Advances in Economics, Business and Management Research, volume 81
1st International Scientific Conference "Modern Management Trends and the Digital Economy: from Regional Development to Global Economic Growth" (MTDE 2019)

Information technologies in math education: pro et contra

Tarasova O.V.
Orel State University
Orel, Russia
tarasova_orel@ mail.ru

Savvina O.A.
Yelets State University named after Bunin
Yelets, Russia
oas5@mail.ru

***Abstract* — The article considers the necessity, importance and practicability of the digital technologies used in the math education. The purpose of the analysis is to identify the advantages, disadvantages and risks of using digital technologies in the math education. The article includes a review of publications on using digital technologies in education. It is emphasised that in recent years the students' culture of mathematical speech, especially oral, has deteriorated. The students were interviewed to identify the influence of information technology on the math education. The survey was organised among the students and graduates of Yelets State University named after I.A. Bunin and Orel State University named after I.S. Turgenev. According to the survey results, digital learning will have a positive effect on students' motivation, but just for a moment. The comparison of the survey results demonstrates that the students are not interested in the subject of math, but in the form of material presentation, not in the content of the material presented, but in the dynamics of the presentation, i.e. in what is not related to the math education.**

Key\words — e-learning tools, digital technologies, math education, student training.

I. INTRODUCTION

Today, the information technology has become a familiar component in almost all areas of modern life. According to the public educational standards for higher education approved by the Ministry of Education and Science of the Russian Federation, students should be provided with access (remote access), also for e-learning and distance learning, to modern professional databases and information reference systems set up and updated in the modules' work programmes.

The advantages of digital technologies include visibility, information availability, teachers' time saving, easy development of methods along with high efficiency, increased motivation of students, etc.

This topic has been the subject matter of numerous publications, conferences and congresses. Unfortunately, however, the discussion is mostly focused on minor issues of implementing digital technologies rather than on general issues of their practicability and application effects.

The analysis whose results are available further in this paper is aimed at identifying the advantages, disadvantages and risks associated with the digital technologies applied in the math education.

The 'risk' is interpreted as a predictable negative feature of a potential situation when learning mathematics.

II. BACKGROUND

Digital educational technologies emerged for discussion in the last decades of the 20th century. I.V. Robert (1997) developed fundamental principles of education based on information technologies in Russia. Geoffrey Roulet (1996) suggested that information technologies be used as a tool to synchronize training theories and practices for a teacher of mathematics in Canada.

Positive aspects of information technologies are mentioned in a large number of works. Oonk W. (2009) suggests using the multimedia environment to enrich theoretical knowledge with practical skills. Ming-Hung Lin, Huang-Cheng Chen, Kuang-Sheng Liu (2017) argue that the use of digital technologies encourages to learn greater than traditional methods.

Volodko I., Cernajeva S. (2017) indicate that the information technologies for learning math will facilitate the work of teachers and make the learning process more attractive and effective. To facilitate the work of teachers and excite students, the Department of Engineering Mathematics at Riga Technical University created several math courses at Ortus, compiled and implemented a series of tests in the Ortus environment, created an auxiliary course on elementary mathematics at the MOOC platform and a math course for high school students at the Ortus website.

Mikheeva, M, Schneider, S., Beege, M., Rey, G.D. Boundary (2019) did not question the expediency of the information technologies any more, but studied the conditions under which they had greater effects. They noted that courtesy in the instructions had no effect on the training results.

At the same time, the Internet widely spread at the turn of the XIX – XX centuries had a negative impact and resulted in internet addiction. K.S. Yang, Professor of the University of Pittsburgh (2000), found out the following negative impacts: rejection of social life, disregard of the daily duties at work or home, reduced time spent with real people where work time is used for personal purposes, deteriorated health.

Long before that, N.A.Berdyaev, a Russian philosopher (1989), warned of the danger of digitalisation for a human being. He wrote, 'The massive technical organization of life destroys all personalization, all individuality and originality, everything becomes faceless and massive, shapeless…, but the technical civilisation, the technicalised and mechanicalised society want the man to cease being uniform and entire, i.e. to cease being a personality' (Berdyaev N.A., 1989, p.155, 156).

