists of seven successive levels of professional and personal development and is conceptually related to self-regulation strategies and motivation. We summarized the work of the authors in Table 2.

Table 2: E-learning model theory in the interests of sustainable development (compiled by us on the basis of research [36])

Level models	Resource	Purpose of the resource
Goal setting	FORGE	allows students to set their own goals by choosing their own learning resources and programs
	MyLearning Mentor	offers students an interface to set their own goals for each week
	eLDA	allows students to set their own learning trajectories by choosing learning material
Self-esteem	FORGE, The Serious Game	allow students to review the assessment of their acquired knowledge by performing course assessment activities
	Learning Tracker, eLDA	offer visualization of student progress throughout the course
Seeking help	eLDA, Video-Mapper, MyLearning Mentor	include a chat room where classmates can exchange ideas and find solutions needed for further learning
	eLDA, Video-Mapper	include chat and discussion forums
Self-motivation	FORGE, The Serious Game	support self-motivation through interactive activities (labs, interactive assessment)
	eLDA	allows students to choose the most appropriate material
Strategic management	MyLearning Mentor	allows students to choose the most appropriate material
	eLDA	allows students to determine their own learning path
Consciousness	Learning Tracker	offers students visualization so they can view and monitor their progress in the course
Organization	Video-Mapper	supports the organization of learning process by offering students the ability to take notes during video lectures

According to the work of the authors of the e-learning model within the framework of education for sustainable development, progress in e-learning motivation goes through six stages. This is sparking interest, moving from interest to desire, getting inspired and active, self-improvement in establishing social contacts, achieving balance in e-learning and obtaining innovative results. For the development of social interaction, it is advisable to involve students in the role of moderator, consultant, or mentor and in role-playing games in the e-learning environment [36].

During the study of definitions of the concept of “e-learning”, analysis of theories of learning, theories of adoption of information and communication technologies, models of e-learning for professional and personal development, we paid attention to the presence or absence of terms that would directly or indirectly indicate the interaction of participants in the educational process within e-learning. For the purpose of researching the advantages and disadvantages of interaction between a teacher and students in the conditions of e-learning, we singled out two ways of pedagogical interaction:

- Direct pedagogical interaction during e-learning (organized during synchronous learning);
- Mediated pedagogical interaction during e-learning (refers to asynchronous learning).

Advantages and disadvantages of direct and indirect interaction of the teacher with students in the conditions of e-learning

E-learning is organized in innovative learning environments, access to which is provided by the use of the Internet network. Unlike face-to-face interaction [15], interaction in these environments can be organized as:

- Direct pedagogical interaction in e-learning - it involves the mutual influence of e-learning participants on each other, which takes place at a clearly defined time, which is recorded in the class schedule, does not depend on the physical location of the teacher and students, but involves their presence in the class in the role e-teacher and e-students;
- Indirect pedagogical interaction in e-learning – it involves the impact on electronic students of the content of educational materials that are developed in advance by the teacher and placed in the educational environment of e-learning, the performance of the role of an electronic teacher is not foreseen.

Each of these methods of interaction has its advantages and disadvantages. Let us consider them.

During e-learning, direct interaction in innovative learning environments, which are pre-created on the web, can take place regardless of the physical location of the teacher and student. Instead, during mediated interaction, an electronic student is given the opportunity to learn at his own pace, without time and space limitations [2].

Despite these advantages, mediated electronic interaction has significant disadvantages, as it can cause a high probability of the mental workload in electronic students as a difference

between cognitive abilities and the requirements necessary to perform work [11].

A question arises. Under what conditions of direct and mediated electronic interaction the mental workload of electronic students occurs? After all, during direct interaction, a teacher guides the cognitive activity of electronic students, and during mediated electronic interaction, he determines the content of the educational material in advance, presents it in a logical sequence, divides it into logically complete parts, develops accompanying materials (presentation, schemes, tables, drawings, diagrams, etc.).

