Distance learning during self-isolation: comparative analysis

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Abstract. The article provides a comparative analysis of the methods of teaching mathematics to university students of the traditional face-to-face form of education and in the form of distance learning using electronic teaching aids. To compare these forms the main elements that make up the teaching methodology were highlighted: teaching methods, levels of mastering the content of education, the type of educational situation, types of feedback. Each element of the methodology was presented in the form of a hierarchical subsystem performing teaching functions at different levels of assimilation. In the course of the conducted polls of the students and teachers it was found out that the traditional teaching methodology worsened its didactic properties with the transition to a distance form. Therefore, in order to increase the effectiveness of teaching it is necessary to transfer the methodology to new principles of cyberpedagogy and create a closed educational process with a directed information flow.

1. Introduction
In March 2020 all universities in the country were transferred to distance learning. Such necessity forced the teachers to teach students using computer technologies. At the time of the announcement of the COVID-19 pandemic great part of the population was forced to self-isolate but universities of our country didn’t suffer great losses because they had already their own electronic educational system and the teachers used it in an active form.

However, the participants in the educational process did not expect such a rate of turn of events and had to rebuild the already established educational process on the fly. Undoubtedly, I.R. Skorobach [1] is right while pointing out the current unsatisfactory state of distance learning in our universities. But at the same time there are articles where the points of making such an educational form in which learning becomes “more accessible, personalized and adaptable to the individual needs of students” are considered. [2]. Moreover, in the USA at the University of Illinois in Urbana-Champaign a training system has already been created and it is functioning, and it is only our dream [3]. In our country didactic scientists have developed the pedagogical foundations of computer-controlled learning (e-learning) [4] in which the basic principles of a new section of pedagogy – cyberpedagogy are laid.

Due to the fact that mathematical education is at the heart of the scientific and technological progress of human society students should be fluent in mathematical knowledge. In reality their knowledge is far from it. Therefore, in order to increase the effectiveness of the methods of teaching mathematics at the university it is necessary to understand how effectively the process of teaching was carried out.
Comparative analysis of teaching methodology before and during the pandemic can help to understand what has changed and what has remained unchanged with the transition to e-learning.

2. Materials and methods

Let us set the parameters for the comparison. Figure 1 schematically shows the teacher's methodological system which does not depend on his skill and experience. We have already considered a similar scheme but it was made in relation to school education [5]. Now we propose to consider the system in which any teacher of mathematics at the university works.

![Diagram](image)

**Conventional signs:**
I – learning activity to reproduce knowledge with a prompt (realized, remembered, reproduced), cooperative activity of a student and teacher is possible.

II – learning activity to reproduce knowledge on a model in a familiar situation, but without prompting, independently.

III – educational activity on the application of knowledge in an unfamiliar situation, without presenting a solution algorithm, the birth of information subjectively new for a student.

1 – the teacher organizes the process of learning, explains, tells, demonstrates, informs students; 2 - joint activity of the teacher and the student are carried out; 3 - the student independently carries out learning activity in which a certain level of assimilation of training material is realized.

- there is no such an element in the teaching methodology
- this element is modified or weakly manifested in the teaching methodology
- there is such an element in the teaching methodology

**Figure 1.** Composition, structure and functions of methods of teaching mathematics at the university.

The building blocks of any teaching methodology are teaching methods that provide a certain level at which students must assimilate some educational content. Teaching methods are applied in a specific learning situation in which a student plays an active part if he works himself or he plays a passive part if a teacher works. No one educational process can do without feedback. The more often the feedback
is given to each student individually the more effective the training process is for him. We do not claim the completeness of this structural diagram, but it will be sufficient to discuss the issue of changing the teaching methodology in connection with the transition to distance learning. Let us analyze each element separately.

It is known that M.N. Skatkin, I. Ya. Lerner, V.V. Kraevsky and their followers established the composition of the content of education which is passed on to the younger generation from their predecessors. Knowledge about the world and ways of working, the experience of reproductive activity, which is acquired in a standard situation, the experience of creative activity, which is acquired in a non-standard situation for a given student, is transferred to the new generation. The fourth element, the experience of emotional-value relations connects the three previous elements and is acquired through the “living source of human personality” (K.D. Ushinsky).

