

Mathematical education and communication environments of information society

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Abstract — The article is devoted to the discussion of new features of mathematical education in modern society, the prospects for the introduction of information society services in the field of education. The aim of the work is to substantiate the impact of the level of development of information and communication technologies in the country on the level of mathematical education, analysis and assessment of the impact of alternative (non-formal) communication information environments to improve education.

The researchers study the problem of the influence of computer technologies on perception of Mathematics topics and improving Math skills. The random sample is consisted of 65 students from Saint Petersburg State University of Architecture and Civil Engineering. Experimental results demonstrate the significant improvement of student's modelling skills by the help of computerized virtual cases.

Based on the findings it is possible to draw conclusion about significant influence of computer technologies on Math perception. Using computer programs, which involve a large number of users interacting in the field of educational problems, provides the improvement the state of mathematics education. The authors used mathematical methods, official data and experimental results.

Keywords — mathematical education, information network society, online-resource.

I. INTRODUCTION

The Internet communication has become an essential part of our life. We can use the Internet applications for decision many problems and working from many different entry points.

Mathematical education is the basis for training students in many technical areas.

The study of this discipline provides students with a variety of tools for the analysis of quantitative dependencies, construction of mathematical models for the management of production and economic processes and forecasting the results of various scenarios for solving professional problems.

The specificity of the modern state of mathematics teaching is connected with the fact that there are wide possibilities of using information communications for teaching this discipline.

In this regard, it is necessary to analyze the impact of the level of information and communication technologies in the country and the level of mathematical education, to assess promising areas of use of opportunities for information and

communication interaction on the Internet for effective learning and self-education in mathematics.

The authors of this article used official data of The Global Information Technology Report 2016 (www3.webforum.org). We try to substantiate the impact of the high level of development of information and communication technologies in the country on the growth of the level of mathematical education, reveal various possibilities of using Internet resources for teaching mathematics, solutions problems of increasing motivation and reducing anxiety in teaching mathematics, the problem of giving the course of mathematics the latest mathematical achievements.

Currently, scientists pay great attention to various aspects of the development of communication in social and technical systems, the development of technologies for teaching mathematics, solving problems of mathematical education [1-46].

The authors identify the main problems and complex key points in the modern society and mathematical education; offer their solution through the using of Internet resources and Internet communications (Fig.1).

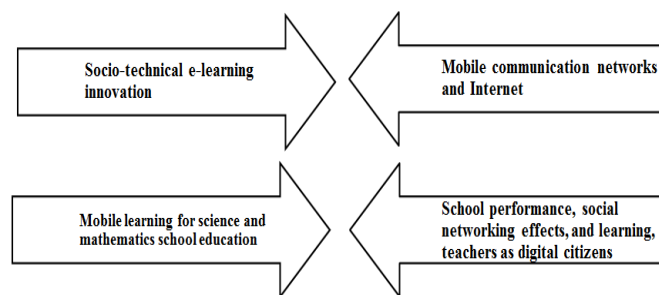


Fig.1 The main problems and complex key points in the modern society and mathematical education/

The aim of the work is to substantiate the impact of the level of development of information and communication technologies in the country on the level of mathematical education, analysis and evaluation of the impact of alternative (informal) communication information environments to improve the efficiency of education.

II. METHODOLOGY

We decided to analyse relationship between the Quality of math & science education and ICT indicators by the Spearman

Rank Correlation methods in order to find out the strength and direction of the relation between the ranks.

The Spearman's Correlation Coefficient is a nonparametric measure. It is used to find out the strength and direction of the association between two ranked variables.

We analyzed the rank correlation between the ranks of ICT indicators and rank of math education using the Global Information Technology Report 2016 (www3.webforum.org).

The Global Information Technology Report described the state of networked readiness.

The network readiness index shows the level of ICT for each country as the level of full use of information and communication technologies (ICT) to improve competitiveness and well-being.

Under the theme "Innovating in the Digital Economy", the Report also examines the role of information and communication technologies (ICTs) in driving innovation

We used data for 18 countries (Table I).

TABLE I. COUNTRY NETWORK READINESS INDEX

Country	Networked Readiness Index, rank	Quality of management schools, rank	Quality of math & science education, rank	Social impacts, rank
Singapore	1	4	1	1
Finland	2	13	2	18
Netherlands	6	8	7	3
Netherlands	6	8	7	3
Japan	10	51	9	16
Malaysia	31	22	12	28
Taiwan, China	19	33	15	20
Germany	15	25	16	30
Canada	14	5	18	11
France	24	11	19	17
Korea, Rep.	13	59	30	4
Italy	45	28	41	62
Sweden	3	16	43	12
United States	5	9	44	7
United Kingdom	8	3	46	5
China	59	85	49	41
Russia	41	100	58	45
India	91	55	63	69

The Box-and-whisker plot displays the median, the quartiles, the maximum and minimum. So we can see that the rank of Quality of management schools has the highest variance. The rank of Networked Readiness Index and the rank of Social impacts have lowest variances (Fig.2). There is "one"- Networked Readiness Index, "two"-Quality of management schools, "three"- Quality of math & science education, "four" - Social impacts of ICT.