Following Berdyaev's point, V.Yu.Katasonov (2018) noticed that the digital technologies would damage the spiritual side of mankind and restrain the freedom of man.

I.V. Robert (2010) developed didactic standards for digital training media. According to the author, failure to comply with didactic standards would result in computer abuse, neglect of hygiene, etc.

E. Balalaeva (2016) highlighted some of the negative aspects of e-learning tools application due to the risks associated with the implementation of the basic didactic principles such as scientific character, accessibility, awareness, efforts, etc. Students have no constant direct contact with their teacher whose functions are partially taken over by e-learning tools, therefore, the didactic requirements to such tools should become stricter.

Years of experience demonstrate that the students' culture of mathematical speech, especially oral, has been deteriorating. To answer a question during a problem lecture, the students just turn to their gadgets, reference books without even trying to recall a mathematical fact.

G.A. Klekovkin (2018), a modern mathematician, proved that clip thinking generated by digital technologies had a devastating impact on the math education.

III. Materials and Methods

The aims of the analysis have been achieved based on

- methodological problems of forecasting as a whole and a theory of civilisation predestination in education (N.A. Berdyaev and others);
- factor analysis with a substantive approach, i.e. on the experience and theoretical conclusions from it. The analysis of educational programmes was performed in Yelets State University named after I.A. Bunin (with 80 years of math training experience), Orel State University named after I.S. Turgenev (with 100 years of math training experience);
- Practical methods: survey, multiple factor analysis of the 27-year math teaching experience of the article authors).

The authors of the article conducted a survey (see below).

68 people took part in the survey *Impact of Information Technology on The math Education* (16 students and graduates of the *Math, Natural Science and Technology Institute of Yelets State University named after IA Bunin* and 52 students and graduates of the *Institute of Education and Psychology of Orel State University named after I. S. Turgenev*).

The age structure of the survey (2019) participants was determined with the answer to the question: *You graduated from High School (select age)*:

TABLE I. YOU GRADUATED FROM HIGH SCHOOL (SELECT AGE):

Age	**17 – 19 years old**	**20 – 22 years old**	**More than 23 years old**
Number of people	15	35	18

Most of the respondents spent their time online for 2 – 8 hours per day (77% of the interviewed). About 21% of the respondents accessed the web spending less than two hours a day and 1% of the students stayed online for over 8 hours a day. The authors were surprised receiving comments to the answer to the question such as *the day long* (less than 1% of the respondents).

The following diagram illustrates the survey results for the question *'How much time do you spend in the web every day*?»

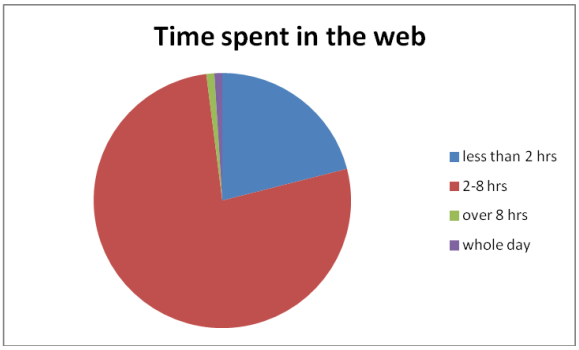

Fig. 1 Time spent in the web

Answering the question '*Did you ever notice that you spent more time in the web than you had planned?'* a significant number of the respondents (54%) said *Yes*, and 29% of the respondents did not even think about time allocation at all. 12% of the respondents were ready to spend as much time as they want as long as they were interested. And only 5% of the respondents stated that they had no opportunity to stay in the web for a long time.

The key question was *What do you use a computer for (IT as a whole)*. It suggested more than one answer to be selected, and 47% of respondents did select several ones.

How do the students use modern IT achievements today? At first sight the results are positive.

For a good number of the respondents (83%), the computer is a source for searching and processing information, 38% do not imagine their communication without a computer. 31% of the respondents believe that the computer and the information technology in general are for entertainment.

