COMPUTER ASSISTED INSTRUCTIONAL TECHNOLOGIES: NEW DEMANDS FOR TEACHERS' STAFF

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Abstract. Computer assistance has been actively introduced in all forms of instructional technologies over the last decades. In addition to lab exercises, exam testing and information search, a new type of YouTube lectures are widely spread now in many universities. That is why some traditional forms of instructional technologies require serious upgrading. The upgrading process has to take into account some disadvantages of traditional computer training and testing. As a consequence, there is an objective need to change the role of the instructor in a lecture hall and at reciting classes. One of the most serious problems in computer exam testing is reduction of students' creativity. The second serious problem is the loss of independence in the process of decision making. To avoid most of disadvantages of computer assisted learning a new sequence of instructor's action was studied. This sequence can be divided into three stages. The first one is connected with the process of preliminary familiarization of students with the new conceptions. It is the so-called Tutorial Set of Actions. The second stage is the main one. At this stage the instructor trains students to create their new skills and abilities. It is the so-called Competence Creating Stage. At the last third stage the instructor gives consultations to students who are performing their independence researches. It is the Advisory Stage. The continuous sequence of these three stages is the main novelty in the modern computer assisted education.

Keywords: PC-assistance, instructional strategy, instructional triad, individualization, managing stages, competencies, personal behaviours testing, cooperative discussion, information search technologies.

Introduction: Brief overview of several novelties in instruction technologies

All animals respond to changing environment through their activities. A set of animals' actions transforms into their behaviour. Higher animals have a period of creating and fixing their main reactions which are a base of their behaviour [1]. But only people have special institutions that are created to teach and train complex actions of each individual. Moreover, the human evolution formed a special group of people whose activities were to teach and train other people. The formation of this group took very long time. Nobody can specify the exact date from which the teaching process became widespread. However, teachers and their followers were already well-known in ancient times [2; 3]. Over the next centuries the teaching process changed significantly several times. These changes were caused by some important circumstances. The main of them are connected with the demographic situation, technical and technological progress, development of human philosophical knowledge, and growth of diversity of the society.

After the Renaissance period most of the Western countries built a regular educational system [4]. The general idea of this system was to meet the challenges of social environment. Changing environment immediately creates new educational demands. The changes in the social environment and in the areas of human knowledge occur continuously. Yet, the educational system is very conservative. Its continuous improvement is impossible in principle. Therefore, the transformation of the educational system is characterized by periodic jumps. To put it simply, one can say the educational system stores small contradictions and new facts that become active after their quantity exceeds a certain limit.

There are some challenges in social environment that can create active transformation of the whole educational system. These changes are connected with the changes in a set of necessary skills and practical abilities, increase in the time of active learning and emergence of the new technical tools and technological ideas which are used in the instructional processes. Over the last decades, new informational technologies have dramatically changed all areas of instructional techniques [5]. Possibility of computer assistance and direct Internet connection between all participants of the educational system led to a new understanding of the role and goals of teachers' staff. As a result, some discussions about teachers' participation in computer-assisted instructional technologies started. The intensity of this discussion is supported by economic estimations of training costs. Reassessment of necessary instructors' actions in transformed educational technology usually accompanies the process of restructuring of instructional technology. Many controversial ideas are frequently created in

such discussions. Therefore, the main goal of this presentation is an attempt to find a reasonable estimate of new principles connected with a changed instructor's position in computer-assisted technology at the tertiary and post-graduated levels of education.

Historical transformations of instructors' actions: from personal contacts via group training to computer-assisted technologies

Let us briefly describe instructional actions at different times. Ancient Greek philosophers taught a very few persons at the same time. The learning technology at that time mostly consisted of a combination of discussions, monologues and very simple narrates which were predecessors of modern lectures. Certainly, there was no curriculum. The main motivation at this period was a will of each pupil to study. The philosopher could choose its auditorium also. In a small auditorium a lecturer-apprentice contacted each other face-to-face. These contacts were close and very personal. Every student could change his lecturer. It was their free choice. Respectively, a lecturer could also change auditorium at his own will. It looks like there were no restrictions in this field. One can say it was typical education with individual contacts of lecturer -apprentice. Such instructional technology was the best for that time.

