Communication Models in the Digital Learning Environment*

Tatyana Noskova[1]
noskovatn@gmail.com

Svetlana Kulikova[1]
kulikovasvs@gmail.com

[1] Herzen State Pedagogical University of Russia
Saint Petersburg, Russian Federation

Abstract

Abstract The paper presents the features of information and communication activities together with the behaviour of modern youth in the digital environment. It is necessary to develop approaches to the use of students' social activity for solving educational problems with the help of computer technology and mobile communications. The authors describe the features of digital educational communication that are important for the qualitative organization of modern educational practices. Building a new communication model for the digital learning environment is one of the main objectives of its design. Three sub models of communication are proposed - an informational, an intersubjective and an intellectual.

Keywords: *communication, educational communication, digital communication, communication models, network interaction, digital learning environment, information resources, intellectual systems.*

1 Introduction

Digital civilization associated with the active use of computer devices, the Internet and web technologies, has defined a new era in the development of education of the entire world community. Digital environment has become a new global educational platform. It has taken on the role of a global information library and a communication channel. This opens up a new way for development and self-development for students through software and hardware, through the virtual space filled with new tactics and strategies for educational activities, new information ethics and culture, new tools and forms of interaction.

Today, computers and the Internet are both the conditions and tools that determine the new way for a person, his (her) training and education, development and self-realization. Digital devices (computers, tablets, and smartphones) become a natural "extension of a human hand", they determine the reference points and the range of human actions; they reflect a sequence of mental activities, perform simple routine operations and complex intellectual work. These devices are "embedded in a physical body of a person" because they become a part of the way of thinking, determine motivation, behaviour, strategies and values, facilitate work, enter the circle of news and interesting events, and are able to listen and reproduce information.

Young people unconsciously become "hostages" of the new digital environment. Media resources, social services, telecommunication technologies are the primary source of knowledge and communication, activities, and interconnections. At the distance of one "click", "at hand", young people have everything necessary for life - useful materials and links, announcements, applications, and contacts [Arkhipov et al, 2019].

Using non-linear strategies in digital information and communication space, from one information block to another (net surfing), young people quickly extract information, transform and present it in various formats (verbal, written, graphic, multimedia), enter into various communication links, and solve various tasks.

"Live knowledge" - knowledge of specific people, emotional and sensual, becomes popular among young people as a new source of information. The digital environment becomes a platform where you can simultaneously search for answers to your questions, track events, make acquaintance, comment and join discussions; present your image to the world through numerous selfies. The variety of resources and forms of network communications immerse young people into a multidimensional world where everyone can play different roles: a player, an organizer, a creator, an observer, a victim, etc.

The transformed sociocultural space entailed a change in the functional qualities of the traditional educational environment [Lyapina, 2019]. It was supplemented with new computer tools for creation and development. Such tools integrate multimedia, Internet technology, and virtual reality. New characteristic features of the modern educational environment appear. Among them, we can name information redundancy, variability and selectivity (choice from diverse environmental elements taking into account individual needs and personal needs). Besides, we witness activity orientation (search, transformation, maintenance, interaction, and transmission of information), structuring and navigation (hypertext representation information with multidimensional connections between information nodes for successful orientation), automation and use of algorithms (for the increase of the problem solving speed).

A spatial and temporal framework of the educational environment is expanding due to

open, free access to information and communication resources. The digital environment becomes a field for independent and creative activity, where a person actualizes own motivational, cognitive and communication aspects of education.

2 Problem statement

Digital sociocultural environment has changed the usual ways and forms of human communication that are the basic categories of being, necessary for socialization, understanding of the world, and the formation of a worldview. Under the conditions of digitalization, the traditional understanding of the essence of the "communication" concept has also changed.

During interpersonal communication, a person is involved in an open acoustic space, where he uses natural verbal and non-verbal communication channels - gestures, facial expressions, intonations, timbres of speech, and patterns of behaviour. A feedback (reaction) from a partner is received immediately. The synthesis of a "person speaking," "person listening," and "person watching," determines the complete involvement of all participants in the course of natural oral-verbal communication, their interaction in a single system of space-time coordinates.

Traditionally, a communication model includes three structural components: the exchange of information (communication), the perception and understanding of a partner (perception), as well as interaction. This structure of communication reflects reactions of partners in the face-to-face communication process and allows everyone to respond quickly to the communication situation, changing the whole process, if necessary.

Obviously, communication is an integral part of human perception. There are several definitions of communication. It is often considered from the position of actions as a one-way process of transmitting signals without feedback. In addition, it is understood as a system of interactions, a two-way process of information exchange. During communication, interlocutors alternately act as recipients and sources of information. Communication is a socially creative and a meaning creative process that takes place in a specific context and through the use of symbols. In this situation a commonality is created and self-perception is formed [Borodachev et al, 2007].

