

Digital medicine education problems and online solutions

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Key words: education, digitalization, bioinformatics, databases, e-Health

Motivation and Aim: Education in medicine base on modern internet-technologies is a priority for contemporary organization of medical care. Distant education in recent years raised series of problems in the materials availability, access by the students. The epidemic situation of the last two years has only accelerated the adoption of measures for remote organization of medical consultations; these problems have been discussed both at the RAS and at events held at Sechenov University in Moscow, at scientific and educational conferences [1]. Bioinformatics as a modern scientific discipline meets more and more applications in biology, medicine, requires re-training of the specialists. Of special interest is the computerization and automation of teaching informatics-related disciplines, including medicine – in the areas of telemedicine, e-Health [2, 3].

Methods and Algorithms: The issue of developing bioinformatics courses is related to the adaptation of the training to the educational profile of students and trainees [4]. Thus, according to the experience of the work of teaching bioinformatics students – mathematicians require not only a different presentation of the materials, but also the methodology itself, in contrast to students in medical and natural students who do not have enough skills in computer science, programming, and writing their own code. The assessment of students' skills is given on the basis of personal teaching experience in Novosibirsk State University for biologists of the Natural Sciences Department, for students of pharmacy specialization "Bioengineering and bioinformatics" at Sechenov University, and at PFUR (Peoples' Friendship University of Russia), as well as for the students of the Financial University under the Government of Russian Federation in Moscow.

The situation with the frequent transition to distance learning in Russia from 2020 required the development of new methods of teaching, with the possibility for students to use Internet resources and do independent work without access to a stationary computer class, in remote mode. The authors proposed a training course on basics bioinformatics, the use of elements of which began at Novosibirsk State University in the early 2000s (<http://lcg.nsu.ru/ru/home-2/>), then was adapted for students at Sechenov University in Moscow (<https://student.sechenov.ru/>), and later, since 2021, at the Agrarian and Technological Institute of PFUR (<https://www.rudn.ru/education/schools-and-departments/institutions/agricultural-technology-institute>) [5].

Results: The bioinformatics course was read for students at Sechenov University in Moscow; it was presented online only on the university's internal website (<https://student.sechenov.ru/>). Let us note a number of qualitatively new educational

tasks in the field of digital health, such as the use of blockchain technologies, the use of Artificial Intelligence (AI) methods in supporting medical decision-making [2, 3, 6].

There is great interest in the development of such a bioinformatics course from a number of universities in Russia. For replication, video tutorials need to be recorded and examples of scientific problems to be adapted to different directions. A project has been formed which was used in applying for grants to the Russian Science Foundation and the Potanin Foundation (<https://zayavka.fondpotanin.ru/ru/>). The concept of the proposed educational course includes a theoretical part (listening to the course in the form of lectures, video lessons) and a practical part – performing tasks on the use of computer programs and databases, to solve practical tasks, in written form, which are evaluated by the teacher and can be of independent value as reference scientific papers. Course content includes the fundamentals of bioinformatics databases, online tools, and web services for medical consultations. Successful examples of published students work are presented [5, 6].

Conclusion: Overall, the goal of the project is to teach digital specialties, bioinformatics in medicine using online and hybrid approaches. As already noted, the issue of developing bioinformatics courses is related to the need to adapt training depending on the educational profile of the trainees. The transition to distance learning requires the development of new methods of teaching, with the ability of students to perform independent work using only Internet resources, which in turn meets a number of challenges due to limited access to a number of online services in Russia (for example, data storage in Google cloud storages) [7].

Acknowledgements: The study is supported by the Potanin Foundation grant for masters' teachers (ГК22-000797).

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