Approximately, at the V century AD the knowledge grew very fast. Its content became diverse. From this time each student had to get information from several lecturers. Moreover, effective instructional technology required classes with several students. The price of this was a loss of close personal contacts of lecturer-student. It was a starting point of serious contradiction: each lecturer had to teach several students simultaneously and take into account the difference in their personal behaviours. Two ways of overcoming this contradiction were known. The first one was the orientation on average model of students' possibilities and their background. This way step by step brought the education strategy to its modern form. The second way was very specific and rare. In this case a group of qualified teachers was created for a specific period of time to give personal lessons to one person only. Certainly it was very expensive. Only notable or wealthy families could afford to give such education to their children. Some additional problems associated with socialization of the students, who got such education, were frequently created as a result of this strategy. As additional development way, a mixed education system was widely spread as well. In this case the first educational level relied on individual teachers. The education at the next levels used group classes. Over the last decades of the medieval period a famous teacher Jan Amos Komensky radically rebuilt all educational process in the Western World [4]. After this all education technologies were based on standard curriculum, different forms of classes and many other novelties. These novelties launched all modern educational technologies. In these technologies each faculty was in touch with a group of students. Consequently, individual contacts of lecturer-apprentice were diminished.

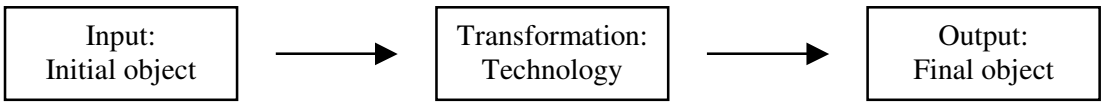

Fig. 1. **The triad form of instructional strategy.**
The middle (transformation part) is frequently called: technology or method

After the medieval era the development of education technologies was closely tied with creation of special tools and different techniques. Starting from a simple piece of chalk the special educational technique stage by stage began using different recorders, movies, radio sets, TV devices and so on. New tools influenced not only the technologies. At the same time, the requirements to instructors' skills changed, too. Moreover, the skeleton of instructional technology was rebuilt little by little. The instructional strategy may be traditionally presented in a triad form. This triad consists of an initial object (input) and a final one (output). In the case of educational systems, the input and output parts of the triad are students. The middle part is traditionally defined as a method (Fig.1). Frequently, the method as the transformation process is denoted as technology, too. One can say that the education strategy transforms students from the initial state (input) to the final one (output). The difference between these two states is connected with knowledge, skills and abilities (KSAs) of a student at the initial and final stages of transformation [6]. The transformation or production process includes a

schedule of operations and different technical systems, such as engines, tools, and instruments [7; 8]. Traditional study of educational technology ignores its interaction with environment. It means, the educational technology is confined. In this case KSA received and created at the secondary educational level are a start (input behaviour) for the third level. The output of the third level is a starting point for the next level. KSA in mathematics, for example, are described very well using this model, which we call "confined instructional technology". Teaching of some subjects, i.e., mathematics and chemistry among them, is usually confined. Contrary to this, information from TV, books, and movies creates active interaction flows from an environment. These flows influence the instructional technologies. As a result, in this case instructional strategies cannot be defined as confined. Movies, TV, and books transform most of confined technologies into a non-confined form. These transformations dramatically started in the middle of the XX century. Nowadays, computer-assistant instructional technologies, open internet access and especially "YouTube lectures" transformed teaching of all subjects at all possible levels into open ones [9-11].

Open instructional technologies and a new form of independent students' home training impose new requirements to the instructor's actions in a classroom and lecture hall. As it was mentioned [12], some passionate professionals proclaimed full replacement of lecturers' staff with recorded TV and YouTube pieces. Despite serious criticism of these crazy ideas one can say that nowadays PC-assisted technologies are a new challenge. Our further discussion is one of the first attempts to find correct answers to a set of questions which are created by this challenge.

Problems to be solved by a lecturer in a new situation

Creating new knowledge and information about different concepts is the core of lectures for all taught subjects. The lecturer builds his (her) theoretical material taking into account average students' KSA. Therefore, real text, examples and some emotional actions will be focused on a specific audience. It can be realised only with active and constant feedback. It is hardly possible to check students' reaction and their understanding of the taught stuff without direct observation of the listeners' behaviour [13; 14]. There are a lot of small, yet, very important factors which can significantly influence the perception of the taught information. That is why each experienced lecturer constantly adapts his (her) words¸ intonations and examples. Answering the students' questions, stimulating activity examples and different mini-problems help a lecturer find optimal strategy for increasing the audience attention. To this traditional management of instructional strategy nowadays situation added the necessity to control the increased flow of external information. Recently it was enough to know the main printed books connected with a studied area of knowledge. Yet, free access to the Internet, information exchange in social nets and watching different TV educational programmes made this informational flow poorly controlled. One can say a common modern lecturer practice is combined with active tutorial work in the field of managing independent students' informational search. It is evident; lecturers are still the main persons in realisation of such instructional strategies. The professional lecturer's competence is significantly expanded as a result of extensive use of computer and the Internet teaching assistance. It is obvious, that different recorded lectures can never replace a lecturer in the new education strategies. By our opinion, this is the first and yet the simplest answer to a set of new educational challenges.