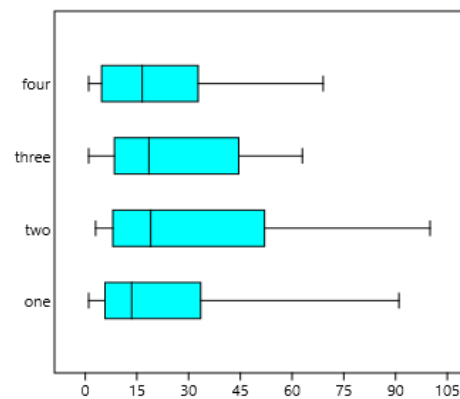


Fig.2. Box-and-whisker plot

We calculated Spearman's Rs coefficients using data for these countries in order to find correlation between ranks and represented results in Table II (there is "one"- Networked Readiness Index, "two"-Quality of management schools, "three"- Quality of math & science education, "four" - Social impacts of ICT).

TABLE II. CORRELATION BETWEEN RANKS

	One	Two	Three	Four
One	1	0.65	0.57	0.81
Two	0.65	1	0.44	0.70
Three	0.57	0.44	1	0.51
Four	0.80	0.70	0.51	1

The graphical view of rank correlations is shown in Fig.3. Calculations were fulfilled with the help of program Past Version 3.21, Øyvind Hammer, Natural History Museum University of Oslo. We can see that there is rank correlation 0.57 ($p < 0.05$) between Networked Readiness Index, rank and Quality of math & science education, rank. Other factors have less rank correlation with rank of Quality of math & science education. Therefore we can conclude that increasing the Networked Readiness Index (rank) is providing the increasing the rank of Quality of math & science education.

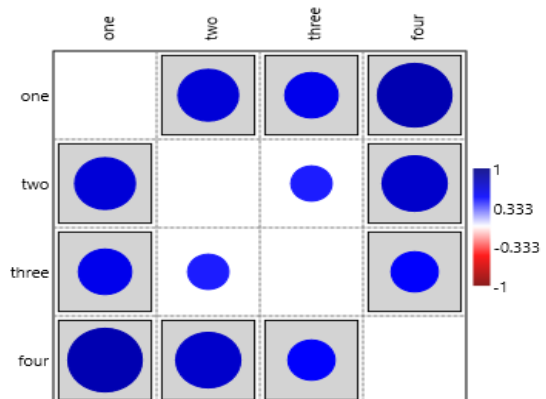


Fig.3 Graphical view of rank correlations ($p < 0.05$ boxed).

The rank of Networked Readiness Index connects closely with the rank of Quality of management schools (0.65, $p < 0.05$) and rank of Social impacts (0.81, $p < 0.05$). The high level of Networked Readiness promotes the high quality of

management schools and social impacts. We proved that Internet was very important for math study. So we try to describe important free online ICT tools which can help to study math.

III. USING ONLINE RESOURCES FOR MATH EDUCATION

We can use different online tools for math education. There is a table with classification of different types of online resources for math education and examples. We describe only free tools for self-education (Table. III): Math forums, Web-quests(sites), Math games sites, YouTube and other resources, Math Network societies, Online math programs, Preparing for tests online(sites), Online math schools.

TABLE III. FREE TOOLS FOR SELF-EDUCATION

Tools	Examples
Math forums	http://mathhelpforum.com http://mathhelpplanet.com/ https://www.math10.com
Web-quests(sites)	http://www.webquest.org http://www.teach-nology.com/
Math games sites	https://www.mathplayground.com/ https://www.homeschoolmath.net/
YouTube and other resources	Math lessons https://www.youtube.com/channel/UCnXGMGv-8m1vHsaudaMo9ag Teacher Math Lessons https://www.youtube.com/playlist?list=PLC4BAFE27DABD155C Introduction to Network Mathematics By Bruce Hoppe http://webmathematics.net/
Math Network societies	MathQED https://mathqed.com Math Concentration http://www.mathconcentration.com
Online math programs	Geogebra https://www.geogebra.org/ Wolframalpha https://www.wolframalpha.com
Preparing for tests online	https://math-ege.sdangia.ru/ https://math-oge.sdangia.ru/
Online math schools	Schoolyourself https://schoolyourself.org/

We used Google search to show the ranks of different Google math groups (Fig. 4, Fig. 5)

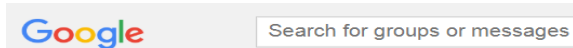


Fig.4 Google search for groups or messages

We can see the graph view of analysis of keyword-based search results. The rank of math software is higher than the rank of math textbooks (math textbooks are out of our list).