Figure 1 shows the hierarchical structure of the teaching methodology. It is known that any methodological system has its own stock of didactic capabilities which is determined by the “law of conservation in didactics” [6]. Therefore, explanatory and illustrative methods can never provide a second level of assimilation of educational material, as it is required while teaching mathematics at the university but intuitive-visual feedback cannot establish this degree of assimilation. Mathematical knowledge is acquired at the application level through the use of reproductive teaching methods. But first of all, the training system must guarantee a student the assimilation of knowledge at the first, disciplinar level. Both the first and the second levels of assimilation are checked by special pedagogical tools - tests of the corresponding levels, and what is more, it is done frontally for everybody. The experience of creative activity can only be acquired through the methods of problem presentation, partial search and research and verified by tests of the third level. The creative level of assimilation is reached after the first and the second levels have been overcome.

In this way the system of teaching mathematics at the university “works” through the eyes of didactic scientists. In fact, everything happens differently. No methodical system of teaching mathematics which is functioning at the university guarantees the assimilation of knowledge at a given level. And the levels themselves are not given diagnostically, therefore, they cannot be achieved for fundamental reasons. University education “slips” and graduates do not meet the requirements of the society.

3. Results and discussion of them
Let us carry out a comparative analysis of the elements of the teaching methodology of mathematics in the implementation of the main stages of teaching in face-to-face and distance learning. Acquaintance with the content of mathematical education takes place at lectures, where the teacher sets out the essentials of the theory in a certain logical sequence. The same presentation is also offered in the course of distance learning with the only difference that the teacher cannot monitor the student’s involvement in the educational process every minute, since the latter is out of sight, “off screen”. For the same reason the teacher cannot regulate his speed of presentation, cannot dwell on some details taking into account the composition and preferences of the students. Of course, a student has the opportunity to ask the teacher a question but it takes more time than in face-to-face process of teaching.

In the popular LSM Moodle training system a student has the opportunity not to listen to a teacher’s lecture, but to study it according to the proposed text or to find the necessary information on the Internet himself. A prepared student can test himself using a test that the teacher invented and placed in his e-course. And the students’ knowledge will be assessed according to the tasks, which the teacher invented. Grading will also depend on how the logic of the questions was made and what rating scale he chose. It should be pointed out that a teacher’s subjectivity and the level of his competence in the taught subject rules while informing students about the main statements of the theory of the studied subject. A university lecture carries an informative function. Thus, lectures in distance learning do not significantly improve the quality of education as such an element as “experience of an emotional-value relationship” disappears. Thus, the methodology becomes less effective.

Another element of the educational process at the university is classes in which students acquire knowledge and skills in the practical application of the theory. In face-to-face training a teacher
interprets the methods of solving problems “in the flesh”, responding to the students’ questions, adding or excluding the planned tasks. Working in a distance mode, as when conducting a distance lecture, a teacher sets out ways to solve problems at the pace and in those volumes that he planned without taking into account the individual characteristics of the students. If the teacher’s e-course contains a detailed description of the methods for solving problems, then the student may not be present at the lesson held in a remote mode. In this case a student himself has to understand how to apply the theory. Thus, practical lessons in distance learning also do not improve the educational function of the training system, but give a student a certain degree of freedom in choosing the time and pace of studying the educational material. Practical lessons in distance learning become as informative as lectures, thus, they do not guarantee the achievement of a given level of learning.

The third element of the system of teaching mathematics at the university is control in all its oral and written forms (typical control work, tests, questionnaires, colloquia). In face-to-face education students write classroom written work as independently as possible in front of the teacher who keeps an eye on them. The teacher himself conducts oral polls finding out the degree of preparedness of a student and assessing him in accordance with his ideas about the assessment that he records in the register list.

We analyzed the amount of time that students and teachers spent during the educational process in face-to-face and distance learning. The authors took for the analysis a part of their academic load of an associate professor, PhD and found out that in one academic week in face-to-face teaching they are to give 13 academic hours of classes (4 hours of lectures and 9 hours of practical training) and they spend 0.5 hours on preparation for these classes. In total they spend 19.5 academic hours on scheduled classes. In the course of distance learning, when a standard time of 2 hours was set for preparing 1 hour of classes using distance learning technologies, it was necessary to spend 2 times more time, i.e. 39 hours. In fact, it took 10-12 hours a day to prepare assignments for students, check these assignments and communicate with students. This is also two times more than the standard.