More than half of the respondents (60%) said they used Web for education. As there is a confusion now between the concepts of "information availability" and "education availability", as well as the concepts of "having knowledge" and "having information", the first case has to do with impersonal information not allocated to the subject, i.e. a person, whereas the second one – with the image refracted through the person, a fact obtained from learning.

For the sake of objectivity and awareness of the answers to the question about using a computer for education, we checked the correlation between the responses received and the answers to other questions such as: *For what purpose do you usually recommend your friends to use electronic tools?, What*

educational tools do you usually use (specify names, e-mails or links)?.

Only 15% of the respondents recommend their friends to use Internet for education, and none of the respondents specified a single educational math tool.

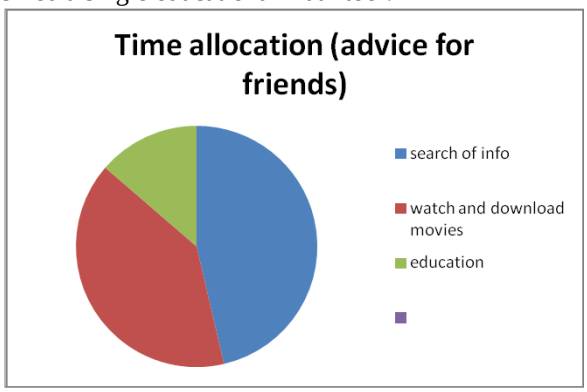

Fig. 2 Time allocation

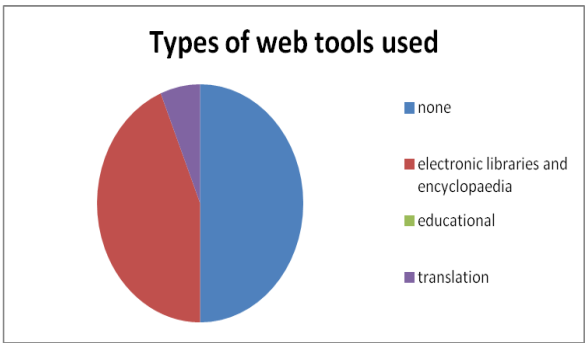

Fig. 3 Type of web tools used

Thus, the respondents do not access the web for improving their math knowledge, but for other (often entertaining) purposes.

Only 21% of the students said, *If the ICT are used at math lectures and classes there comes a desire to go on learning the topic.* More than half of the respondents (54%) think that the key point is that the lessons 'are interesting'.

It confirms that excessive visual aids and animation tools used when presenting a math material often draw attention to the pictures and the dynamics, but distract from the math concept or fact being covered at class.

In response to the question *In a store you need to calculate 1,25*4. What will you do?* about 50% said that they would do a mental calculation. Only one person (over 23 years old) wrote '5' in the comments – the result of the calculation.

At the same time we have to recognize a great role of the web as a reference and a source of information. 37% of the students specified encyclopaedias and electronic libraries (Wikipedia, the address of the university electronic library http://lib.elsu.ru, http://library.oreluniver.ru, etc.) as educational resources. This, on the one hand, confirms the mix-up of the notions between 'educational' and 'information (reference)' tools, and, on the other hand, demonstrates the prospects of using the web to make a research or obtain information.

IV. Results

We should neither underestimate or overestimate the opportunities of the total individualisation of education using digital tools. Rejection of the training courses, collective in form and substance with great opportunities of dialogue and interaction, will result in curtailing social contacts, emerging individualism in social life and, finally, in autism, etc.

Being so scarce in the educational process, the live dialogue will decline with the use of a computer. Indeed, a child who has just come to school and is willing to talk, will have to listen to the teacher most of the time at the lesson and speak up only upon permission, when he is 'called to the blackboard'. During the academic year students can speak just for a few tens of minutes, having to perceive information silently for the rest of time. So the speaking ability, being a tool of thought, stays out of work.

Student do not have enough practice of dialogue using the language of the science studied, and it is well known that without it no independent thinking will ever develop.

Moreover, when talking to a computer programme the talker is anonymous, having no face, no feelings, no heart.

The actual practice of training in Russia suggests the following sequence: presentation of the material → consolidation → control. When introducing digital technologies, the scheme is almost the same. Training acts as a highly individualized process when the students work with the familiar information available on the screen.

