

Web-based online course training higher school mathematics teachers

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Abstract. The article looks into the problem of theoretical aspects of using Web 2.0 technology in higher education. This paper describes answers of 87 respondents who have helped to identify the most required types of educational content for the integration to pages of the online course training higher school mathematics teachers. The authors carry out a theoretical analysis of researches and resources that consider the development of theoretical aspects of using web tools in higher education. The research presents the characteristics common to online courses, principles of providing a functioning and physical placement of online systems in webspace. The paper discusses the approaches of creating and using animated content in online systems. The authors describe the methods of publishing video content in web systems, in particular, the creation and use of video lectures, animation, presentations. This paper also discusses several of the existing options of integrating presentations on web pages and methods of integrating mathematical expressions in web content. It is reasonable to make a conclusion about the expediency of promoting online courses, the purpose of which is to get mathematics teachers acquainted with the technical capabilities of creating educational content developed on Web 2.0 technology.

Keywords: Web 2.0 technology, online-course, training higher school mathematics teachers.

1 Introduction

1.1 Problem statement and its topicality substantiation

With the emergence of web education which is defined by Horton as “any purposeful use of web technologies with the aim of person’s formation” [11], scientists have faced

an important task which is to create a perspective new system of education. The usage of teaching aids in the educational process, based on using Web 2.0 tools, has enabled it [13; 14; 25]. Dina Rosen and Charles Nelson [27] have stated that these tools have a great potential for education providing a new quality of students' self-study. Yasemin Koçak Usluel, Sacide Güzin Mazman [15] and Kulthida Nugultham [22] agree with this idea. In their research they determine that using Web 2.0 in the educational process can increase the motivation level and stimulate creative students' skills, and in its turn, it encourages the formation of self-education culture. Akhilesh K. S. Yadav and Amala A. Patwardhan [39] have stated the actuality of Web 2.0 technology during education while analyzing an economically profitable solution to the integration of their tools. Among the conclusions, scientists have noted an insignificant usage of Web tools in higher schools. Pavel Livotov [18] has raised issues connected with pedagogical use of Web 2.0 technology. In the scientist's opinion, in spite of all the barriers of involving such services, web-oriented education is a rapidly growing educational area. With the help of these services, we can offer a bright educational environment created with the usage of different strategies and technologies of education. Gabriela Grosseck [9] has related online systems to such environment, indicating the actuality of developing theoretical aspects of using Web tools in higher education. Scientists have claimed that it has to influence the creation of programs of future research and development of scenarios concerning Pedagogy 2.0 for the higher education sector.

1.2 Analysis of the latest researches and publications

We have investigated the experience of scientists who have contributed to the implementation of Web technologies to higher education. Carrying out such analysis we have studied recommendations by Ricardo Torres Kompen, Palitha Edirisingha, Richard Mobbs [33] who point out the importance of describing Web 2.0 tools and services that may be chosen to collect and process the information. Under these conditions, according to scientists, students' formal and informal education is under control during the whole life. This idea corresponds with the conclusions made by Gintarė Tautkevičienė, Mindaugas Dubosas [31], who have agreed that continuing education and knowledge refreshment should become an integral part of a student's education. Scientists have emphasized the need to develop such Web 2.0 tools that will encourage students' desire for publishing and sharing the knowledge created by them. Describing the assistance that should be provided by the teacher using Web 2.0 tools in the education, Isidoros Perikos, Foteini Grivokostopoulou, Konstantinos Kovas and Ioannis Hatzilygeroudis [24] have offered the development of online courses for tutors' informal education that would ensure the enhancement of experience and skills of higher school teachers.

So, each of the aforesaid scientists has recommended starting the implementation of Web tools into education from their analysis. According to the experts, such an approach will help to understand what every tool can offer for students' education and how they can be integrated into educational classes and remote courses of higher schools.

Following the conclusions made by scientists, we can see the usage of such an approach to develop online courses with the purpose to prepare higher school mathematics teachers [35; 37; 38]. The majority of conducted surveys among teachers using the platform “Higher School Mathematics Teacher” [10] have confirmed our decision to start the description of using only the questions that interest respondents the most at the moment. So, this article aims to carry out a theoretical analysis of peculiarities of developing educational online systems and to review several technical capabilities to create educational content for the integration on the pages of online courses training higher school mathematics teachers.

