Software for Interactive Lectures on the Theory of Probability and Mathematical Statistics

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Abstract— **In this article proposed an interactive approach to the lectures on the theory of probability and mathematical statistics using software and mobile technologies. The approach is presented to how it is possible to involve the entire group of students in the lecture in the collection of data and modeling of the queuing system. The mobile application for student gadgets is shown that allows to interact and manage the simulated system. The work of the macro for Excel, which collects data, calculates and visualizes the results, is shown. Here also presented a program for interactive modeling of a queuing system during lectures.**

Keywords- mobile technologies in education, smartphone, smartphone application, macro, theory of probability, queuing system, modeling, interactive approach

I. INTRODUCTION

Lecture is a logically harmonious and consistent presentation of the material, which, as a rule, has a pronounced theoretical character. This form of education is one of the main part in the educational process in universities. However, lectures in their traditional form are now increasingly questioned about the high level of their effectiveness. The following shortcomings of the classical form of the lecture are noted:

- different degree of involvement of students in the course of the narrative;

- lack of feedback;

- passivity of training, as a result of which the passed material is quickly forgotten;

- the lack of development of students' craving for independent work, etc.

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At present, the traditional passive form of conducting lectures is replaced by another - interactive. Interactive lecture is a form of learning that involves the continuous interaction of participants in the process under the supervision of the teacher. In particular, in the process of communication, students learn to think critically, analyze the situation, acquire communicative skills. In addition, the participants of the lesson have the opportunity to ask the question they are interested in and receive a response directly to the lesson, which significantly intensifies the process of learning the material.

Today mobile phones, smartphones and some other gadgets are the most available technologies with wide possibilities for students. These opportunities can be used to make a full-time education process more effective and interesting [1].

Latest surveys results of pupils and their parents have shown that self-study educational topics modern students prefer both in classical textbooks and on the Internet, social networks, using mobile apps and tablets (Edutainme.ru). In the middle grades the percentage of students who prefer to use the mobile application or tablet was almost 11% of all students and 27% of the number of students who prefer classical textbooks. In high school these percentages have changed to 27% and 57% accordingly. The results of the parents' survey have showed that almost 50% of them believe that the electronic textbook should be a mobile application.

The results of these surveys show the relevance of the use of mobile applications to support the learning process for increasing the efficiency of the study material and to increasing the interest to the studied subject and its prestige in the student's eyes.

There are the categories of mobile learning [2]:

• technological mobile learning – some specific technological innovations are in academic environment to demonstrate technical feasibility and pedagogical opportunities [3];

• miniature, portable electronic learning (e-learning) - the use of mobile, wireless and portable technologies for playback approaches used in conventional e-learning tools;

• learning related to audience – technologies are in use in classroom to support cooperative learning (for example, interactive boards); informal, personalized, situational mobile learning [4];

- remote/rural/developing mobile learning – technologies are in use to solve the environmental and infrastructure problems.

In general, organizational, exploration and methodological work on the development and implement of the new strategies, forms and methods of education is required for use of new mobile learning opportunities in the learning process and improve its efficiency [2].

II. THE PRINCIPLE OF THE DEVELOPMENT DIRECTIONS OF MOBILE TECHNOLOGY USE IN THE EDUCATIONAL PROCESS

Due to the fact that modern smartphones or tablets have a wide range of functionalities, they can replace a personal computer and can be used not only as e-books, but also as interactive tools that enable to provide interaction between the teacher and students. This interaction can be organized not only during practical classes and laboratory works, but also in lecture halls where there is only one teacher computer and connected projector.

Almost in all Universities (technical, medical, educational, economic) in various disciplines theory of probability is studied as well as mathematical statistics and basics of mathematical modeling. Modern specialist must be able to process data obtained during the performing of the experiment, market analysis, etc.

There is software of GPSS World, AnyLogic, etc that don't allow you to interactively perform modeling of systems with the direct participation of a group of students. This software do not include applications for mobile phones (smartphones, tablets) which can increase study efficiency of the theory of modeling and mathematical statistics.

The aim of this work is to develop a software complex consisting of a server application for personal computer and client application for mobile devices designed to support the process of learning the basics of the theory of probability, mathematical statistics and modeling.

Using the developed software complex should improve the quality of teaching and learning principles of queuing systems functioning and determination of basic probability concepts through visualization, interactivity and independent control of the operation of the simulated system by a group of students in the classroom during studying of the relevant theory.

III. EXISTING MOBILE APPLICATIONS TO SUPPORT THE LEARNING PROCESS

Now existing mobile applications to support the learning process may be divided into the following groups [4]:

1. mobile applications to support the educational process and educational communication. These apps allow for student to learn the schedule, news and university's organizational events [6];

2. applications for playback of multimedia educational Web resources (audios, videos, podcasts, graphics, maps, pictures) [7];

3. applications for fast access to educational sites, resources, reference books, dictionaries [8];

4. applications as an actual learning tool provided the development of training materials adapted for mobile platforms (tests, tutorials and instructions on the mobile apps) [9, 10].