It is obvious that such theoretical schemes provide no opportunity to implement a problem lecture, problem lesson, seminar discussion, business game or scientific and educational work.

Students' health is an important point related to the use of a computer for training. Enhanced and perfected learning process, significant continuous pressure, low physical activity, specific environment in the classes with displays, etc., impact the students' health.

The implementation of the Internet technologies results in the Internet addiction manifested in the obsessive desire to go online and the inability to exit the network. According to psychological researches, the most vulnerable group for getting addicted to Internet is represented by adolescents who demonstrate such features as: dissatisfaction and irritation when distracted from the Internet by necessity, anxiety, distractibility, insufficient concentration, problems with self-control, tendency for affective response, reduced emotional intelligence, excitability, reduced self-control, uneasiness, impaired social adaptation, conflict in communication, infantilism, restlessness, depression, suicidal tendencies, forgetting to study, etc.

In this regard, they have learning problems as they visit sites which have nothing to do with self-education, chat for hours in the chat rooms, talk with friends and play interactive games instead of learning.

The increasing amount of aggressive information makes the users process a larger number of messages for a shorter time, build their information routes based on a random situational choice. [G.A. Klekovkin p.44].

Klekovkin rightfully thinks that digital technology may also result in clip thinking characterized by shallowness, inability to analyse things, lack of clear logic, inability to set

priorities or establish logical links, dominance of the "mechanical" memory where the obtained information is "erased" from, inability to concentrate, operation only with short meanings (the increasing complexity of the subjects being studied results in absolute misunderstanding of the material being studied), fatigue when studying mandatory disciplines, absence of the need for self-examination or self-assessment, focus only on the external superficial signs of the problem, not on its essence, etc.

Currently, the use of several information and communication tools at once, as well as the completion of a number of other tasks ("multitasking"), is becoming more and more common. Scientists of Stanford University made a research to compare the effectiveness and the speed of processing information by "multi-tasks" and "non-multitasks". M. Spitzer, a German neurophysiologist and practicing psychiatrist, took a closer look at the problem and came to the conclusion that people doing several things at once developed two qualities – superficiality and inefficiency [Klekovkin p.41].

There are surveys to further adjust the contents of the topic under study based on the feedback. The risks associated with the implementation of the visibility principle are most predictable. When analyzing the existing electronic tools, attention was repeatedly drawn to using visibility at the expense of the content, to replacing the conceptual components with illustrations, and effective techniques. If redundant, visual aids distract the students and prevent them from following the deployment logic of the subject. Researchers note that the attempts to get people interested through excessive animation and games fail to achieve the desired result, primarily due to the "contrast effect" when the student being familiar with dynamic computer games and simulators expects the same dynamics from the curriculum.

The survey results confirmed the advantages, disadvantages and risks associated with the digital technologies applied in the math education.

The questionnaire had ten questions including:

1. How much time do you spend in the web every daye?

a) less than 2 hours a day;
b) 2 to 8 hours a day;
c) more than 8 hours a day;
d) your comment.

2. Did you ever notice that you spent more time in the web than you had planned?

a) yes;
b) I spend as much time as I want, I don't care about time;
c) I never asked myself a question like that;
d) no, I did't;
д) no, I have no opportunity to stay online for a lot of time.

3. What do you use a computer for (IT as a whole)?

a) for communication;
b) for searching and processing information;
c) for entertainment;
d) for learning;
д) your comment.

4. You recommend your friends to use electronic tools

b) for searching and processing information;
c) for watching movies and downloading music;
d) for learning;
д) your comment.

*5. In a store you need to calculate 1,25*4. What will you do?*

a) use a calculator;
b) do a mental calculation;
c) confide in the cashier;
d) your comment.

6. If the ICT are used at math lectures and classes

a) the lessons are interesting;
b) you find out a lot of new things;
c) there comes a desire to go on learning the topic;
d) your comment.

7. Your math performance at high school was

a) satisfactory;
b) good;
c) excellent;
d) your comment.

8. Your math performance at the last university exam was assessed as:

a) satisfactory;
b) good;
c) excellent;
d) your comment.