The analysis of the results of scientific research revealed that electronic interaction during e-learning can cause the mental workload of electronic students under various conditions, namely when:

1. E-learning requires e-students to have a high or sufficient level of skills that are necessary for the active activity of e-student in the educational environment of e-learning, in particular, such skills as:

- Ability to work with high-tech equipment. According to the results of the research of scientists [12], if these skills are formed at a low or medium level, there is a high probability of an increase of the mental workload in the electronic student, as a difference between cognitive abilities and the requirements necessary to perform the work [13].
- Ability to work with IR technologies. To organize mediated electronic interaction, the teacher uses information delivery technologies, which, in terms of intellectual and time costs for obtaining it, significantly reduce the intellectual potential of the electronic student, which was supposed to be directed to processing the content of information [28]).
- Ability to manage study time without outside help and the ability to manage own learning rhythms. If these skills are not developed, e-students will feel time pressure, which, in turn, will create conditions for the mental workload [33].
- Ability to separate basic and auxiliary information. During mediated electronic interaction, e-students perceive the educational material as a whole, do not distinguish between the main information and the auxiliary information that clarifies or explains the main content, and, therefore, try to process all the material with the same intensity. In the conditions of direct electronic interaction, the work with the educational material is directed by the e-teacher. He makes appropriate accents while working with the content of the material, which, in turn, prevents the mental workload of e-students [19].

2. It is difficult for e-students to learn in a self-disciplined way, in which case mediated interaction causes the mental workload [34].

3. E-students lack motivation for instrumental use. According to research results [9], motivated students, as a rule, have a higher level of readiness to use various technologies to meet their educational needs. If e-students lack the motivation to use tools or they have partially mastered the technology that the teacher uses to organize mediated electronic interaction, or students do not have enough technical capabilities to use these technologies, then under such conditions the vast majority of e-students will experience excessive mental workload (according to the results of research [2]).

4. E-students perceive the educational system as complex and confusing. In this case, they cannot assess the potential benefits of combining the learning material with the technologies that the teacher has developed. According to the results of a study by scientists [14], perceived difficulties are negatively related to the effectiveness of interaction during e-learning and to productivity.
5. The organization of mediated electronic interaction can be designed by a teacher with an emphasis on teaching (that is, on the transfer of information and structured knowledge to electronic students) and on the process of student learning (that is, it contains methodical support to independent work of students). According to the results of the study [29], it is important to project the mediated interaction in e-learning with an emphasis on both imaginary teaching and the real process of electronic students' learning.

6. The organization of mediated interaction in e-learning can make e-students 'sleepy'. According to the results of the study [5], drowsiness occurs as a result of the lack of face-to-face communication.

7. The organization of mediated interaction in e-learning is carried out without taking into account the type of student's education by the teacher. Special attention should be paid to students who show poor progress during e-learning. According to the results of the study [34], the practice of sending e-mails before the start of classes with the encouragement of students who demonstrate slow progress during e-learning is positive; also, involvement of mentors in observing these students to provide them with the necessary advice is expedient, as well as sending encouraging emails to students who are showing slow progress.

We supplemented the theoretical generalizations on the problem of organizing direct and indirect interaction of teachers with students in e-learning with experimental data. The pedagogical experiment involved 16 lecturers and 350 students of the Faculty of Pedagogical Education of the Borys Grinchenko Kyiv University (Ukraine), as well as 12 lecturers of the Municipal Institution "Kirovograd Regional In-Service Teacher Training Institute named after Vasyl Sukhomlynsky" (Ukraine) and 240 primary school teachers who studied on advanced training courses.

The pedagogical experiment covered 2 periods. The first period was the period of spread of COVID-19 (2019-2021 years); II period was the period of introduction of martial law on the territory of Ukraine. During these two periods, blended learning was replaced by e-learning to continue learning, first in the conditions of self-isolation caused by the global spread of COVID-19, and from February 24, 2022 - in the conditions of the aggressive and criminal actions of Russia as an aggressor country. It should be added that before the beginning of the pedagogical experiment in the educational institutions mentioned above, e-learning was implemented as a component of blended learning, that is, it was a typical phenomenon for educational practice.

During the first period, the respondents' intellectual efforts were aimed at adapting to the conditions of end-to-end implementation of e-learning. Adaptation to new learning conditions affected the respondents' activity. The activity of teachers, first of all, was aimed at solving various aspects of e-learning, in particular: organizational and technical (72% of respondents-teachers expressed interest in mastering new IC technologies); content (84% of respondents-teachers pointed to supplementing electronic courses with methodical support to facilitate independent work of students, as the number of students studying asynchronously increased).