We can conclude that communication as a necessary element of interactions for individuals involved in the exchange of knowledge, information, values, assessments, and meanings. Communication is a socially conditioned process of transmitting and perceiving information in the conditions of interpersonal and mass communication through various channels with the help of various communicative means.

In the digital environment, students involve in a communication based on their own motivations, self-organization and joint solving of accepted problems. To learn in such interactions from the experience of others, it is necessary to consider communication as an activity, to study the features of digital communication, to identify how communication process changes in digital environment in comparison to classroom activities [Noskova, et al, 2015]. It becomes important to search for answers to the following questions: What new tasks can digital educational communication solve? How communication activity changes in the course of networking? What new models of digital communication arise?

It is necessary to understand the systemic changes that are manifested in digital ed-

ucational communication. Teachers need to learn how to carry out effective educational communication not only in the form of classroom instruction, but also in an expanded (digital) educational environment where it is also necessary to solve a wide class of educational tasks that ensure the quality of the educational process.

It is necessary to start using a social activity in the digital environment, which is already familiar to young people, for educational purposes. It is important to learn building educational communication with the focus on new needs, the needs of young people, based on computer technologies and mobile communications.

3 Substantiation of a digital communication model

In the traditional form of education (in the classroom), a teacher is a source of knowledge, an organizer and a leader of educational activities. A teacher aims at helping learners to achieve their goals and objectives. Interacting with students, a teacher involves them in educational communication. Verbal and visual methods stimulate learning and cognitive activity. These methods fill the educational process with meanings, emotions, connections, relationships, values, and practical experience.

In the digital learning environment, there is a transition to contactless interaction, a transition from a centralized (hierarchical) interaction model, characteristic of an in-class situation, to a student-centred digital model (network, virtual). A new model of the learning process consists in the evaluation of the informational stream by the learner who searches for the most useful information for solving personal educational tasks [Taratukhina, 2018].

A teacher stops being the only source of knowledge and stimulus of educational communication, but becomes the creator of resources that store knowledge in convenient forms and formats and are adequate to the essence of the digital environment [Laptev et al, 2016]. A teacher accompanies, supports, directs independent activity of students through various types of educational resources of the digital environment: information, communication and management recourses [Noskova, et al, 2015]. A student stops being a passive participant in the process of interaction, but gets actively involved in interactive learning (based on ICT), through multi-lingual forms of interaction. Due to the combination of individual and group work, through distributed network collaborative activities it becomes possible to solve a wide range of educational tasks simultaneously: educational, cognitive, developing, and social tasks. A student becomes an active participant of communication activities.

What is the fundamental difference between a digital communication model and other communication models?

Various models of communication have been described. For example, C. Shannon [Shannon, 1948] proposed a linear model of communication. There was also a model of M. de Fleur [de Fleur, 1982 et al] and a circular model of communication by W. Schramm [Schramm, 1954] and H. Osgood [Osgood et al, 1957]. In addition, V. Morozov [Morozov, 1988] proposed a two-channel communication model, and P. Lazarsfeld [Lazarsfeld, 1948] used a two-step communication model. Analysis of these models shows that each of them in its own way reveals the structure, elements and dynamism of the communication process. However, they do not take into account the peculiarities of educational communication, especially communication that takes place in digital coordinates.

A principal difference of the model proposed in the paper, is its functioning with ICT. Communication is carried out with the help of technical channels through a variety of social services on the Internet, educational web platforms and numerous ICT tools.

Thus, the space-time boundaries of educational interactions are expanded, information exchange between subjects becomes possible through synchronous and asynchronous communication in 24/7 mode. Thanks to ICT tools, the density of communicative acts increases. There is a rapid exchange of messages and an expansion of the communication tasks range - from help and counselling to joint activities within a network project and cooperation in a network professional community, when social services allow solving interaction tasks in a new way with the use of a "collective mind" [Tyrer, 2019].

The form of presenting information that has changed in the digital environment and the nature of its perception, when a text is integrated with various multimedia forms of visibility (pictures, photos, memes, and video), gives rise to a new phenomenon - "visual communication". This is the new means to express thoughts, emotions, and feelings, based on visual images. Today, young people do not need extra words, they are happy to turn to drawing stories, comics, infographics, animations, slides, collages and videos. It is not by chance that a complete or partial absence of non-verbal communication in the digital environment, in a written communication, is filled with various punctuation signs and symbols, stickers and statuses, emoticons, memes and all sorts of visual images. Thanks to such symbolic communication, one can easily and quickly transmit the necessary information, and demonstrate a certain emotional state.

Three groups of factors influence digital communication and educational interactions.