Teacher's participation in computer-assisted checking procedures

It is well known that one of the major advantages of computer-assisted learning is a possibility to save an instructor from routine operations. On the one hand, it enables an instructor to focus on more important actions. At the same time, computer-assistance gives an opportunity to increase a number of routinized actions. One of such actions is periodical check of students' achievements between exams and at pre-exam discussions. To this end, different test surveys are used almost universally. Both teachers and students love them. There are several types of tests. Their classification and main behaviours were repeatedly described. The most commonly used one is a test in which a student has to find one correct answer from a set of three-five answers. All types of tests may be divided into two groups. The tests of the first group are created by a lecturer or with his (her) direct participation. They are in a good agreement with the content of a theoretical part and the problems discussed at reciting classes. One can say these tests are perfectly adapted to a local situation. The students who are

involved in such educational programme usually get better scores than the students educated in other places. Therefore, many checking procedures use the test of the second group. These tests are the same for many institutions and different from government programmes. They do give more objective information about students' competencies. As a result, an experienced instructor has to combine the test of these two groups. He (she) should study the test of local type to provide the tests with the same complexity. That is why each instructor needs reliable statistics of students' answers. This, in turn, requires constant correction of the test packages [14-16].

In the routinized testing strategy a correct answer to a problem is originally introduced into the PC-programme. It means, only one answer is a correct one. All other answers are treated as mistakes. To ensure this, a test has to be strictly obvious. However, it can be a case when students' understanding is not uniform. One frequently does not understand that in some cases a computer-assisted system rejects all non-standard and unexpected students' answers as erroneous. Here one encounters the main disadvantage of computer-assisted checking. This disadvantage is that the rigid standardization of the correct answer eliminates a small number of students with original and creative points of view. After several cases with poor scores such students usually lose their creativity. Let us describe two examples of typical tests in which one can detect some hidden alternative correct answers. The first example was artificially created based on the widely spread traditional strategy. In this test a student has to find an object which differs from the others in the short list:

TURTLE
TRUNK
SQUIRREL
TIGER

Each experienced instructor immediately recognises a traditional idea here: to check if a young preschool child or pupil of the first/second educational level really understands which word describes a non-animated objet. So, the correct answer in PC-programme would be: TRUNK. Most of the examined pupils usually give this answer. Yet, there are some other possible correct answers. So, SQUIRREL is the only word, in which the first letter is not T. The word TIGER is the only word without letter U**.** This is the reason for having a discussion with the students given "non-correct" answers: for understanding if it is misunderstanding or original point of view.

The second example is a real story. In the training laboratory of nuclear physics there was a set of portraits of famous scientists who used to work in this field. Yet, instead of Russian physicist Sergei Vavilov an assistant hung a portrait of his brother geneticist Nikolai Vavilov. When an instructor found this mistake he asked a group of students: "WHOSE PORTRAIT FALLS FROM THIS PATTERN?". Suddenly one student said: "IT IS MARIE CURIE". It was so strange and unexpected that the instructor asked: "WHY SO?". The student answered immediately: "SHE IS THE ONLY LADY IN THE GROUP OF GENTELMEN". It is an excellent example of non-standard thinking.

These two examples illustrate that situation with routinization of PC checking procedures create a new problem: the necessity of actions to prevent a loss of creative students. This problem influenced the new instructional strategy after PS-assistance in education.

Some problems with keeping students' ability to make independent decisions

Computer-assisted training is connected with a set of student's actions. Most of them are given in special instructions or guide-books. Usually a sequence of necessary actions is written to be clear for shy and even a weak student. In most programmes the sequence of necessary steps is rigid. To miss any simple or non-key action is strongly forbidden. It is a well known situation when students lose interest in understanding the reason and sense of their actions. They begin following blindly the guide instructions and do not make any attempt to understand the sense of their own work. After some time many of the students lose their creative abilities. The more gifted students the bigger the loss of their creative potential they feel. The simplest way for compensation of this disadvantage is to adapt computer training programmes to the real intellectual level and competence of each student [14; 17; 18].