The analysis of the questionnaires of student respondents who studied in the asynchronous mode proved the presence of advantages:

- The ability to choose the time for studying (98% of student respondents) and the pace of studying educational material (86% of student respondents);
- The opportunity to save travel time, absence of travel and accommodation expenses (94% of student respondents);
- The opportunity to use various IC technologies to interact with the teacher and other students (88% of student respondents);
- The opportunity to combine study and work (82% of student respondents);

- The possibility to study from any corner of the world (city, village in Ukraine, from another country) (82% of student respondents);
- The possibility of studying in the conditions of the introduction of martial law, the spread of any pandemics, self-isolation, deterioration of health (81% of student respondents);
- The opportunity to participate in various conferences, seminars, lectures, webinars in the country and abroad (68% of student respondents);
- The opportunity to organize individual work and work in pairs and groups (62% of student respondents);
- The possibility of transparent electronic assessment (51% of student respondents);
- The opportunity to organize work based on shared Google documents (48% of student respondents);
- The possibility of repeatedly listening to recordings of teachers' lectures and re-reading the content of educational materials (21% of student respondents)).

The analysis of the questionnaires of the student respondents who studied in the asynchronous mode showed the presence of shortcomings:

- 92% of student respondents experienced psychological discomfort due to the lack of direct interaction with the teacher;
- 67% of student respondents pointed to hypodynamia;
- 46% of student respondents indicated problems with the technical condition of gadgets, outdated software, sound, video image;
- 31% of student respondents pointed to a slowdown in the pace of studying material;
- 23% of student respondents indicated an insufficient level of self-organization development;
- 18% of student respondents indicated a worsening of posture;
- 12% of student respondents felt a loss of motivation to study;
- 11% of student respondents testified about the low provision of computer equipment (one computer both for the work of the parents, and for the study of the student, and for the study of brothers and/or sisters);
- 8% of student respondents made a willful effort to overcome the desire to postpone the study of educational material for later;
- 3% of the student respondents indicated a deterioration of vision (a lot of time must be spent at the computer, preparing for classes, performing various tasks and during e-learning);
- 3% indicated that it was difficult to develop practical skills or abilities.

During the second period (the period of the introduction of martial law on the territory of Ukraine), the intellectual efforts of the respondents-teachers were aimed, first of all, at maintaining the psychological state of students in the conditions of both synchronous and asynchronous learning (telephone communication, individual and group web meetings, SMS messages, web counseling, recording of classes held in synchronous mode).

The analysis of the questionnaires of respondent lecturers and teacher respondents who combined e-learning with advanced training courses proved that teachers, performing their professional duties, first of all found out the geographical location of students; the conditions in which they were; availability of devices for e-learning, Internet access, stable connection, notebook, pen, textbook, etc. During the organization of e-learning, special attention was paid to the selection of tasks, their number, methods of motivating students, exercises on concentration of attention, stimulating assessment, implementation of an individual approach (since the possibility of learning in synchronous mode appeared only in the presence of electricity supply, Internet communication, working device, etc.).

During direct interaction, teachers first of all paid attention to the psychological state of students (if necessary, they provided psychological support; provided exercises for psychological relief; used techniques for regulating the emotional state; allocated more time to collective performance of exercises and tasks. E-teachers informed the students that the “air alarm” signal had been announced and reminded them of the actions in this case.

Based on the analysis of questionnaires of student respondents, it was established that during the introduction of martial law on the territory of Ukraine, students were most worried when could not join the synchronous e-learning and interact directly with the e-teacher and e-students. This was due to the conduct of hostilities in the territory of their residence, constant “air alarm” signals, lack of electricity supply and communication. It is significant that in 96% of student respondents, the need to study educational material in interaction with an electronic teacher and electronic students is constantly felt: 78% of student respondents noted that interaction during study helped them overcome anxiety caused by military actions, maintain the pace of study, learn new educational material faster and more effectively, and experience positive emotions. All student respondents noted that they dream of live communication with the teacher and fellow students.