Firstly, an image of a partner can be formed in different types of digital communication. A person-to-person interaction, mediated by telecommunications, takes place directly between the environment stakeholders. Remote communication with an unlimited number of users expands the familiar face-to-face communication. As a result, in the digital environment there is an increase in social contacts, for example, discussions with academic teachers, dialogues with future employers, participation in forums with leading experts in the subject area, search for friends in social networks, discussion with strangers, etc. Digital communication is enriched by flexible, non-linear information exchange schemes, which make it easy to move from individual and small-group work to mass interactions (for example, on the basis of social media). Consequently, new forms of interaction appear - "one-to-group", "one-to-many", "group-to-group", "group-to-many", and "many-to-many". Interpersonal communication in the digital environment is complemented by a new actively functioning system - "person-to-digital object". This is an interaction of a person with a variety of information resources and information arrays (sound, audio-visual, multimedia, etc.), interactive media, computer training programs. The abundance of information resources accumulating in the digital environment generates new types of educational interaction: "person-to-hypertext", "person-to-media", "person-to-multimedia" when a person searches for a necessary information, extracts and interprets its content. Over the past decades, not only the habitual forms and ways of communication expanded, but also the very nature of interaction with a technical device has changed. Today, human-machine interaction has expanded from office applications to intelligent systems and virtual reality systems. A digital subject-to-virtual-subject communication system, built on the basis of interactions with a virtual assistant, consultant, and a smart machine in an interactive form, is assessed as an advanced, progressively developing area that meets the needs of the developing digital society.

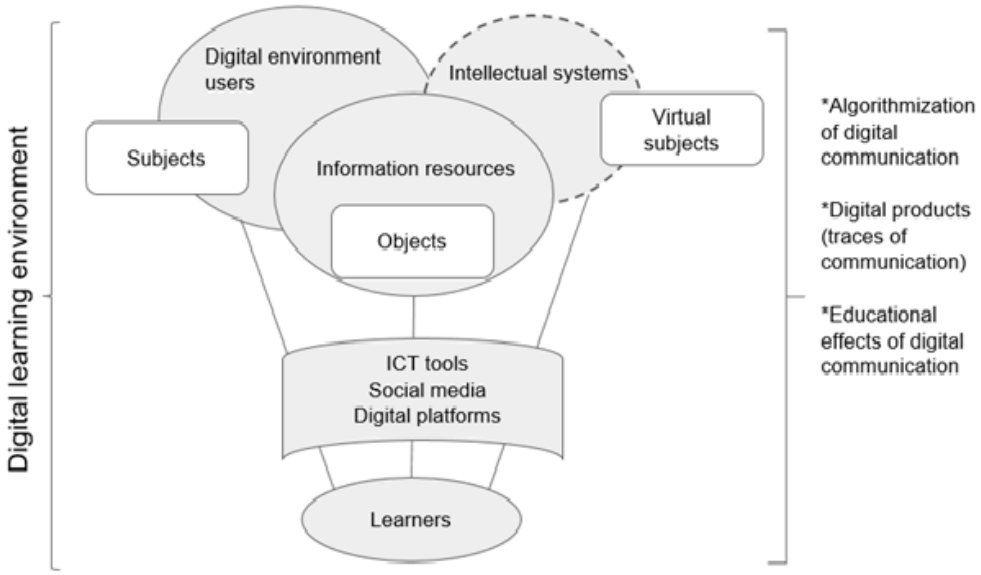

Figure 1: Communication model in the digital learning environment

Secondly, an algorithmization of communication in the digital environment takes place. Communication carried out on the basis of software and hardware is characterized by the formalization and algorithmization of actions determined by the ICT tools capabilities. The algorithms can be set from the outside, by a teacher, or initiated by a learner himself. Algorithmization of communication is a definite sequence of communication actions, an interaction scheme that varies depending on the educational and communication tasks solved by a person. It can vary from interactions with texts to dialogues with an intellectual system. This is a flexible algorithmization, since in the digital environment a person has a certain freedom of actions and can modify communication algorithms to fit personal needs and requirements.

Thirdly, fundamentally new is the accumulation of communication activities results ("products", "traces") in the digital environment. Each individual and / or group action performed in the network is stored in a computer memory (stored on online servers) and represents certain "educational traces of activity" [Noskova, 2007]. For example, communication, unfolding on the basis of newsgroups, educational blogs, social networks and multi-level virtual worlds becomes publicly available. These saved virtual discourses can be used as objects of reflexion or become the grounds for further communication.

Accumulated results of communication activities allow "seeing" a person in the digital environment - his goals, aspirations, opportunities, willingness to interact, emotions, etc. This helps correcting educational activities gradually in order to provide a necessary measure of assistance in learning.

