# NSP "ICTINSES" – ACHIEVED RESULTS FROM THE FMI TEAM AT PU. II

## Todorka Terzieva, Angel Golev, Asen Rahnev

**Abstract.** *This article presents summarized results from the implementation of scientific tasks within the NSP "ICTINSES" by the FMI team at Plovdiv University. The implemented activities in two of the main components are indicated – Electronic infrastructure for open science and Digital technologies in teaching and learning. Under the second component, the emphasis is on scientific tasks in several areas: creation of publicly available educational resources; modern means for digitalization in education and work with young talents; augmented virtual reality in learning and three-dimensional models for illustrating learning content. Training of students was conducted in the established Laboratory for 3D modeling, more than 10 experimental 3D models for training and qualification of students and teachers were developed.*

**Key words:** NSP ICTINSES, distributed computing, computer and mathematical modeling, digital technologies in teaching and learning.

## 1. Introduction

The National Science Program "Information and Communication Technologies for Unified Digital Market in Science, Education and Security" (NSP "ICTinSES") includes three main areas in which related activities are allocated. Its scope allows effective implementation of the objectives and overall improvement of the e-infrastructure for open science, the application of digital technologies in education and information security [20].

Faculty of Mathematics and Informatics at "Paisii Hilendarski" Plovdiv University participates in scientific tasks as a partner within the NSP "ICTinSES". The implemented activities in two of the main components are indicated – Electronic infrastructure for open science and Digital technologies in teaching and learning [21]. The team of PU consists of 26 highly qualified lecturers, 9 of them are young scientists and doctoral students. Publication [5] presents the results obtained in the first year of the

ICTinSES project (23.11.2018 – 30.11.2019). This article aims to present the implementation of the main activities, research tasks, as well as the achievement of the most important results and indicators set in the program in the second year (01.12.2019 – 30.11.2020) of NNP "ICTinSES" by FMI. Scientists from the University of Plovdiv have published 22 scientific articles in specialized journals and proceedings of international conferences. As a result of the work of FMI team in the first scientific component, 4 monographs have been published, 3 of which have been published abroad [7, 11, 13, 15]. Of all publications in the second year – 10 were referred to the Web of Science and/or Scopus (SJR), 7 papers were presented at international conferences. Detailed information for servicing the activities and reflecting the results of the scientific team of PU can be found on the specially created website [21].

## 2. Electronic infrastructure for open science and open access to scientific results

Within this component of the Program, the team of PU participates in two scientific tasks: High-performance and distributed calculations and Computer and mathematical modeling with application in engineering and natural sciences. The results obtained for the second year of the program can be summarized in the following activities:

- A number of new logistics models with the so-called "polynomial variable transfer" have been studied. In addition to the in-depth theoretical apparatus related to the study of approximation properties of adaptive models, special attention is paid to their intrinsic structure and the possibility of approximating specific data from the spread of the COVID-19 epidemic worldwide. Particular attention is paid to the proposed model for data analysis (prevalence and mortality) for Bulgaria. These forecasts differ minimally from the actual data on the spread of the disease until the period of elimination of the quarantine period for Bulgaria [8, 13];

- Continuation of research related to conducting sensitive analysis on emerging models of "growth" and imposing the proposed by team members modern methodology for assessing the right to exist in the approximation of specific data in the field of Debugging and Test Theory and Computer Viruses Propagation Theory [6, 9, 10, 11];

- In a monograph [7] Prof. Kyurkchiev considers some general-

izations of existing reaction-kinetic schemes and the models of "growth" generated by them. The non-standard dynamic models proposed by the author are analyzed with databases established in practice. The right of existence of some of these models in approximation in the scientific fields is shown: Debugging and Test Theory, Computer Viruses Propagation Theory, Biostatistics. Particular attention is paid to the modification of growth models with polynomial transfer and the possibility of approximating data from the field of "Corona Virus";

- The monograph [15] is a continuation of several other monographs and is devoted to the latest trends in modeling in Debugging theory and their application. A Hausdorff metric was chosen to evaluate the test data, which are modeled with sigmoidal and other cumulative functions. All considered models are tested with real data;

- In paper [14], we study intrinsic properties of some models of growth with polynomial variable transfer that give a very good approximation of the specific data on the pandemics in Cuba by June 5, 2020. The proposed approximation of these data gives an extremely good coincidence with the real picture of the disease. Foreign experts working in this field have shown interest in this article. The models have the right to exist in the treatment of issues from different fields of scientific knowledge;

- The published book (Part IV) [11] is a continuation of the author's research on the topic: "Debugging and Test Theory". New models appearing in the literature (in the last 2 years) for approximation of "failure data" from a test of software products and platforms are considered. At the same time, a number of new non-trivial specialized models for approximating data in this direction have been proposed. Comparisons are made in the application of existing and new models for analysis of a number of "datasets";

- In [18] are considered various modifications of the famous Suja Distribution. Relevant cumulative analogues have been shown to be well used in various fields in the study of the spread of computer viruses. The article (Part VII) is a natural continuation of the authors' research in this area.