2 Method

We have held a survey of higher school mathematics teachers on using Web technologies to provide online education. The analysis of respondents’ answers to the survey questions published at the forum of the platform “Higher School Mathematics Teacher” [10], has influenced the description of technical capabilities to create educational content for the integration on the pages of online courses training higher school mathematics teachers. Besides, we have carried out a theoretical analysis of researches and resources, which consider the development of theoretical aspects of using Web-tools in higher education. Since the development of online courses of the platform involves the usage of a significant proportion of mathematical content, we also analyzed methods for integrating mathematical formulas into web content and developed a model for creating mathematical content on the pages of online courses.

2.1 Online course as a kind of electronic education

Electronic education is a general term to describe the areas of online education, web-education, and education using technologies. Costinela-Luminița Ciobanu (Defta) and Nicoleta-Magdalena Ciobanu (Iacob) [5] relate online-education (web-education) to electronic education. According to scientists, computer-oriented education can be considered as a component of electronic education that does not require constant interaction with the teacher and other students.

Ciobanu [5] idea has been agreed with the results of the research by Tuncay Sevindik, Necmi Demirköser, Zafer Cömert [29] and Paulo Alves, Luísa Miranda, Carlos Morais [2]. The scientists define online course as a kind of electronic education, in other words organized purposeful educational process built on pedagogical principles, which is realized on basis of technical tools of modern information-communication technologies and represents logically and structurally completed educational item, methodically provided by a unique complex of systematized electronic tools of education and control.

Investigating the characteristics common to online courses while considering technical support of online courses, we follow the positions developed by Ciobanu [5]:

- the educational process is carried out in the virtual class;

- educational material is available on the Internet and includes the text, links to other Internet resources, images, audio, and video material;
- the virtual audience is coordinated with the instructor who plans the activity of working group participants, discusses the aspects of the course using the discursive forum or chat, provides additional resources, etc.;
- education is a social process; the studying community is created through interaction and cooperation between the teacher and working group participants;
- tutors provide control over the participants' activity, work with subgroups, audio, and video interaction etc.

Besides, we have taken into consideration the recommendations FAO [6], DIGICOMP [32] and Leicester Learning Institute [17] concerning the development of materials for online courses. The developers of recommendations emphasize the importance of video materials, animation, photo materials, audio materials, animated graphics, tables, presentations, etc.

2.2 Principles of providing a functioning and physical placement of online systems in webspace

Educational online systems as network software require the detection and description of technical conditions of the use. Online systems, which are built using the client-server architecture, are widely used at the moment. Thus, it is necessary to define technical requirements to both the client and the server. Among the main factors of educational online systems activity, Mark S. Frank, Keith Dreyer [8] and Borka Jerman-Blažič [12] have distinguished its physical placement on the server. The quality of hardware-generated and software of the server and width of the communication link play a critical role in the quality of provided educational services.

Nowadays several main kinds of hosting are being widely used as a server.

1. *Virtual hosting (Shared)*. It represents a server, the resources of which are equally divided among the users. Using such kind of hosting is expedient for web systems of a small scale with the number of visitors usually no more than 100 per 24 hours.
2. *Virtual private server (VPS/VDS)*. It provides individual resources to every user. With its help, it is possible to set up the operating system and other software. Such hosting is used for projects of average visiting rate and processing degree.
3. *Dedicated physical service*. The user rents or organizes by him/herself the server by hardware under independent control. Its use is expedient to develop resource capacious projects with high requirements for information processing speed and the number of visitors.

It's necessary to take into account the fact that kinds of hosting 2-3 require the appropriate qualification from the teacher or a specialist 's involvement to set up and support system software of the server.

2.3 Approaches to create and use animated content in online systems

Using animation in educational web content plays an important cognitive role while studying any course, in particular, mathematics. The analysis of research results made by Michael D. Byrne, Richard Catrambone, John T. Stasko [4], Orhan Ercan, Kadir Bilen, Ayşe Bulut [7], Ramón Rubio García, Javier Suárez Quirós, Ramón Gallego Santos, Santiago Martín González, Samuel Morán Fernanz [28], Thorsten Rasch, Wolfgang Schnotz [26], Kateryna Vlasenko, Olena Chumak, Irina Sitak, Olga Chashechnikova, Iryna Lovianova [36] has proved the efficiency of adding animation to the educational information.

Using animation implies the stages of creation and placement. The stage of creating animated effects requires founded choice of realization technology considering the specifics of the objects to which the animation will be applied.

Nowadays there are several approaches to creating animation.