Adaptation of the PS-assistance educational strategy requires the creation of two-three programmes for training of the same material. The difference between them is their different

complexity. Each portion of new information is complemented with tests. If the testing tasks are hard for students, the quantity of wrong answers is too high. The proportion of wrong answers should not exceed any given amount. In case this proportion is very high the programme has to reduce the complexity of the testing tasks. If the proportion of wrong answers is small then the tasks should be of a higher complexity. The criteria of the necessary proportion can be based on Skinner's ideas [19; 20].

It is a very tempting idea to have a set of programmes of different level of complexity. Yet, it takes a lot of time and efforts to create a convenient set of adapting training exercises. The most difficult part of an adapting programme is to create a comfortable and reliable switch to automatic transitions between different levels of complexity. This switch would be universal for different situations. However, we do not know any good example of its realisation. One can say this time is an interim stage when the switching is done manually. There is no doubt, the ability and will to work with adapting programmes is new and useful instructor's competence under computer-assisted educational strategy.

Instructional strategy in the open educational technology: how to search and estimate the validity of new information

The intensity of outside information flow received by students has increased sharply over the last decades. Nowadays, this information comes not only in hard copies. Mostly, it comes via movies, TV and especially via the Internet. Nobody can trace all sources of new data that influence a student. It is hard to say which sources are really taken into account by different students. Outside flows from the Internet, books and mass media can be called vertical flows. In addition to these input flows, there is a system of horizontal information exchange via social nets and different informal students' contacts. At all times there was no reliable control over the quality of scientific data in mass media and popular publications. It is well known that you cannot fully trust all Internet data. Therefore, there are serious reasons to doubt the quality of information received by students from outside information flow. To prevent possible students' misunderstanding of the studied subjects the modern instructional strategy has to answer these challenges. At first, there are some problems to solve. Let us describe their list [21].

First of all, each instructor must help a student search and save information he (she) needs. The best way is to give a brief introductory course at the freshmen period. After finishing high school most of students have practical experience to work with PC and most of them have the Internet access at home. Yet, their knowledge is not systematised. Therefore, a theoretical base and several practical exercises must be included in the curriculum core. Yet, this theory cannot give good results without everyday practice. At this period discussions at reciting classes must show a student the main Data Bases connected with his (her) future specialisation. The instructor's goal at this time is rather tutorial. It means each instructor has to give different advice and help solve simple search problems if necessary. Each instructor must work in close contact with cybrerian (librarian with excellent PC and Internet background). All these efforts can be successful if a student works in the team which uses modern Internet search technologies every day. Finally, at the stage of the pre-diploma practice and at the period of post graduation studies all students must return to the theory of Internet searching which should be accompanied with intensive practical training. In addition to these educational actions, each instructor should constantly give practical advice how the validity of information should be checked. It is possible to do only when having everyday close contacts of instructor-student.

None of students can learn all data brought by outside information flow. According to this, each instructor has to gather special lists of the most useful sources of educational information. Unfortunately, these sources are not evenly distributed among all the parts of the taught subjects. This is evident in the analysis of printed materials only. In the early 90s when no information from the Internet influenced students' knowledge, the authors studied this problem in detail [15]. We invited the students from 12 universities of the former USSR to answer which popular books and TV-programmes were known to them. A special method of social study was developed to get valid results. We found out that in all the universities not more than 30% - 40% of respondents regularly read additional information devoted to studied subjects. According to the data over the recent years a number of students using the Internet as an additional source of independent information has been constantly more than 90%. Yet, the quality of this information is really worse than two decades ago.

More interesting is the information about quantitative distribution of popular sources of information on various topics [9; 14]. We do not know new data about the distribution of files with popular scientific information on the Internet. Yet, the historical data about the distribution of interesting books connected with introductory course of general physics, which we described in the 90s, are still interesting. In our investigations we divided all content of general physics for engineers and chemists into seven parts. After this, the general subject catalogue of Russian National Library (RNB) was carefully investigated. More than 60 % of materials were devoted to three topics only. They were classical mechanics, theory of relativity, space and nuclear physics. At the same time, we invited a group of experienced professors and instructors, who regularly taught physics and chemistry, to arrange the topics of the course in accordance with their complexity. The ranks given to them are in good agreement with the average exam marks for these topics. Comparison between these ranks and distribution of the average number of pages of popular books convincingly demonstrated an unexpected fact: the more difficult for students' understanding the topics were, the worse the situation was with the supporting books and TV programmes.

