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# Web-Based support for higher school teachers: insights from a survey and theoretical analysis

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**Abstract.** This article delves into the theoretical aspects of utilizing Web 2.0 technology in higher education. The study examines the responses of 87 participants to identify the types of activities conducted by higher education teachers and determine the Web 2.0 tools that can enhance their instructional practices. The authors conduct a comprehensive theoretical analysis of existing research and resources that focus on the theoretical foundations of incorporating Web tools in higher education. The research presents the common characteristics of online courses and discusses principles for the effective functioning and physical placement of online systems in the Web space. Based on the findings, the study concludes that promoting online courses aimed at familiarizing Mathematics teachers with the technical capabilities of creating educational content using Web 2.0 technology is highly feasible. This article contributes valuable insights into the theoretical underpinnings of Web 2.0 technology in higher education and offers recommendations for integrating these tools into instructional practices.

**Keywords:** Mathematics teachers, types of activities, web-tools, a personal e-Learning environment model

## 1. Introduction

With the emergence of Web education, scientists have faced an important task which is to create a perspective new system of education. The use of teaching aids in the educational process,

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based on using Web 2.0 tools [12], has enabled it. Rosen and Nelson [28] have stated that these tools have a great potential for education providing a new quality of students' self–study.

Yadav and Patwardhan [53] have stated the actuality of Web 2.0 technology during education, while analyzing an economically profitable solution to the integration of their tools.

University Mathematics teachers are not an exception, since their professional activity comprises not only teaching students, but also doing research, analysis, and statistical processing of the information, doing calculations, publishing research papers, popular science materials, presenting reports and materials, communication and collaboration, etc. but, according to research by Bennett et al. [4], Vlasenko et al. [44], Yadav and Patwardhan [53], teachers mostly are not familiar with social media and other useful resources of Web 2.0. Livotov [17] has raised issues connected with the pedagogical use of Web 2.0 technology. In the scientist's opinion, despite 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 use of different strategies and technologies of education. While making a selection of Web-resources, every person has an opportunity to design Personal Learning Environments (PLE) according to their line of work. All things considered, mastering new resources and designing their PLE calls forth timeliness of developing methods and ways to help and support Mathematics teachers.

We have investigated the experience of scientists who have contributed to the implementation of Web technologies in higher education. Carrying out such analysis we have studied recommendations by Kompen, Edirisingha and Monguet [15] who point out the importance of describing Web 2.0 tools and services that may be chosen to collect and process the information. Tautkevičienė and Dubosas [35] 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.

Among studies on the methods for designing Personal Learning Environments, the ones focused on designing PLE for schoolers and students prevail. Their goal is e-learning, remote, or non-formal learning. Thus, Kompen et al. [14] drafted general guidelines for the implementation and use of the personal learning environment by students in a formal format in higher education (University level). Alharbi, Platt and Al-Bayatti [1] tried to allow students to design their technologies of PLE, such as blogs, websites, and Web 2.0 services. The researchers offered a model for designing PLE, which covers both traditional formal (in Universities), and informal (private) academic learning.

Shaikh and Khoja [32] emphasize the necessity to study the role, which a teacher plays in the learning process. The researchers outline the competencies, necessary for teachers who help students plan or design Personal Learning Environments. Couros [6] holds the same opinion and states that a teacher can provide online learning better if they designed their PLE model.

Building a teacher's PLE model requires understanding the essence of the term Personal Learning Environments. There are different approaches to determine it given by Attwell [3], Drexler [8], van Harmelen [10], Kompen et al. [14], Segura and Quintero [31], Shaikh and Khoja [32], but there is no general definition of the term PLE.