9. Which educational resources you usually use (specify names, e-mails or links)?

V. Discussion

The individualisation, the individual progress rate when using digital education is also delusive. The "dialogue" between the computer and the student is greatly different from the dialogue as a way of communication between the people. The dialogue involves the development of the topic and the point of view by means of joint efforts of two or more people. The course of this mutual exchange of thoughts is set up and generated with the dialogue itself which involves emotions.

That is why the individualisation of learning comes true only because there is a development programme built-in in the machine.

The implementation of digital technologies results in clip thinking enabling to process a large amount of information, but preventing from being critical of the facts obtained, in reflecting a lot of various properties of objects regardless of the links between them characterized by fragmented information flow, similarity, complete heterogeneity of the information received, high switching speed between information clips, absence of an integral picture of the world perception.

Clip thinking prevent the young people from learning fundamental science as it must involve deep and long-term reflexion.

The analysis demonstrates that the fatigue of the students after math classes with digital aids was greater than the same with the traditional learning tools.

VI. Conclusion

Internet is an ideal research tool, but students use it seldom because they are interested in other things such as having their own private world where adults have no access, avoiding responsibility for what is happening, being able to feel the

reality of process and completely disengage themselves from the outside world, being able to instantly correct any mistake, being able to make any decisions independently, reducing communication risks.

Digital learning will have a positive effect on students' motivation, but just for a moment. The comparison of the survey results demonstrates that the students are not interested in the subject of math, but in the form of material presentation, not in the content of the material presented, but in the dynamics of the presentation, i.e. in what is not related to the math education.

References

[1] Geoffrey Roulet. Subject Integration and Mathematics Teachers' Practical Knowledge (1996). Journal Article published Mar 1996 in Teachers and Teaching. Volume 2. Issue 1. P. 87 – 103. doi.org/10.1080/1354060960020107.

[2] Mikheeva, M., Schneider, S., Beege, M., Rey, G.D. Boundary conditions of the politeness effect in online mathematical learning Computers in Human Behavior. Volume 92, March 2019, Pp. 419-427

[3] Ming-Hung Lin, Huang-Cheng Chen, Kuang-Sheng Liu (2017) A Study of the Effects of Digital Learning on Learning Motivation and Learning Outcome. EURASIA J. Math., Sci Tech. Ed 2017;13(7):3553–3564.

[4] Oonk, W. (2009) Doctoral Thesis, Theory-enriched practical knowledge in mathematics teacher education Leiden University. ICLON, Leiden University Graduate School of Teaching, Leiden Universityhttp://hdl.handle.net/1887/13866.

[5] Volodko, I., Cernajeva, S. Application of information technologies for studies of mathematics in Riga technical university. 16th Conference on Applied Mathematics, APLIMAT 2017 – Proceedings 2017, Bratislava; Slovakia; 31 January 2017 до 2 February 2017; Pp. 1684

[6] Balalaeva I.Yu. Didactic risks of using e-learning tools // Непрерывное образование: XXI век. 2016. Vol. 4(16) . P. 95–102

[7] Berdyaev N. A. Man and machine // Questions of philosophy. - 1989. - № 2. - p. 155, 156.

[8] Katasonov V.Yu. The world under the hypnosis of the digit, or the road to the electronic concentration camp. - M .: Library of REA named after S.F. Sharapov, 2018 ("anatomy of modern capitalism" series). - 424 s.

[9] Klekovkin G.A. (2018) Negative influence of the computer and the internet on the process of math learning and its results // Mathematical Bulletin of pedagogical higher educational institutions and universities of the Volga-Vyatka region. 2018. Vol. 20. p. 38-47

[10] Robert I.V. Modern information technologies in education: didactic problems; prospects for use. M .: IIRO RAO, 2010. 140 p.

[11] Robert I.V. Modern information and communication technologies in education training course // Informatics and education. 1997. No. 8. P.15–21.

[12] Strelnikova L. Digital dementia // Chemistry and life - XXI century. 2014. - №12. - pp. 42-47.

[13] Young KS Diagnosis - Internet addiction / K.S. Jan g // World of Internet. - 2000. - №2. P.24-29.