

# Innovative Approaches in Higher Education on the Example of the Course «Engineering Mechanics»

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**Abstract.** The article discusses the use of modern digital technologies in engineering education on the example of the online course "Engineering Mechanics". The course is hosted on the National Open Education Platform, and the Engineering Mechanics online course in 2016 was the first Ural Federal University online course hosted at the international MOOC site. The course consists of original digital content: lecture notes, training assignment base (simulators), test and homework assignments, practical examples and demonstration video materials and other educational materials allowing one of the most demanded disciplines in the training of technical specialists to significantly improve the quality of training, reduce costs, increase the motivation of students and use teachers' work more efficiently.

**Keywords:** online course, MOOC platform, e-learning, open education, higher education, network form of education, digital technology, engineering education, digitalization of education

## 1 Introduction

Theoretical mechanics is a fundamental and basic discipline in engineering education.

The traditional approach to teaching theoretical mechanics in Russian technical universities, established in the 20th century, has not changed much. The methodological work is mainly aimed at the replication of overly formalized examples that are far from real practical problems.

Focusing on the engineering content of educational material and modern digital technologies [1] is the way that the authors chose creating a new digital educational content with the expectation of its widespread use in the higher education system of Russia in various forms of organization of the educational process [2].

## 2 Statement of the problem and the method of solving it

The online course "Engineering mechanics" 180 hours (5 credits) lasting 18 weeks in Russian, created in 2015 and placed on the National platform of open education, is

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aimed at radical modernization and significant increase in the efficiency of the educational process in technical universities of the Russian Federation in the discipline of theoretical mechanics[3,4].

The novelty of the work lies in the author's methodical ensuring educational process in the discipline of theoretical mechanics in the form of cognitive-applied block lecture examples and tutorial, as well as activities designed to examples of real machines, mechanisms and structures, and the sequences of technological processes and natural phenomena.

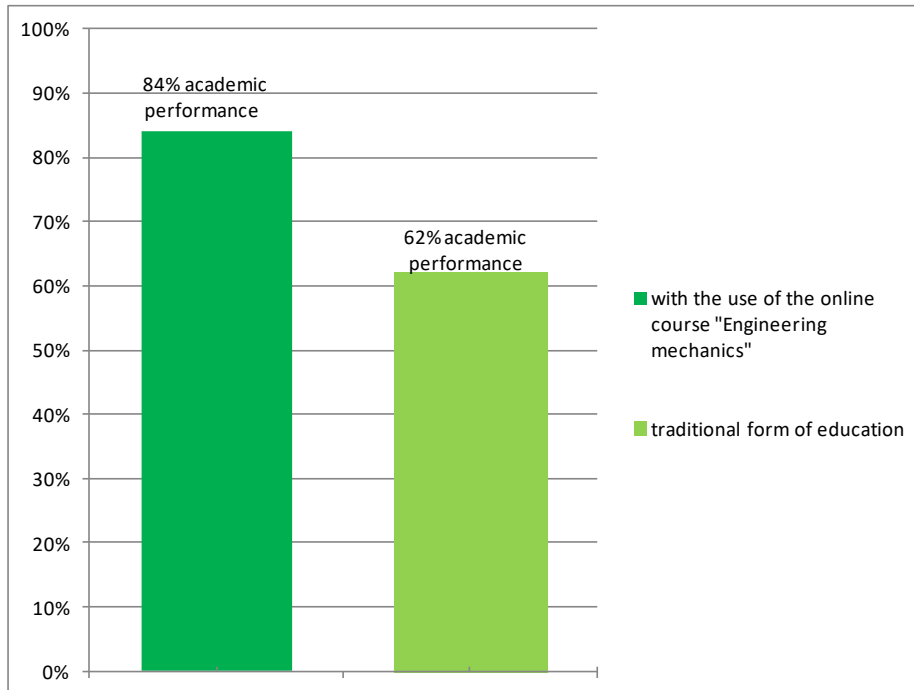
The innovative approach is based on the maximum use of digital technologies [5], allowing to include examples of engineering tasks in the form of sketches and photographs of machines, mechanisms and structures, as well as video clips of technological processes and natural phenomena. This approach supplemented the traditional material with cognitive and applied block. The presence of this unit focuses the attention of students on the real processes and phenomena of the world around us in their mathematical modeling with a clear understanding of the practice-oriented formulation of the problem.

Without violating the traditional unity of the form and content of training, additional cognitive-applied block allows, starting from basic training, to include the student in a motivated active creative cognitive process. At the same time, students acquire skills of independent work on obtaining knowledge using various forms of information: traditional educational literature, electronic textbooks, Internet resources, mutual consultations and consultations of teachers [6].