Within this scientific field of the national program, 14 scientific articles have been published in international journals.

## 3.  Digital technologies in teaching and learning

Within this component of the Program, the scientific tasks of the team are in several areas: creation of publicly available educational resources; modern means for digitalization in education and work with young talents. The research of the FMI team is focused on the development of modern educational technologies, game-based learning, creation of electronic educational resources with augmented virtual reality and three-dimensional models (real and virtual) to illustrate educational content. The main goal of the team of Plovdiv University is to create conditions for the implementation of innovative ways to organize and conduct educational processes and develop publicly available educational resources. The obtained results are in several directions:

- In article [17] we present the results of a study on the types of adaptive systems depending on the technological tools and methodological approaches for implementing adaptability and personalization in learning. Special attention is paid to the applied technologies in the development and delivery of adaptive learning content as well as to the ways of modeling an individual learning path;

- In [16] are studied and analyzed some of the most commonly used digital educational platforms in the Bulgarian school. The environments are presented in terms of the opportunities they offer in the educational process: usage of ready-made learning content or to create your own, possibility for assessment and self-assessment, feedback for the achievements of the students, an interface in Bulgarian, focus on a specific subject or offering of tools for creating and/or using teaching materials, regardless of the subject area;

- In [2] are present the results of online anonymous survey among 68 teachers from the city of Plovdiv who work in an innovative school approved by the Ministry of Education and Science. The subject of the research are professional experience, used resources, technologies, methods and pedagogical approaches during distance learning, the achieved efficiency, etc. This study shows what are the teachers' attitudes and practices in the use of ICT in the Bulgarian school during training in a digital environment. Both advantages and some disadvantages are taken into account when the conducted training is only in distance form;

- The use of computer and information technology facilitates adaptation to specific individual needs. In [1] we research and represent how using computer technologies and 3D printers can facilitate the Music education for children with severely limited sight. We demonstrate a form of a circle of fifths, suitable for transliteration into Braille. A 3D model of the circle of fifths in Braille is designed. The developed topics provoke interest to carry out similar developments in other areas, not only in music education;

- The work [19] is dedicated to the idea of realization of reflection during distance learning of information technologies by setting tasks for stimulating the reflective abilities of students. The aim is to provide an opportunity to be more active in this country during school hours, such as the following "learning by doing" models. The article describes the essence of reflection and the cycle of David Kolb, which can be realized. A specific assignment is described, which must be developed by the learners using cloud technologies, based on the teamwork conditions and the D. Kolb cycle. The realization was carried out during a distance learning with a group of 7th grade students;

- Educational learning materials have been developed and integrated into the distributed platform DisPeL;

- Continuation of the work for creating augmented virtual reality and three-dimensional models (real and virtual) to illustrate educational material;

- A new curriculum has been developed for training students in an elective course with the following name: "Digital technologies in education". It is intended for students with a Bachelor's degree, professional field 4.6. Informatics and Computer Science, specialty "Informatics", "Software Technologies and Design", "Software Engineering", "Business Information Technologies" and professional field 1.3. Pedagogy of teaching ..., specialty "Mathematics, Informatics and IT", "Information Technology, Mathematics and Educational Management" and Master's degree specialty "Training in Informatics and Information Technology at School" [21];

- In the autumn of 2020 starts training of 32 students in the new curriculum for elective course "Digital technologies in education", developed under the ICTinSES project [22];

- Conducting training of students in the 3D Modeling Laboratory created with the financial support of the project;

- Over 10 experimental 3D models for training and qualification of students and teachers have been developed [23];

- A seminar "Modern tools for digitalization in education" was held with the participation of young scientists and PhD students, within Anniversary International Scientific Conference "Synergetics and Reflection in Mathematics Education", 2020, Pamporovo, Bulgaria [21].
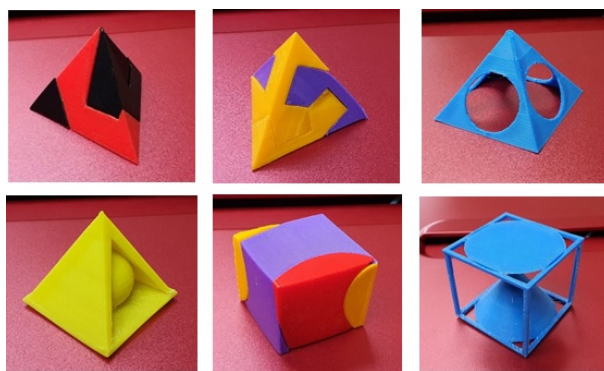


*Figure 1. Developed 3D models*

Within this scientific field of the national program, 8 scientific articles have been published and 6 reports were presented at the international scientific conference Anniversary International Scientific Conference "Synergetics and Reflection in Mathematics Education" [24].

**Acknowledgments**

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