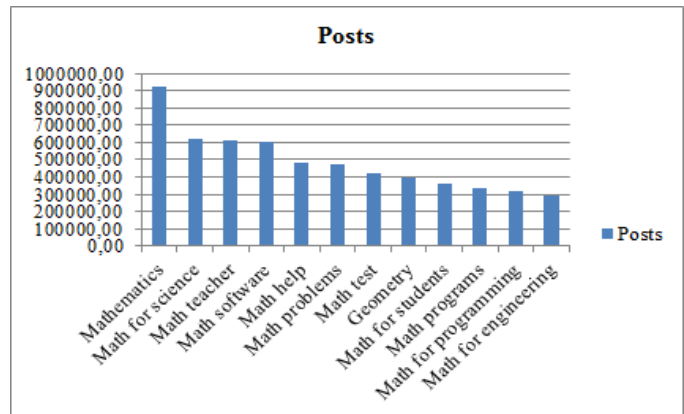


Fig.5. Results of Google search for messages (posts)

There are five absolute leaders in the group's searching list: mathematics, algebra, math for students, geometry and math for science (Fig. 6).

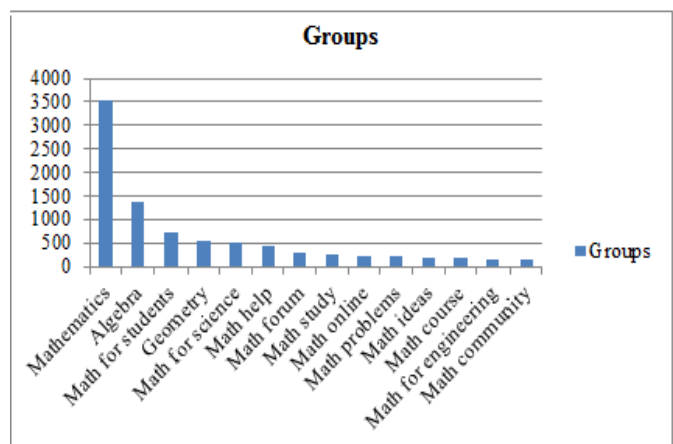


Fig.6. Results of Google search for groups

It is very important to know analytical geometry for civil engineering. So we describe the opportunities of free tool – program Geogebra. The main advantage of this program is the very convenient visualization of lines and curves. GeoGebra Math Apps is free online math software for graphing, geometry, 3D. This program has also tools for solving probability and math statistics (Fig. 7).

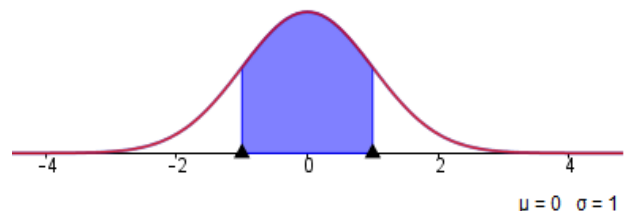


Fig.7. Drawing Normal distribution Density Curve with Geogebra.

The users of GeoGebra can share resources, write posts and comments and solve math problems together. The teachers may give tasks and feedback. It is possible with the help of GeoGebra Groups (Fig.8, Fig.9)