1. *Animated GIF images.* GIF image format differs from other raster graphic formats by its special feature of animation maintenance. It is used for the images that have up to 256 colours with a 24-bit RGB span. The animation is realized in the form of a static frame sequence where every frame is a separate raster image with a time-lapse created in between. The use of such format is expedient to create short-term animation with a small number of colours. It is explained by the fact that a great number of long-term animation frames considerably increase the physical size of the file. This format does not support the sound and interactivity.
2. *Flash animation.* Nowadays it is a popular and powerful technology of creating complete multimedia web use. It can use raster and vector images, build in the sound. Due to the built-in Action Script programming language, this technology supports the interactive constituent. With the emergence of mobile gadgets, technology use has faced the problem of cross platforming and security vulnerability, which led to the loss of use relevance. Starting from 2020 the company Adobe will stop supporting Flash technology.
3. *HTML5 animation.* With the emergence of HTML5 standard, web developers could create animation through direct programming with the use of JavaScript language without using additional application programming interfaces or plugins. The standard enables the creation of interactive animation with integrated audio content. Separate libraries for animation such as Three.js and A-Frame are created to facilitate the development process [20].

2.4 Video content publishing in web systems

The subject matter of online courses consists of various educational materials that are used to increase the level of motivation among listeners. Video lectures are one of the most popular kinds of such materials. There is considerable experience in using video lectures while giving mathematics courses.

Ana-Maria Suduc, Mihai Bizoi, Gabriel Gorghiu, Laura-Monica Gorghiu [30] and Natalia A. Parkhomenko, Sergei A. Zolotukhin [23] believe that one of the greatest advantages of using video in the educational process is that video lectures provide a

personality-oriented approach to the education. The listener can learn the material according to his/her pace of assimilating the educational material. We support the researchers' idea that video content has a major emotional impact on the listener in comparison to the text.

There are various methods of adding video content to the web page. We offer to review several of them.

1. Preliminary video publishing on services that provide video hosting services.

Video hosting is a web service that enables us to publish, store, review and promote a video on the Internet. Nowadays the most popular video hosting is YouTube. It allows downloading in formats such as avi, mov, 3gp, mpg, mpeg, mp4, mkv.

Besides YouTube, there are also alternative services, in particular, Vimeo, Dailymotion, etc. The listed services provide functional opportunities similar to Youtube but have their peculiarities. While integrating video content publishing on video hosting to the web page, there is a possibility to both download their video and add one of those stored at the service.

Among the advantages of such a method we can point out the following ones:

- downloaded video files don't take up space on hosting;
- video content downloading takes place quite fast;
- there are no strict restrictions concerning the size of downloaded files;
- video is available for review both on your site and video hosting.

One of the disadvantages is that the process of downloading a new video file takes up additional time.

2. Integration of video content published on social media pages.

This method of video integration is similar to the one described above except for the fact that servers of social media are used as video hosting. We offer to state the main characteristics by the example of social network Facebook.

The use of such a method enables to create a direct connection between the page on Facebook and the web-page where the video is integrated. The posted video reflects the name of the page, from which it was downloaded. It influences positively the process of promoting the page on Facebook. We can point out the opportunity of setting up video autorun among the advantages.

The disadvantage is the dependence between confidentiality settings of the publication on Facebook and video publishing on the web page. In other words, if the video was posted on the site page and then on Facebook, confidentiality settings were changed and video publication stopped being publicly available, then there will be a notification on the site that this video is not available anymore for reviewing.

2.5 Presentation publishing

While developing an online course we need to integrate PowerPoint presentations on web pages. PowerPoint presentation is a complex mixture of text, graphics,

explanations, modern functions of software and interaction in real-time with the audience. According to Çiğdem Uz, Feza Orhan, Gülşah Bilgiç [34] such programs as Microsoft PowerPoint allow preparing organized, visually attractive presentations that can be easily remembered by listeners.

We have analyzed the research related to the influence of the presentation on the students' motivation level and academic progress while studying mathematics. Different results are recorded in this research. For instance, in their article about the influence of PowerPoint presentation on short term and long-term memory, Hossein Nouri and Abdus Shahid [21] have determined that students' attitude to PowerPoint was positive and PowerPoint presentations have an impact on short term memory. However, it is revealed that PowerPoint presentations don't influence students' long-term memory.

Tutors can use presentations on web pages as a supplement to text materials, video or audio content. Presentation slides can contain a succinct summary of the educational material.

We offer to review several of the existing options of integrating presentations on web pages.

1. *Direct presentation downloading to the web site and publishing a link to it on the page.* The use of such a method enables users to download the presentation file to their computer for a further acquaintance without any introductory review on the web page.
2. *Converting the presentation into PDF.* The disadvantage of this method is that animation, sound, and interactivity disappear after converting.
3. *Converting the presentation into a video.* The video keeps all the presentation features, except for interactivity.