The authors of this article will follow a definition, suggested by Kompen et al. [14], who consider PLE to be a set of Web-technologies having a different level of integration and which help users manage the flows of information on education, knowledge creation, and skills development. Such an approach, according to Perikos et al. [24] will help to identify the most

suitable tools to create content for PLE. Moreover, scholars firmly believe, that such research will contribute to the development of educational online courses on how to use Web 2.0 tools. Following the conclusions made by scientists, we can see the use of such an approach to develop online courses with the purpose to prepare higher school Mathematics teachers [44]. Relevance and timeliness of the issue to design PLE for Mathematics teachers was discussed during the International Conference on Sustainable Future: Environmental, Technological, Social and Economic Matters (ICSF 2020) [43, 46], the participants of which concluded the necessity to develop and implement online support for Mathematics teachers in designing PLE.

According to the research conducted by Vlasenko et al. [41], first of all, designing PLE requires finding out the types of activities that the teacher carries out, and, secondly, determination of those Web 2.0 tools that can make this activity full.

This article is *aimed* at the presentation of a Mathematics teacher's PLE model and description of Web 2.0 tools that support the teacher during their activities.

## 2. Method

Applying deductive content analysis of research papers by Couros [6], Kadle [11], Morrison [20], Quinn [27], the authors of the present paper concluded the necessity to structure PLE of University Mathematics teachers, based on the types of their activities. When singling out the types of such activities, the authors also took into consideration the survey results. The survey, which had 16 questions, was designed with the help of an open online service and uploaded to the platform "Higher school Mathematics teacher" [39].

87 respondents were involved in the survey, of which 70% have more than 15 years of experience in higher education. 56.5% of respondents hold the position of associate professor, and 30.4% – professor. At the same time, 87% of respondents have a doctoral degree.

The questions were aimed at defining the awareness level of the academic staff about using Web-resources for various types of teaching activity [40]:

1) arranging the learning process;
2) searching for information;
3) doing research, analysis, and statistical processing of the information;
4) doing the calculation;
5) publishing research papers;
6) publishing popular science materials;
7) designing presentations;
8) collaborating and communicating;
9) saving data.

We analyzed the data from the Web-resources Statcounter [33], Free Maths The Geek Page [37], Top Tools for Personal & Professional Learning [36], EmergingEdTech [51], the blog eLearning industry [23], where ranking of Web-tools takes place according to their demand, popularity, and spreading. This data allowed us to create a PLE model for higher school Mathematics teachers (figure 1) [41].

We offer a short review of Web 2.0 tools that can support the teacher's activities.


**Figure 1:** PLE model of University Mathematics teachers.

**Arranging the learning process.** Prometheus [26], Coursera [7], edX [9], LinkedIn Learning [16], Khan Academy [13] help a teacher to choose the courses that will encourage the improvement of teaching subjects. The teacher can take such courses to enlarge their experience and get knowledge and skills that do not concern teaching. Moreover, they can recommend some courses to their students to ensure mixed learning of the subject. It is also important that choosing and taking most courses will encourage the improvement of teacher's training in a different language.

**Searching for information.** Google Search, Yahoo!, Yandex will help a teacher to find the necessary information to write a scientific article or prepare for the lesson. The teacher can find and select for acquaintance and analysis some modern scientific articles on different subjects in peer-reviewed European and American online journals using, for instance, the service Google Scholar. The fact that search is supported in documents of different formats allows the teacher to learn how to work with such formats as PDF, RTF, PostScript, Microsoft Word, Microsoft Excel, Microsoft PowerPoint. Also, for instance, Google Maps allows the teacher to find the locations necessary for work. Editing these locations enables the creation of interactive tasks for students.

**Doing research, analysis, and statistical processing of the information.** The teacher

will be glad to software and cloud calculations for carrying out researches, analysis and statistical information processing. A full set of business and scientific graphics of software STADIA, MS Excel will allow the Mathematics teacher to visualize the results of solving problems by graphic illustrations. Using MATLAB the teacher can organize the visualization of research data through building 3D graphics and the creation of animated videos and demonstrate them to students while teaching a subject. More than 250 statistical functions of the pack STATISTICA the teacher can use to carry out statistical research of any complexity to show the results of their scientific researches. Using SYSTAT and QtiPlot the teacher can represent analytical information of reports in form of graphics, conduct parametric and non-parametric data analysis. Also, the teacher can offer this software to students to carry out statistical information processing in course and diploma projects [38].