In this way, a digital communication model is built on the basis of software and hardware, enriched by complex non-linear communication schemes, diverse and scalable communication links, complemented by new ways of information exchange in the course of jointly distributed activities. An accumulation of communication acts and discourses is possible in this situation (Figure 1).

Based on the selected features of digital communication, three typical communica-

tional sub models can be distinguished:

1. A model of communication with information resources;
2. A model of communication with the environment stakeholders (people);
3. A model of communication with a virtual agent (an intellectual system).

Let us analyse the sub models according to the following scheme: participants of communication and the tasks approached, communication algorithms, and communication products.

4 Description of communication models in the digital educational environment

4.1 Model of communication with information resources

In this model, communication is understood as information exchange. Communication unfolds in the digital environment on the basis of interactions with a polymodal content of the environment.

Digital resources are the main part of the digital learning environment. It includes many web-based information sources. These can be separate documents, multi-format files, virtual reality systems, multimedia and semantic knowledge networks.

As a rule, a digital resource has a special structure and form of presentation. It is filled with certain informational content, built in accordance with a specific genre and equipped with software and hardware for an easy work. Software and hardware are an arsenal of computer tools that allow performing an unlimited number of practical actions with the content, with its static and dynamic elements. For example, a free movement of text, objects scaling, viewing of images and videos, exploring three-dimensional models and interactive animations with the possibility to stop and study detailed fragments, listening to music and comments, saving material, replication, writing notes, etc.

Computer tools make it possible to implement active forms of interaction with the content of a resource in order to organize a productive work. A variety of tools makes it easy to manipulate digital resource data, manage the process of effective interaction with it, accumulate information materials and share them. Traditionally, five computer tools are distinguished - interactivity, hypertext, multimedia, modelling, communication [Osin, 2007].

Participants of communication and approached tasks. In the digital learning environment, a learner interacts with different forms of digital content - visual, symbolic, practical, and emotional. A content includes materials for educational, reference, scientific, cultural purposes, as well as results of various information activities - digital media (magazines, newspapers, and information channels). Obviously, the resource base of the digital environment is redundant, polymodal and dynamic (updateable). It is a "freely expandable product" of the educational environment stakeholders' distributed activities. This is achieved, firstly, through an active interaction with the content of individual resources, when users act as consumers of informational content (for example, work with

electronic books, scientific articles, digitized archives, news channels, informational websites, online encyclopaedias and dictionaries, electronic libraries, etc.). Secondly, by filling and saturating the content of the digital environment, when the environment is modified under the influence of users as creators, and in this new quality is perceived by other participants. For example, when a user places in the digital environment his personal results - educational materials (essays, projects, presentations, articles, messages), leaves "traces" of digital activities, for example, the results of electronic testing, polling, voting, quizzes, competitions, protocol of work with network simulators, computer games and various social services.

The information-to-person nature of interaction prevails in this model. The main goal here is the realization of personal information needs. Of particular value is the solution of problems associated with the assimilation of a personal content, the accumulation of knowledge and the formation of primary skills in their application. In the course of such interactions, preference is given to the work with the content, its analysis, evaluation of various scientific approaches, comparison with other materials, and the establishment of interdisciplinary connections.

Interacting with information resources, a learner independently solves a certain range of tasks in a given range of capabilities of computer tools (ICT tools) [Noskova et al, 2018]. He acts as a communicator and a recipient (a subject of information exchanges in the human-computer system). ICT tools in the form of navigation menus, maps, pointers, control buttons, active sign elements equipped with hyperlinks provide a learner with a flexible choice of personal educational routes and content development options. This helps in building an individual strategy for studying.

However, apart from mastering the content of a resource, e learner searches for knowledge based on personal interests, needs and requests. The search process is a sequential action of collecting, processing and obtaining the necessary information, and, if necessary, transferring information to others. An object of search can be knowledge extracted from resources, descriptive information (abstract, instruction, description of an object, facts, and data), goods and services, news and events, people. The result is new knowledge, evaluation skills, critical attitude to information, and the ability to compare, analyse and choose what is necessary and useful.

If the information that a learner finds meets the requirements of the knowledge-value system of the person, it is included in the individual knowledge base; if not – it is rejected. The information found and approved can be included in the educational resource, complementing and enriching its content, and become a new personal knowledge that is possible to hand over to colleagues, business partners, or a teacher [Noskova, et al, 2015].

Communication algorithms. Interactions of users with resources can be of various degrees of determination. For example, "programmed" interaction algorithms within a specific information resource (website, electronic textbook, presentation, simulator), defined by a clear sequence of actions in studying and mastering the content of the resource. "Flexible" algorithms of interactions are realized in a given range of ICT tools capabilities, when there is a certain freedom of nonlinear and multivariate forms of receiving, transforming and storing information, which in turn increases the individualization of learning.