While giving mathematical concepts there is a necessity to publish a significant number of presentations with their constant updates. More complicated integration methods exist for this purpose. Among such methods, we can point out presentation publishing with the use of Google Slides service. Among the advantages of using this method, we can mark the possibility to edit presentations without a necessity to add them again to the page. Such publishing does not require public access to the presentation on Google Slides to build it in on the web page. The disadvantage is that a considerable part of animated, sound effects, which were used in the presentation, disappear.

The alternative way of Google Slides service is the use of services for storing presentations, for instance, SlideBoom.com, Projeqt, SlideShare.net, etc.

2.6 Methods of integrating mathematical formulas in web content

While publishing mathematical content in web there is a problem of displaying mathematical formulas. Nowadays this problem does not have a general solution. Thus, the question of displaying mathematical formulas is actual for discussion. We offer to consider four methods of publishing formulas in web systems.

1. A mathematical formula as a static image.

This method has been the only solution to the problem so far. MS Word is widely used to create mathematical texts and it has an integrated formula editing program MS Equation or MathType. The problem is that while transferring content to the web page using copying the formulas are ruined. For the correct display, every formula should be exported in raster image and should have a link to it in the web document. The disadvantages of such display of formulas are the problems with scale-up, stylization, and alignment of formulas to the text.

2. A mathematical formula as a result of generating structural code.

With HTML5 standard, the tag `<math>` was added to the maintained tags, it generates mathematical expressions written in the code of the web page using layout language MathML based on syntax XML. However, nowadays this method has an issue of cross browsing that makes it impossible to use it broadly.

3. A mathematical formula as a front-end library object.

This method of displaying formulas is based on the usage of JavaScript libraries of mathematical expressions. In this case, the formula is written in the form of structured code, usually using the semantics of the TeX computer layout system. The recorded code is converted by the library into images and displayed on a web page. The conversion takes place in the user's browser. The libraries used include such as KaTeX, JsMath and more powerful MathJax [19].

4. A mathematical formula as a back-end library object.

This method of displaying formulas is similar to the previous one, but a server's library of mathematical expressions is used. The conversion takes place on a platform server, which can create additional server load. The library used is PhpMathPublisher.

Through content analysis, we have developed the model of methods for creating mathematical content on the pages of the online courses (see Fig. 1).

3 Results

In order to carry out the analysis defined by the aim of the research, we have held the survey among the higher school mathematics teachers concerning the detection of types of educational materials, which are necessary for the process of creating online courses of mathematical direction using Web 2.0 technology.

We have offered the respondents to go through a survey using the forum on the platform "Higher School Mathematics Teacher" [10]. 87 respondents from different higher schools took part in it. Teachers' answers helped to identify the most demanded types of educational content for its integration on pages of the online course. We asked them to range the types of educational content according to the scale: 1 – such type of educational content is necessary while creating a course; 2 – use of this type is not expedient. Table 1 provides the ranked survey results.

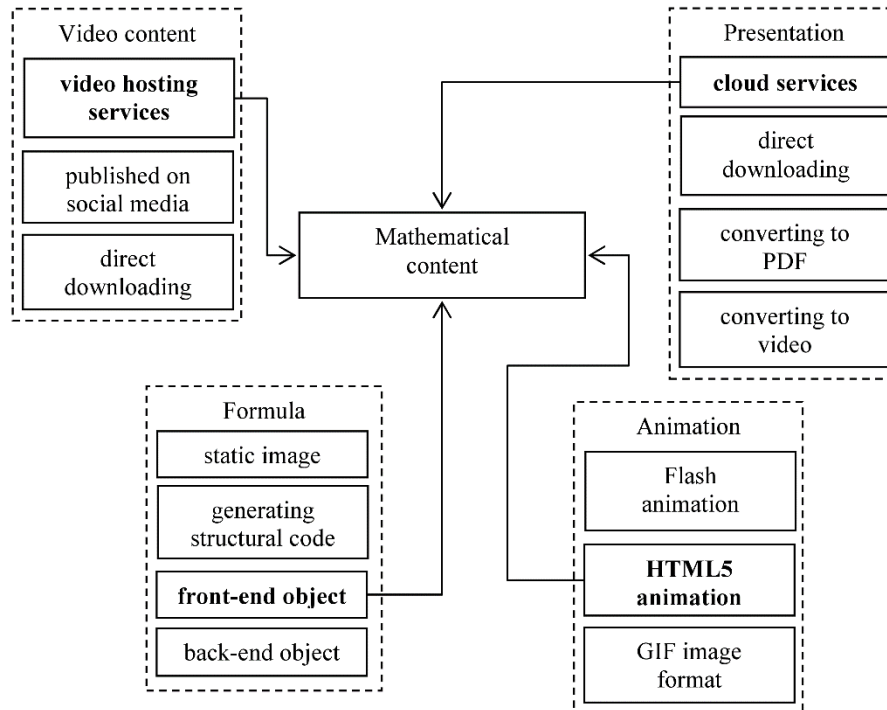


Fig. 1. The model of methods for creating mathematical content on the pages of the online course.