For example there are next mobile applications.

The application called "UrFu Student" is developed for students of the Ural Federal University. It is designed to track changes in the schedule and adding educational materials [http://digit.ru/internet/20131009/406486059.html].

The app «Frog Dissection» allows performing of 3D-dissection of the frog which resembles a real preparation. The program contains detailed instructions for conducting the experiment, anatomical comparison of frogs and humans and the whole set of necessary tools that are displayed at the top of the screen: scalpel, tweezers, safety pin, etc. In addition the app allows you to study in detail each dissected organ [http://newtonew.com/blog/posts/223].

The app «Human Anatomy Atlas» is a fully interactive 3D anatomical atlas that allows you to interactively and visually explore the human body. Feature of the program is the presence of high-grade models both male and female anatomy, each of which contains about 2,500 anatomical structures [http://android-soft.org/programs/health-fitness/605-human-anatomy-atlas.html].

The application «LinguaLeo» is designed for interactive adaptive English language learning. It determines prior to the training what the user already knows and what he will have to study, also it generates individual recommendations for training depending on the skills, goals and interests. The app provides access to movies, books, TV shows and music from the rich collection of materials prepared by professionals and other users [http://lingualeo.com/ru/#pass-test].

Applications «Higher Mathematics» [play.google.com/store/apps/details?id=com.mathhelper.math] and «Statistics» [play.google.com/store/apps/details?id=ru.studiomobile.questions.statistika] contains the basic theory of higher mathematics and mathematical statistics and allow us to study the basic principles and concepts of these theories in the form of handbook.

IV. DEVELOPED SOFTWARE COMPLEX FOR INTERACTIVE LEARNING USING MOBILE TECHNOLOGIES

The purpose of the developed software complex is to support the process of learning the basics of the theories of mathematical statistics and modeling, especially in lecture halls where there is a projector connected to the computer.

Developed software complex consist of two parts:

1) the mobile application that is installed on smartphones or tablets to students. The application is designed to collect data for further statistical processing and transaction management in the queuing system;

2) Excel file which contains a macro in Visual Basic for Application is located at the teacher's computer. The macro allows the processing of collected data and its visualization, also modeling and visualization of queuing systems.

The reason for using this development is to improve the students' participation in the functioning of the modeling system, data and random variables receiving to estimate the parameters of the system functioning. In this way you can clearly see how the queuing system functions, how the probability is calculated, as well as mathematical expectation, dispersion, performance indicators of the simulated system.

Using of a software complex is directed to the student's opportunity to see how system works almost in every moment of time and be one of its parts. View the mobile application on the screen of the smartphone is shown in Fig. 1.

The application can work in two modes:

1) voting mode when the numerical values that depend on the keystrokes are sent to the server. This mode can be used to collect data and study the main concepts of probability and mathematical statistics. Information is stored on the server as an array of values of all votes;

2) mode of queuing system modeling when keys "The entrance of the requirement into the system", "The entrance to the service channel", "First service session" are used to control the transact. Numerical values in this mode are used to set the duration of transact service in the system.

V. STUDY OF BASIC PROBABILITY CONCEPTS AND MATHEMATICAL STATISTICS

Students must perform a task (experience, experiment) which result should be a random variable. In the simplest case may be asked to evaluate any multimedia object (movie clip, graphic) on the fixed scale.

1. In voting mode students assign grades to the multimedia object using the mobile app. The application sends the voting results to the server where the values are written to the array.

2. After the vote the teacher runs the appropriate macro on your PC, there are reference to the server and data downloading. It is possible to work with these data further. For example to determine the frequency or probability of occurrence results. Construct the corresponding histogram.

Thus, visualization and illustration of the definitions of the histogram, frequency, probability, distribution law, the probability distribution function, probability density function, mathematical expectation, variance and standard deviation is occured. Fig. 2 shows the results, which are automatically generated by Excel macros, based on students' voting with the mobile app.
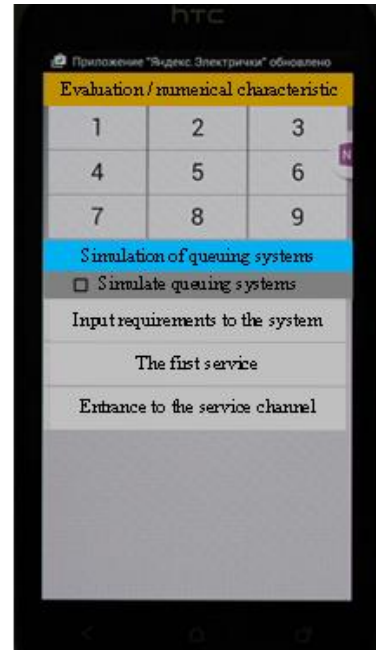