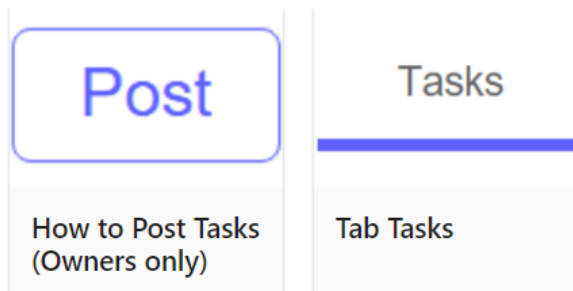


Fig.8. Information for users in GeoGebra

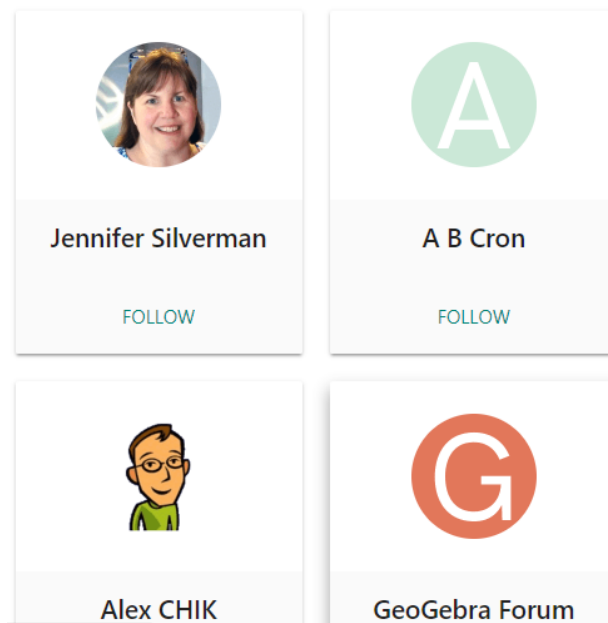


Fig.9. The list of authors from our GeoGebra community.

Here is an example of a network society's shared resources (Fig.10).

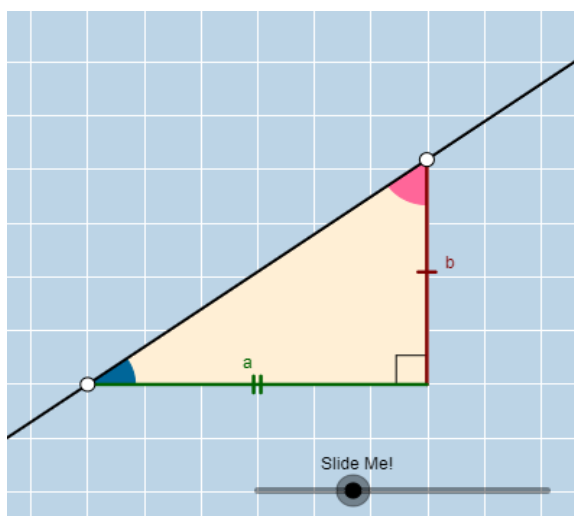


Fig.10. Example of resource

It is possible to make 3D print of own shapes with GeoGebra.

GeoGebra is an example of the deep integration of a mathematical network society and a mathematical tool. This

project is very promising. Now there are about 100 million users of this program in the world.

The researchers study the problem of the influence of computer technologies on perception of Mathematics topics and improving Math skills in this article.

The random sample is consisted of 65 students from Saint Petersburg State University of Architecture and Civil Engineering. Experimental results demonstrate the significant improvement of student's mathematical modelling skills by the help of computerized virtual cases.

We used Scilab for graphical solution of differential equations. The differential equations are applied for describing the mathematical models of practical problems which were presented in two forms for two groups: in text form and in computerized virtual form.

Text form of task is usual (standard) for math textbooks. The computerized form of task is very interesting for students and it raises their motivation at solution math problems (Fig.11).

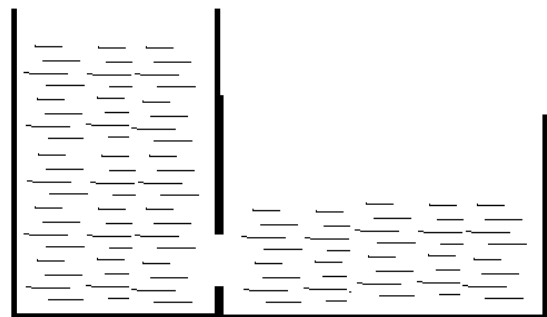


Fig.11. Fragment of task in computerized form.

We asked students give us information about their interest to solving math problems by differential equations. As it is known differential equations are the excellent instrument for mathematical modelling. First group consist of 35 students which solved problems for math modelling given them in computerized form. Second group consisted of 30 students solved the same problems presented in usual text form.

TABLE IV. INTEREST TO SOLVING MATH PROBLEMS BY DIFFERENTIAL EQUATIONS

Group	Answers	
	Mathematical problem is interesting	Mathematical problem is standard
First	22	3
Second	5	25

These data was analysed as contingency table (contingency $C=0.57919$). We can see the influence of computerized form at student's motivation and understanding the complicated themes.

We find out that using computer environment and computer programs provide the improving the mathematical education and raise the motivation at math study.

Online communication tools for education are very effective as it enables immediate real time communication.

IV. CONCLUSION

Modern challenges of society to mathematical education put forward high requirements for the preparation of students. Given there is development of ICT, it is very important to improve the learning process.

Increasing the Networked Readiness Index (rank) is providing the increase in the rank of Quality of math & science education.

It can be noted that the level of mathematical education depends on the level of ICT development in the world. For effective self-education, the following tools can be used in addition: mathematical forum, mathematical network communities and others. The use of all reserves, arising from the use of interconnection in mathematical education, can significantly improve the efficiency of training.

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