During a search activity, it is important for the learner to work quickly and productively with various information files (text, visual, music, and multimedia) for solving

educational and professional tasks. The main objective is not merely finding a necessary and useful information, but also structuring, organizing, collecting it from different sources, recoding from one form to another, creating own databases. Therefore, search algorithms are associated with specific skills and abilities of the learner: the ability to formulate information requests, to apply different methods of search, to extract knowledge, to evaluate information, to comprehend further actions related to the use of the information database, to realize its importance for development and self-education.

Communication scheme: subject - ICT tool - informational content.

Communication products (results of communication activities). Using different forms of interactions with information resources of the digital environment, from simple observing to an experimental research, a learner produces different groups of "products". The first group are "knowledge products", extracted from resources in the form of certain conclusions, judgments, and generalizations arising from an internal dialogue or communication with the author of the resource. For example, a person learns to formulate search queries for solving specific problems, to extract knowledge, to evaluate the relevance of the information found and the usefulness of the information resource as a whole.

The second group are "result products", created on the basis of the information resources under study, for example, an outline, a bibliography, an annotated catalogue of resources, mind maps, infographics, statistics, etc. These products are directly related to the content of the studied resource and arise as a result of work on its understanding.

The third group are "resource products", appearing as a result of personal productive activities (creative activities and research) in the digital environment - an individual project, an abstract, an analytical report, photos, and models. This new educational content expands the digital learning environment with the help of ICT tools. It can be a bank of photographs, educational resources, personal information, text and multimedia materials containing recommendations and instructions, conclusions, answers to questions, action plans, in a certain way structured and equipped with a system of hyperlinks.

4.2 Model of communication with the environment stakeholders

In this model, communication is considered as "digital communication" (network, virtual), as mediated interaction of a person (one or several) with another person and / or a group of people. By "digital communication" we understand the interaction of people through synchronous (online) or asynchronous (offline, delayed) exchange of informational messages presented in various linguistic forms and transmitted using computer technologies. Depending on the ICT tools used, digital communication is complemented, accompanied by the perception of the partner. There are different types of perception, for example, audio-visual perception, when interlocutors see and hear each other through the screen interface, use "live speech", easily read emotions, mood, partner's relationship through sound and image, respectively, can instantly react and change interaction tactics (for example, communication via Skype). Audio perception takes place when the interaction is carried out through voice messages, and perceived features of oral speech determine the course and emotional mood of communication as a whole. Visual perception occurs when using sign-gesture speech (for example, among people with hearing impairments). However, the perception of an interaction partner can be reduced. For example, exchanging text messages, the interaction of subjects can be built on the basis

of compressed, formalized speech codes. This special form of speech activity is called an electronic discourse. A necessary condition for its manifestation is the formation of the linguistic properties of a person, the willingness to present information in the form of electronic written text. The perception of a partner here can manifest itself only due to the so-called "perception of the text", i.e. targeted enrichment of the text with emotions, for example, at the expense of punctuation marks and symbols, emoticons, memes and various visualized images and pictures. In this case, a learner conveys his thoughts, feelings, attitudes, and emotions in relation to the message (and not to the image of the partner).

Participants of communication and approached tasks. The emergence of communication services has significantly expanded the range of network interactions (interaction with friends, colleagues, strangers, academics, employers, etc.). This communication can be called free and open, since it often does not require special lengthy preparation and careful planning; it can arise spontaneously and is more often realized by the choice, desires, preferences of participants. For example, in a network discussion, the main purpose of communication is a quick exchange of views, a quick search for solutions, discussion, comparison of different points of view, positions. Participants mainly transmit cognitive information. This kind of information is easy to recognized, extract and interpret.

Messages transmitted online (in written or oral form - voice messages), as a rule, are intended for a specific addressee (teacher, colleague, scientist). Targeting of a communication message determines its character, tone, content and language. Addressing is associated with the expression of certain feelings, emotions, and values, beliefs of a person, their dosage and brightness. As a result of interactions, a digital communicative objective-practical field arises. In this field only a knowledge component is transmitted, but also a perceptual component that reflects a personal experience of relations, values, meanings and norms of behaviour. In the course of digital interactions, discourse resources are created and accumulated that influence both the course of network communication and the knowledge, attitudes, values of the subject itself. Important is the ability to hear the interlocutor, to discuss, to express a point of view in a logical and reasoned way, with the help of linguistic and multimedia tools in order to convey own position, to motivate, to interpret other people's statements.