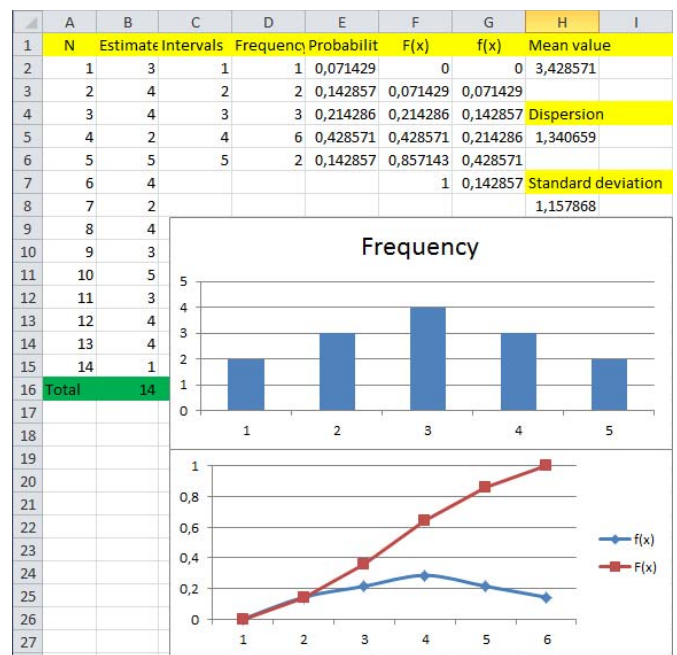Figure 1. View of mobile applications on the smartphone screen

Figure 2. Data collection and analysis in Excel using a macro in VBA

VI. QUEUING SYSTEM SIMULATION

1. The task of studying the principles of queuing system functioning and calculation of that system's basic functioning indicators by example of passing the documents to the departments of public services, businesses, the seller-buyer systems.

2. Check the box "Queuing system modeling" in a mobile application. The conditions of the experiment are

negotiated, in particular, the formation principles of the requests arrival time and the duration of their service.

3. Students independently of each other perform "The entrance of the requirement into the system" on their mobile devices and point the duration of the service. The emergence of transacts in the system is displayed by color change of cells in the entrance requirement area at some point of time. Clicking on the "The entrance to the service channel" makes a transition to the painting over of cells in the area of service channel and queue. At the end of the service there is the requirement exit from the system and painting the last area of the worksheet in Excel in accordance with the specified service time.

4. The teacher in each moment of time is able to clarify and describe the state of the system. Also he able to illustrate its dynamics' change after new transactions (Fig. 3).
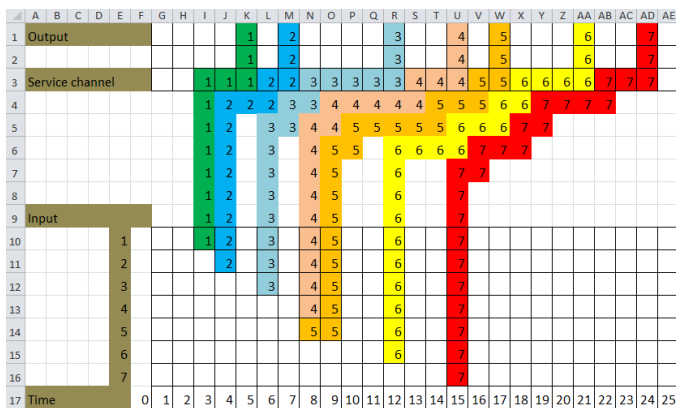

Figure 3.   The results of queuing system simulation

5. The calculation and visualization of the main probabilistic and statistical characteristics of this queuing system:

➤   The average service time per user:

$$\overline{t}^{0} = 1/\mu \, ,$$

where μ is the service intensity;

➤   The average length of service queue:

$$\overline{r} = \sum_{l=1}^{r} l p_l \, ,$$

where p_l is the probability that there are l users in the queue;

➤   The average length of queue is mathematically related to the average time of user wait to service $\overline{\tau}^{w}$:

$$\overline{r} = \overline{\tau}^{w} \lambda \, ,$$

where λ is the intensity of users entering in the system;

➤   The load factor of the i-th service channel:

$$\overline{k}_{i} = p_{i} \, ,$$

where p_i is the probability of the occupied state of the service channel.

CONCLUSION

The proposed learning approach was tested with students who study "Processes modeling of the product life cycle" course in the Ryazan State Radio Engineering University. The result of testing revealed a greater students interest to study elements of the course using the developed applications and an increase of 30% learning effectiveness compared with the control group who learning by traditional methods.

Advantages of this approach:

1)   the entire group of students participated in the modeling of the system (for example, a single-channel queuing system);

2)   visualization of the modeled system throughout the modeling time;

3)   conducting studies in the lecture hall where there is only a teacher computer. It does not require special software.

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