123 students, who were taught by us, were interviewed. We were interested in the answer to the question: “How much time did you spend on studying the disciplines of the course in comparison with face-to-face learning?” The students found it difficult to count with an accuracy of one hour, but in comparison with the previous term, when they studied face-to-face, the opinions of the students divided into two groups. The first group of students, the largest one, which contains 102 people (83% of the respondents), said that it took much more time to complete the teacher’s assignments and study the disciplines of the course than it was before distance learning in face-to-face learning. They had to spend the whole day on the tasks and they got very tired. The second group of 21 people said that it took them less or the same amount of time to prepare and study the disciplines because they reacted to their process of learning without effort or did not study in such a way as they did it before. Thus, both students and teachers assessed the transition to distance learning as more time-consuming and more difficult to complete the tasks.

Analysis of the face-to-face and distance learning of mathematics by the type of activities carried out by teachers and students showed that these activities did not go beyond the traditional ones. But in traditional learning the content of the educational material was brought to the attention of the students regardless of their individual characteristics, without taking into account the individual pace of learning. A specially conducted research showed that students have difficulty in understanding a teacher giving a lecture in mathematics in a traditional form of learning. We found out that only a third of the students who are present at the lesson are in a state “most often understood than did not understand” and “understood throughout the whole lesson” the educational material [7].

It means that the teacher created the traditional open control of the educational process in the scattered information field both in traditional and distance forms of learning. The situation was aggravated by the teacher’s inability to regulate the educational process intuitively, that process, as a rule, is observed during face-to-face training in the classroom. Although the students received assignments from the teacher for the performance of educational activities, these assignments were not individual and the most important thing they had a delayed feedback. Thus, distance learning technologies, which were massively used in teaching students during the period of self-isolation, did not
increase the effectiveness of the educational process and did not improve the result, but, on the contrary, worsened the traditional teaching with all the ensuing consequences.

Our conclusion is conformable with the conclusions of “the main US university publications: Chronicle of Higher Education, Educational Technology, Merlot Journal, etc.”, in which “it is recognized that CL (computer learning) is not better than face-to-face” education, but it is more expensive and more difficult” [8]. “The most important factors, according to the respondents, are “lack of money” and “insufficient competence of CL instructors” [ibid.]. This conclusion was made because the traditional training system didn’t change at all with the appearance of distance learning conducted via computers. So illusions about the formation of competencies during the training period remain illusions.

4. Conclusion

In this article we analyzed the methodology of teaching mathematics in higher education, including in the university where the authors work. The object of the analysis was the traditional education system, which has developed over the years of teaching practice, and the electronic form of education using computer technology during the COVID-19 pandemic when all universities suddenly were transferred to distance learning. We took the composition, structure and functions of the methods of teaching mathematics at the university as the basis for the analysis. According to this methodology it was possible to establish the correspondence of the elements which are presented in the traditional education and distance learning. In the course of the research we established the similarities and differences between these elements.

As a result of the comparison it was found out that distance learning technologies have the same composition of teaching methodology (teaching methods, level of assimilation, type of educational situation, feedback) and the same functions that do not improve the quality of teaching. A computer still plays the role of an aid in the course of “manual” control of the educational process entrusting a teacher with all the same functions of creating a scattered information process with delayed feedback. At the same time it was recorded that a very important element of the content of education – emotional-value relationships that can be transmitted through direct contact between a teacher and a student – disappears from the methodological system or becomes uselessly small.

Thus, in the course of distance learning nothing that would improve the educational process or make it more effective did not happen. On the contrary, during the distance learning the work of a student and a teacher has become more intense, lengthy and ineffective.

The use of computer technology in teaching is a process that cannot be stopped. Therefore, it is necessary to make it go in the right direction. This direction should be the construction of a training system based on the principles of cyberpedagogy. Principles such as the principle of completeness of training, the principle of non-delayed feedback, the principle of closed control of the educational process, the principle of directed information flow, the principle of diagnostics of goal formation should form the basis of a new methodology for teaching mathematics that meets modern requirements of the time.

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