On-line or off-line, any stakeholder of the digital environment can turn to another (familiar or not) with a variety of goals and objectives: informing, expressing gratitude, transmitting information (sending a letter), training, notifying, managing activities, sharing experience, demonstrating knowledge and skills, developing competencies, expressing oneself. As a result, a whole spectrum of educational tasks is resolved - interacting, structuring messages, analyzing messages and discourse, co-working, establishing new connections and relationships, solving problems of socialization, developing communicative and social competencies.

Particularly popular today are network communities that emerge on the basis of social services of the Internet and common interests of their participants. Communities are formed with the aim of sharing experiences, opinions, and results of actions; emotional and psychological support is provided to the users by the forces of the whole community. It becomes important to get help, advice in difficult situations or to provide support to another person. Such interactions can be systematic, when people agree on interaction in advance, or they may interact in a delayed mode.

Another example is a networked collaboration when a group of people joins forces to

achieve a jointly adopted objective. The goal of the interaction is to obtain a final network product, which is created by a group of people distributed in space and time. Participants are equal partners, who have equal opportunities in striving to achieve a successful result by making a positive personal contribution to the common result of the group. They learn to share knowledge and skills, cooperate, support, help each other, motivate each other to succeed, because the joint result will depend on the individual activity of each participant. The interaction centres on joint actions agreed between the participants and aimed at achieving a common goal (through the distribution of roles, mutual assistance, and mutual control). A feedback occurs through the network interaction, through self-organization and self-management.

Networking becomes the main condition for joint activities. In the course of joint actions, users interact with resources, obtain new knowledge, and solve problems of searching, accumulating, and analyzing sources. More important, they themselves become the initiators and organizers of network discussions; actively involve others in communication for joint decision-making and assessment of progress towards the ultimate goal. Choosing communication services, scaling the circle of collaborates (external partners); participants learn to express their own thoughts in the form of messages or multimedia, with the help of visualization tools and comments. In the interactive mode, they learn to see the depth of the problem, establish multidimensional connections, analyze, draw conclusions, find different solutions and choose the most optimal ones.

Digital interaction contributes to the development of important skills – expressing own competent opinion, being concise, giving reasons, listening to the opinions of others, being aware of the importance joint activities, performing mutual assistance, and self-control.

Participation in various types of networking is associated with the gradual accumulation of all actions in the computer memory to achieve the result (product). These efforts are saved on various services in the form of digital traces of activity, which then make it possible to analyze, evaluate and adjust the process of achieving individual and collective goals, explore the prevailing emotions, interests, requests of subjects, their personal qualities, penetrate the psychological atmosphere of the working group.

Today, networking is not merely a new form of educational process organization, but also a way of developing, filling and structuring the digital educational space, a condition for collective and personal self-realization and self-presentation in the modern educational environment.

Digital self-presentation is a personal organization and structuring of achievements in the digital environment based on social services. It is used, on the one hand, in order to create a certain impression of oneself or to create a virtual image with the aim of self-expression and self-realization. On the other hand, it is important for self-assessment and self-assertion through recognition by a wide audience. Self-presentation in the network can be viewed in two aspects of network communication: “face to face” in the process of online interaction and mediated by off-line communication services, such as blogs, forums, social networks, personal web pages. The presented information reflects not only the essence of the presenter, but also the measure of personal activity, interests, responsibilities, and the proportion of time spent. Accordingly, the effectiveness of self-presentation will be determined by communication skills.

Communication algorithms. Flexible polymodal interaction algorithms characterize the model that is achieved by reflecting personal characteristics in the communication process. Information transmitted by subjects is "packaged" in a simple or a complex form of utterances, enriched with personal and professional attitudes, values, and beliefs. As a rule, such algorithms reflect social views, emotional character and practical experience of a particular person or group of people. For example, communication algorithms in the course of joint activities, or self-presentation algorithms.

In this model, communication algorithms are associated with social activity, which has different degrees of definition and direction: from one to one, from one to many, from many to many.

Synchronous communication algorithm is implemented through chats, video conferencing, messages. Asynchronous communication algorithms are realized via newsgroups, email (linear algorithm) and forums, blogs, open educational platforms (branched algorithm).

The choice of communication algorithm depends on the determination and awareness of personal goals and objectives: it can be information, information transfer (sending a letter), training, notification, activity management, organization of knowledge acquisition, assessment and control of knowledge, development of competencies, etc.

Communication scheme: communicator or recipient - ICT tool - information content –communicator or recipient.

Communication products (results of communication activities). Digital communication products can be distinguished by written, oral, audio-visual and multimedia information, which is transmitted in the process of interactions. The basis of these products is a certain message structure, built in accordance with the rules and norms of netiquette, for example, greetings and farewells, notifications, gratitude, etc. Accordingly, these products can be of different scale. Firstly, there are transmitted signs and symbols, abbreviations, words, images that reflect emotions and feelings, the attitude to a specific communication situation, phrases, and remarks. Secondly, there are detailed messages containing specific knowledge, skills, conclusions, tips, recommendations, etc. Thirdly, the largest unit includes network discourses that allow analyzing both the communication activities of each participant and the course and strategy of communication in general.