The online course "Engineering mechanics" is in the public domain. Educational materials fully reflect the content of the traditional course on theoretical mechanics, while the presence of cognitive-applied block significantly increases the motivation and interest of students to cognitive activity. It provides increase of progress at development of the required competences, promotes development of engineering skills in modeling of technical objects and processes and carrying out calculations with the required degree of accuracy.

### **3 Results**

To assess the effectiveness of the developed course in 2015 – 2016, a comparative study of the performance of Ural Federal University students was conducted. Figure 1 shows the comparative performance of the traditional form and using the online course "Engineering mechanics". 648 students took part in the study.



**Fig. 1.** Comparative academic performance of students of internal form of training of the Ural Federal University in theoretical mechanics.

The results of the study showed an increase in academic performance by 22 % using a digital educational resource. This indicator practically does not change from year to year at the subsequent application of the digital educational complex.

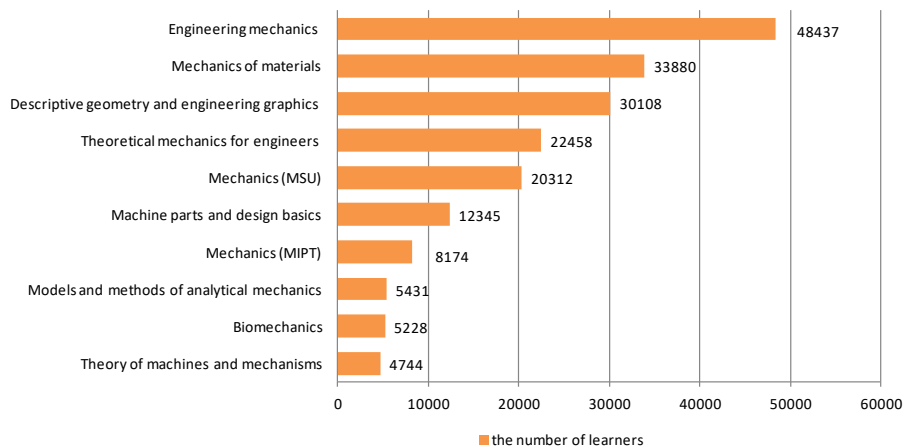
The following forms of use of educational and methodical developments are possible: multimedia support in the traditional full-time form of training, mixed form, online training with Advisory support [6]. At the same time, the means of diagnosing the success of the listener is the test database of control tasks, which has become a digital resource for automatic weekly and independent final control of an almost unlimited number of listeners.

The priority project in the field of education "Modern digital educational environment in the Russian Federation" was approved by the Government of the Russian Federation on October 25, 2016 within the framework of the state program "development of education" for 2013-2020. The aim of the project is to create by 2018 conditions for systematic improvement of the quality and expansion of opportunities for continuing education for all categories of citizens through the development of the Russian digital educational space.

The online course "Engineering mechanics", based on the assessments indicated by experts and students, in 2016 was exhibited in the "single window" format on the portal "unified digital educational environment" within the framework of the priority project

"Modern digital educational environment of the Russian Federation", where 113 universities placed 1063 courses from 37 platforms.

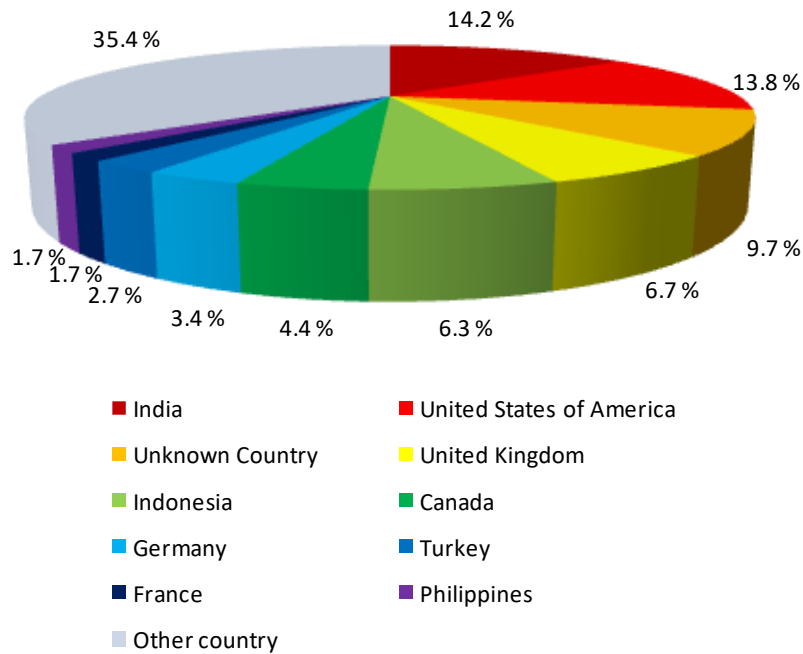
According to the portal "unified digital educational environment" 48437 students of the course "Engineering mechanics" significantly exceeds the number of students in other online courses of basic engineering training (Fig. 2).