4 Conclusion

I. On the basis of the analysis of learning theories in the context of interaction between the teacher and students, it was established that the interaction between the teacher and students is built on the basis of:

- Imitation of the teacher's actions (according to the theory of behaviorism [30, 32]);
- Internal motivation of students to acquire knowledge; it involves formulating the goal of educational activity by them (according to the theory of cognitivism [4, 30]);
- Creation of conditions for active formation of personal experience by students (according to the theory of experientialism by Kolb) [16];
- Cognitive inquiries, aimed at mastering new knowledge, skills and acquiring the necessary experience (according to the theory of connectivism (G. Siemens [31]));
- The adoption of information and communication technologies and their use for the organization of interaction is explained by the following causal relationships: antecedents - beliefs - attitudes - behavioral intentions - actual behavior in the organizational context (according to the theory of adoption of information and communication technologies by Venkatesh & Davis (2000) [35]);
- Promoting progress in e-learning motivation through six stages (igniting interest, transitioning from interest to desire, gaining inspiration and activity, self-improvement in establishing social contacts, achieving balance in e-learning and obtaining innovative results (according to the theory of the e-learning model within the framework of education for sustainable development [36]).

II. We formulated the following definitions:

- Direct pedagogical interaction in e-learning - it involves the mutual influence of e-learning participants on each other, which takes place at a clearly defined time, that is recorded in the class schedule, does not depend on the physical location of the teacher and students, but involves their presence in the class in the role e-teacher and e-students;
- Indirect pedagogical interaction in e-learning – it involves the impact on electronic students of the content of educational materials that are developed in advance by the teacher and placed in the educational environment of e-learning; the performance of the role of an electronic teacher is not foreseen.

III. As a result of the analysis of scientific works, the following were identified:

1. The advantages of direct and indirect interaction between the teacher and students in e-learning conditions (building direct interaction in e-learning is carried out regardless of the physical location of the teacher and student; building indirect interaction in e-learning is carried at one's own pace, without time and space limitations [3].

2. Disadvantages of direct and indirect interaction of the teacher with students in the conditions of e-learning can be briefly summarized as follows:

3. There is a high probability of the mental workload in electronic students when:

- Skills are formed at a low level (in particular, ability to work with high-tech equipment such as specialized software [12]; the ability to work with ICT technologies [28]; the ability to manage one's learning time without external assistance and to manage own learning rhythms [33]); the ability to separate main and auxiliary information [19];
- It is difficult for students to study in a self-disciplined way [34];
- Students lack motivation for instrumental use [9];
- E-students perceive the educational system as complex and confusing [14];
- The teacher projects mediated interaction in e-learning with an emphasis on teaching (i.e., on the transfer of information and structured knowledge to electronic students), and pays insufficient attention to the process of student learning (i.e., does not add methodical support for the organization of students' independent work) [34]);
- Indirect pedagogical interaction in e-learning can cause sleepiness in electronic students, which occurs as a result of the lack of face-to-face communication [4];
- Indirect pedagogical interaction in e-learning is organized without due attention to students who demonstrate low progress during e-learning (according to Sugawara et al. [34]).

IV. As a result of the analysis of the data of the pedagogical experiment, we formulated the following conclusions:

1. During the period of the spread of COVID-19 (2019-2021), the transition from blended learning to e-learning affected the activities of teachers. They responded to the identified opportunity for students to study asynchronously by developing additional methodical support (presentations, video lectures, workbooks summarizing the educational material in diagrams, tables, and matrices) to support students' independent processing of the educational material. Therefore, during the period of the spread of COVID-19 (years of 2019-2021), teachers paid considerable attention to the organization of mediated electronic interaction with students.
2. During the period of the spread of COVID-19 (2019-2021 years), almost all students who switched to asynchronous e-learning for good reasons or did it from time-to-time experienced psychological discomfort due to the lack of indirect pedagogical interaction in e-learning; a third of them slowed down development of educational material; one-tenth of the students felt a loss of motivation to study and constantly overcame the desire to postpone the study of the educational material for later.
3. During the introduction of martial law on the territory of Ukraine, the intellectual efforts of the respondents-teachers were aimed, first of all, at adapting the content and process of synchronous and asynchronous learning to the new conditions of organizing interaction with students, paying attention to the conditions in which they study, balancing their psychological state, change in methods of motivation, evaluation, ‘shaping’ meaningfulness of interaction, and implementation of an individual approach.
4. During the introduction of martial law on the territory of Ukraine, student respondents began to prefer synchronous learning. They attributed the presence of interaction with an electronic teacher and electronic students, maintaining the pace of learning, faster and more efficient assimilation of new educational material, experiencing positive emotions to the advantages of such training.

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Primary Paper Section: A

Secondary Paper Section: AM