Communication products can be of different purposes. For example, they can be created to satisfy personal needs, requests and interests (comments, messages in an interrogative, clarifying form, personal judgments and conclusions). In addition, they can be targeted to provide help for others (thematic discussions) or present results of joint activities in the network (a co-written essay on the Google Docs service, a digest, a collaborate project).

"Traces of activity" left by users in the process of digital communication help studying their successes and difficulties, correcting interactions if necessary, and organizing an individual professional support.

4.3 Model of communication with a virtual agent

In this model, communication is considered as the interaction of a person with a virtual agent (intelligent system).

Over the past decades, the requirements for the education system have changed. The

emphasis is on a new educational policy aimed at lifelong learning and the opportunity to learn not only in the classroom, but also in a remote mode, taking into account personal needs and preferences. The leading positions are occupied by intelligent e-learning systems as an educational trend [Education foresight 2035]. Intelligent system (IS) is "an automated system based on knowledge, software complex, linguistic and mathematical tools for the implementation of the main task - the human activities support and information retrieval in the advanced natural language dialogue mode" [Ostrouh, 2015]. The concept of an "intelligent system" has various definitions, but the core of the intelligent system is the knowledge base, intelligent algorithms, the ability to solve problems of high complexity and machine learning.

Intelligent systems are substantive embedded in our life, providing comfort and mobility (for example, smart home, virtual lab, smart phone, robots, etc.). Today, educators are increasingly discuss various implementations of IS in learning interaction - this is considered as a significant trend for future education [Education foresight 2035].

Participants of communication and approached tasks. An intelligent learning system includes several essential components. The first is a knowledge base. It contains a unique experience, expert knowledge, accumulated in teaching methods [**?**]. The second component is a model of a student. The system collects and accumulates information about a student's individual attributes and constructs a model profile of a learner including a chosen set of attributes or characteristics related to the learning process. This is a prerequisite for the successful selection of an action plan, an adequate choice of system response and a direction of the learning strategy. The third component is a learning process model, presenting the information submission mode, the sequence of learning tasks, monitoring and evaluation procedures. The intelligent interface is a point of communication between the system and the user, organizing human-computer dialogue partly resembling natural interactions with a teacher.

A student obtains not just a virtual teacher, but also a personal assistant, an expert in a specific problem area. A teacher in turn receives an assistant in training due to the redistribution of training functions between the teacher and the system. IS takes on the tasks of a learning content presentation, monitoring and evaluating personal achievements, detecting errors and identifying their causes, generating tasks related to the level and preferences of a particular student, etc. By analyzing the actions and reactions of a student's behaviour, the system constantly adjusts the training model, adapting the training material to personal needs of the student, offering interactive support in solving problems and assistance in personal educational path. As a result, we can talk about joint human-machine solution of various tasks, co-participation and co-management of learning objectives.

An interactive, multimedia learning environment can be created on the basis of an intelligent system. It allows the learner to be engaged into various multimodal activities. The learning content structure changes dramatically — a pre-defined actions sequence and hypertext are replaced by a knowledge base in which persons in different learning contexts repeatedly use information objects. The intelligent instruction system is focused on launching person's internal activity; his self-organization, self-management, self-realization, and self-regulation in cooperation with the technical environment. Thus, the intelligent system acts not only as a powerful technological tool, developing the intellect, but also as a tool for creativity, human self-realization, stimulating self-cognition,

revealing competence.

Let us give examples of the IS use in education.

A virtual voice assistant, created by Yandex - Alice (`https://alice.yandex.ru/`) - represents a self-learning artificial intelligence that is not limited to a set of predefined answers, but apples for communication neural networks, trained on a huge database of Internet texts, books and films. Alice recognizes voice commands and is ready to support a conversation on any topic, as for instance can identify humour. The Alice educational potential is relevant to communication competencies shaping (dialogue, maintaining a conversation, formulation of understandable questions, finding answers, etc.). In the learning process, the abilities to formulate search queries, to analyze content, to configure learning algorithms are significant. Alice can be personally trained, taught to support a conversation in the context of certain scenarios (topics). To do this, setting algorithms in a special visual designer is required.

Other examples of intelligent robots are Robot George (an English teacher `http://www.liveenglish.ru/`), and Saya - a robot teacher, planned to be adapted for the initial stage of education in Japan. Telepresence robots allow teaching from anywhere, broadcasting speech and image on learner's tablets, smartphones and laptops. For example, Robosem from the company Yujin Robot (South Korea).