**Fig. 2.** The number of students in basic engineering training courses placed in a single window of a single digital educational environment.

The online course "Engineering mechanics" in 2016 became the first Ural Federal University course placed on the international platform edx.org. In total, 4 universities of the country and 26 courses are represented on this platform. The presence in the modern international market of educational services contributes to the implementation of the tasks of the national Project 5-100. Statistics provided by the platform edx.org demonstrated the widest coverage of students of the online course "Engineering mechanics". The total number of international students over four years is 17,819 from 155 countries.

The percentage of countries launching the online course in 2019 is shown in Figure 3.



**Fig. 3.** Geographical coverage of the online course "Engineering mechanics" according to the platform edx.org, 2019 launch.

The main result of the work is a radical change in the content and form of presentation of traditional material on mechanics. The unity of a bright visual image, a strict mathematical model and rational solution of examples and problems is a new approach for achieving high learning outcomes for students.

The course is widely tested on the territory of the Russian Federation and abroad. The educational resource was used by more than 50 thousand students around the world. Ural Federal University has used it since 2015, since 2016 it is actively used by network technologies in Russian universities, in 2016 it entered the International educational platform. The possibility of such coverage of students and systematic support by the authors of the educational resource demonstrates the unprecedented effectiveness of digital educational technologies without losing the quality of training and the preservation of the contingent.

The online course "Engineering mechanics" took the first place in the nomination "Best practice of creating open online courses" at the fourth international competition of open online courses "EdCrunch Award OOC 2018".

## 4 Conclusion

Currently, there are no analogues of the course both in Russia and abroad, either in terms of the number of students or the set of author's solutions that allow the most effective use of all the possibilities of modern educational platforms.

Online course "Engineering mechanics" allows one of the most popular disciplines in the training of technical specialists to significantly improve the quality of training, reduce costs, increase motivation of students and more effectively use the work of teachers.

## References

1. Lapshina S.N., Romanovskaia E.M. The relevance of the use of electronic educational resources in professional education. In: Simos TE, Tsitouras C. (eds), International Conference on Numerical Analysis and Applied Mathematics, ICNAAM 2018, vol.2116 American Institute of Physics Inc. 2019. doi: 10.1063/1.5114441.
2. Larionova V., Tretyakov V. (2016) Otkrytye onlayn-kursy kak instrument modern-izatsii obrazovatelnoy deyatelnosti v vuse [Open Online Courses as a Tool for Modernization of Educational Process in Universities. Higher Education in Russia, no 7, pp.55–66.
3. Tretyakov V, Larionova V, Bystrova T. Developing the concept of Russian open education platform. In Proceedings of the 15th European Conference on e-Learning, ECEL 2016. Vol. 2016-January. Academic Conferences and Publishing International Limited. 2016. p. 794-797.
4. Semenova T., Vilkovala K., Shcheglova I. (2018) Rynok MOOK: perspektivy dlya Rossii [The MOOC Market: Prospects for Russia]. Voprosy obrazovaniya / Educational Studies Moscow, no 2, pp. 173–197. doi: 10.17323/1814-9545-2018-2-173-197
5. Shangina E.I, Ilysheva N.N, Shangin G.A, Lapshina S.N, Parusheva S.S. Model of mobile learning and its application in the educational process. B International Conference of Numerical Analysis and Applied Mathematics, ICNAAM 2017, vol. 1978. American Institute of Physics Inc. 2018. doi: 10.1063/1.5044046.
6. Larionova V, Semenova T, Bystrova T, Tretyakov V. MODELS OF USING MOOCS IN HIGHER EDUCATION: ORGANIZATION AND FINANCE ASPECTS. B Chova LG, Martinez AL, Torres IC, редакторы, 12TH INTERNATIONAL TECHNOLOGY, EDUCATION AND DEVELOPMENT CONFERENCE (INTED). International Academy of Technology, Education and Development. 2018. pp. 9223-9229. (INTED Proceedings).