Widely introduction of the Internet into the educational technologies changed all numerical data discussed above. Yet, the lack of planning materials for additional students' independent reading remained. As a result, each lecturer has to create his (her) special list of printed materials, TV and YouTube lectures and useful URL-addresses to give it to students. Each instructor must periodically investigate the main questions, which the students are surfing on the Internet. There are several new methods for experimental study of this problem. Some of them are based on the study of Internet statistics and classical interview methods. However, there are some new strategies to get necessary objective data. One of them is tied with the estimation of students' interests and motivations. For instance, we counted the number of students' tasks that the students independently selected from the list with more than eighty given topics. We can see the preferred themes change with the time. The speed of this change is not very high. Yet, periodical observations of preferred tasks are certainly required.

In our opinion, this paragraph demonstrates the new instructor's competences in the information work obligatory to build the modern PC-strategy of education.

Compromise between individualisation and diversity

Each complex system with hierarchic structure requires stability and sustainability at lower levels of a system. A variety of system properties is provided in its upper levels. This is fully true concerning all kinds of education problems, strategies, KSA, competences in the first place. In modern complex strategies a contradiction arises between the stability of one part of the instructional system and the diversity of the second one. It has to be resolved by correct actions of instructors' staff. Nowadays, PC-assistance with any problem can create a large set of standard situations. This computer guidance allows a student to study much more situations than it is possible to observe in practice [22]. Unfortunately, there are many reasons due to which students can realize in the classroom only a small part of them. Modern strategies recommend the students to select randomly only two or three possible regimes. Therefore, the real educational investigation is a typical strictly individualised process. The traditional non-computerised strategy does not ensure different experimental conditions for several students. It is hardly possible to provide serious diversity in the situations studied by several students. Such ability is given by PS-guided training experiment or numerical investigation. The only obstacle associated with its usage is the fact of poor choice of experimental parameters in a group of students. The instructor's task in this situation is to give good tips for this choice. If it is fulfilled, a group discussion of results in post-experimental discussion creates the necessary diversity for getting generalization at a higher level. This contributes to maximum efficiency of small group's investigations. In this strategy the instructor helps the students' creativity. The instructor's role is to tie the individualisation of personal student' actions with the diversity given by computer. It can be realised in the course of students' joint discussions under instructor's guidance. Possible instructor's participation in these discussions is usually welcome. The new type of such educational strategy generates a hidden possibility of computer aided training.

Conclusions

Despite significant changes in educational strategies, the role of the instructor in the case of PC-assisted technologies is only growing. Moreover, there are some new competencies necessary for successful work of university faculties. The main vector of changes in the list of modern instructors' competencies is a compensation of the excessive averaging computer programmes and the Internet and TV demonstrations. Full return to personal teaching is impossible. That is why all practical novelties are connected with the maximum possible individualisation of teacher-apprentice contacts. Content specific recommendations regarding the new instructor's strategies differ in some way during the whole period of students' training. One can detect three main stages in the instructional strategies at tertiary level. The first one is applied to sophomore period. At this time, an experienced instructor must help a student create new skills in searching information, estimation of experimental errors, understanding of introductory problems of his (her) future specialisation. It is the period when different general recommendations given by the instructor are necessary. One can denote it as THE TUTORIAL STAGE OF INSTRUCTIONAL STRATEGY. The next stage begins at freshmen years. Yet, its main activities are associated with the period of senior students study. At this time the learning strategy in cooperation with computer assisted training forms a basic foundation of professionally oriented KSA. This is the main fundamental stage of instructional strategy – THE COMPETENCE CREATING STAGE. The third last but not least stage is advisory, consulting and leadership work at the pre-diploma period and at the post-graduation education. One denotes it as THE ADVISORY STAGE. The main goal of this study is to help students solve independently important problems of their first practical work. It should be noted that all three strategies (tutorial, competence creating and advisory) are used during the whole educational time. The difference between the stages is connected with the predomination of one of them. All new competences in connection with the traditional ones say that instructor's actions are also necessary in computer assisted educational technologies as before. In our opinion the presence of a qualified teacher now becomes more necessary than it was in the past.

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