Today, there are already examples of combining artificial intelligence with a hologram to create robot assistants. In 2018, in the Monterrey Institute of Technology (Mexico) several classes were conducted by a teacher hologram [Belmonte, 2017].

In recent years, chat bots have become particularly popular. This artificial intelligence system simulates human interaction with text and voice based on the principle of chatting. Chat bots allowed turning human-machine interaction into an illusion of real human communication in the dialogue mode [Smyslova 2018]. Bots can work as separate applications or be embedded to search engine of a learning platform. For example, a chat bot performing functions of a tutor's assistant is in demand within a MOOC [Tegos et al, 2019].

In the field of education, chat bots are aimed to improve the training effectiveness and the quality of interaction with learning content. They help to solve a wide range of problems relevant to digital education - information search, motivation for learning and cognitive activity, support in learning, students' knowledge and skills shaping, promotion of educational services. Chat bots can adapt to personal learning needs and preferences and support students according to their knowledge levels and learning strategies.

Applying analytics to chat bots, teachers receive additional quality indicators of students' behaviour, knowledge and skills. This data reflect details of content access and studying: a number of views, mistakes, frequency of references and requests to the bot on a particular topic. By accessing student-bot conversations, a teacher can analyze the situation and identify difficulties, timely take control and make necessary adjustments.

Over the recent years a variety of bots has been used - timer-bots, messenger-bots, reminder-bots, assistant-bots, tutor-bots, game-bots, relaxation-bots, chat-bots. For example, an educational chat bot Edubot in Facebook is a virtual assistant that fosters peer-to-peer mentorship as a way to improve the quality of education. Chat bot named Jill Watson is a teacher in virtual lecture halls (Georgia Institute of Technology). Wikipedia voice-bot is a bot with a voice search function on Wikipedia. Andychatbot allows practicing English with a friendly companion Andy. Numerous chat bots for training appeared in Telegram [Pereira, 2016].

In university practice, other several examples can be cited. Andes Physics Tutor is an intelligent physics training system, developed by the University of Arizona and the University of Pittsburgh, with the support of the Pittsburgh Research Centre for Learning (http://www.andestutor.org). An intelligent natural language question answering system – a Start system is also known (`http://start.csail.mit.edu`).

Communication algorithms. The most flexible adaptive communication algorithms characterize this model. These are the most complex, variable algorithms - tutoring (informing) and personality reflection tasks are solved simultaneously. The system takes into account personal needs, demands, capabilities and influences as a communication participant. Obviously, the interaction between the human and the intelligent mediator allows to implement primarily personal communication algorithms, with the priority of personal preferences and interests. The system offers personal action plan based on the multidimensional data analysis and the student in turn agrees or makes the necessary adjustments. These algorithms can be implemented both within the framework of a linear and non-linear communication.

Communication scheme: the person - information arrays - the intelligent system.

Communication products (results of communication activities). In this model, communication products can be analyzed from the perspectives of a learner and an intelligent system.

Via the algorithmic and automated system activity, a user quickly receives feedback based on actions analysis, error detection and identification of knowledge, skills and motivation. A learner becomes an active partner in a human-machine interaction, able to answer and ask questions. The system either responds immediately, or "leads" the user to the correct answer. As a result, students not only obtain new knowledge, but also implement personal learning models based on own activities, personalized knowledge and achievements.

An intelligent system records all personal actions, stores all dialogues, results, and data reflecting student's mental conditions at a certain point of activity. Applying multidimensional data analysis, the system is able to give advice and recommendations, predict the situations, and select the most effective ways to solve problems. Consequently, a quality personal support is implemented. Intelligent system constantly adjusts the learning path, adapting the training content and offering interactive support in solving problems. Accordingly, many examples of personal learning models are stored in the system memory.

An intelligent system knowledge base is updating constantly in interaction with user. It is expanding and enriching with new connections and relationships. The more diverse are personal learning strategies and communication modes, the more actively the intelligent system learns, acquiring "autonomous intelligence" [Zhdanov, 2008].

5 Conclusion

The digital educational environment changes forms, algorithms and nature of communication as compared with classroom human interaction. Digital communication expands the range of links, increases the number of social partners, contributes to the emergence of new social societies, and supports learning tasks personal solutions. Tracking personal

actions, the digital environment is able to reflect current trends in the behaviour and activities of young, in their needs and demands.

A learner's role changes significantly in digital communication conditions - he becomes an active person, ready to acquire and apply knowledge independently, to express a personal position.

It is important to learn how to organize and manage the educational communication in the new environment with multivariate relations, various communication services and communication activities. Typical communication sub models provide optimization of students' learning activities, promote digital learning environment productivity, and improve the quality of the educational process as a whole.

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