Table 1. The ranking results of types of educational content for its integration on the pages of the online course.

No	Type of educational content	Respondents' answers		Result
		1	2	
1	Video content	60	5	55
2	Animation	51	4	47
3	Presentations	42	8	34
4	Math formulas	38	6	32
5	Audio content	32	5	27
6	Formatted text	25	7	18
7	Tables	14	6	8
8	PDF content	14	8	6
9	Structures	13	14	-1
10	Diagrams	12	21	-9
11	Schemes	12	24	-12
12	MS Office content	9	22	-13
13	Photos	8	29	-21
14	Special symbols	7	61	-54
15	Columns	8	65	-57
16	Pseudocode	3	63	-60

According to the ranking results, we make a conclusion that the most required types of educational content are video lectures, animation and presentations (see Fig. 2). Also, a great number of teachers consider it necessary to include mathematical formulas to the subject matter of the online course.

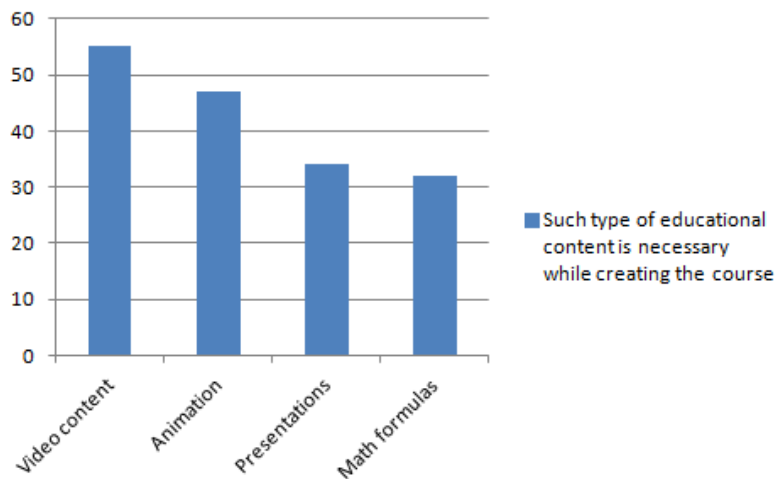


Fig. 2. The most demanded types of educational content.

4 Discussion and conclusions

Taking into account the conclusions of the researches by Gintarė Tautkevičienė, Mindaugas Dubosas [31], Patrícia B. Scherer Bassani and Débora Nice Ferrari Barbosa [3] about the limited involvement of Web 2.0 tools by teachers, following Ricardo Torres Kompen, Palitha Edirisingha, Xavier Canaleta, Maria Alsina Josep, Maria Monguet [16] we believe that it depends on the teachers' experience or their education. In most cases teachers are not just acquainted with Web 2.0 tools, thus they don't use them while creating online courses for students. We completely agree with Riyadh Alhassan [1] that teachers' acquaintance with the involvement of technical tools to create educational content for its integration to pages of online courses has to be carried out gradually. The research by Akhilesh K. S. Yadav and Amala A. Patwardhan [39] has proved our idea about the necessity to carry out a theoretical analysis of technical capabilities of Web 2.0 technology, the use of which can interest teachers. Thus, analyzing scientific literature and resources that describe the use of web technologies, we have taken into consideration the idea brought by mathematics teachers expressed at the forum of the platform "Higher School Mathematics Teacher" and have given an analysis of tools, which nowadays are actual for mathematics teachers.

Recommendations and Future Studies. Modern students are active Internet users, though its limited use has been marked during the education. It means that teachers have to show students how they can use web applications in their educational activity. We believe that it's possible to do it only through promoting online courses, the aim of which is the acquaintance of mathematics teachers with technical capabilities of creating educational content, developed on basis of Web 2.0 technology. Teachers' and students' training to involve web tools in their activity is one of the directions of our future research.

Acknowledgments. We are grateful to everyone who has become an active participant in the forum.

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