**Doing the calculation.** The systems of computer Mathematics MATLAB, Maple, MathCAD and online calculators Math Editor, Cantor, KAlgebra allow optimizing the solution of many mathematical problems. Mathematics teachers' use of these programs in their professional activities allow using a complex mathematical machine without learning algorithms at the professional level, in particular, while training specialists in engineering, and during the implementation of a project method while learning Mathematics [5]. Modern systems of computer Mathematics that are equipped with text editors allow teachers to use them while preparing scientific publications [19].

**Publishing popular scientific materials.** The presentation of your achievements is the most common type of activity among Internet users all over the world. The teacher can post video lessons, video lectures, practical classes using the platforms YouTube, and TED Talks. Teachers can popularize their experience having a personal blog on Blogger, in Google applications or mathematical pages on Instagram.

**Publishing research papers.** Using Open Science in Ukraine [21] helps the teacher, would-be scientist, postgraduate students, and Master students to find sites with the list of specialized editions of Ukraine and Ukrainian editions that are indexed in Scopus and Web of Science. If the teacher has publications in the editions that are indexed in Scopus and Web of Science, then the registration in the world database Scopus [30] and database Web of Science [52] will allow the teacher to get a h-index in Scopus and h-index in Web of Science, accordingly. Being registered in Google Scholar the teacher can monitor the citation of their publications in the editions of another level. Having a personal identifier ORCID iD [22] the teacher identifies himself / herself as a scientist and author of researches. The identifier ORCID iD guarantees the scientist: correct citation of their articles, the possibility to publish articles in prestigious international scientific editions, possibility to form a personal rating in Ukrainian scientific citation index, a possibility to take part in international ratings, a possibility to apply for grants.

**Designing presentations.** The teacher's learning of at least one of the programs PowerPoint, Keynote, Google Slides, Prezi, Quick Slide Show, Zoho Show, Google Presentation to work out stream presentations will allow supporting a speech with a presentation to visualize materials of a lecture or a practical class. The presentation and its demonstration to students especially during online education encourage a more efficient understanding of the material presented by the teacher.

**Collaboration.** Learning such tools as CoCalc, Google Drive, Evernote, OneNote, Blackboard Collaborate, Wikipedia will allow the teacher to create notes, have an event calendar, discuss

new ideas with colleagues, use possibilities of common document editing by several users, organize communication with students [25].

**Communication.** Services of online communication such as Facebook, Twitter, LinkedIn, Yammer, e-mail, Skype are better in the teacher's communication with colleagues and students. Using the service Zoom will allow the teacher to hold classes in form of video conferences and online meetings with colleagues and students. Using WhatsApp allows users an immediate exchange of text messages via voice and video connection.

**Storing data.** Services Microsoft HDInsight, Skydrive, Google Drive, Dropbox will help the teacher to organize efficiently data storing. The use of these services enables the teacher to store files in the cloud, synchronize on several devices, easily exchange big files, and cooperate using them with colleagues and students.

## 3. Results

Creating a selection of Web-tools that support the teacher's activities we considered the respondents' answers to the survey questions.

From the offered types of activities of a higher school teacher's PLE model, the respondents consider the organization of learning activities the most important (78.3% of respondents). The second place is given to such types of activities as carrying out researches, analysis, and statistical information processing, and publication of scientific materials. Cooperation is in the third place (60.9%), and the fourth is given to communication (52.2%).

Let's show the division of teachers' opinions regarding the use of Web-tools according to the types of their activities.

To the question: what tools for the organization of learning activities do you use most often – the respondent in 80.4% of cases answered Moodle, the platform Coursera took the second place – 23.9% (figure 2).

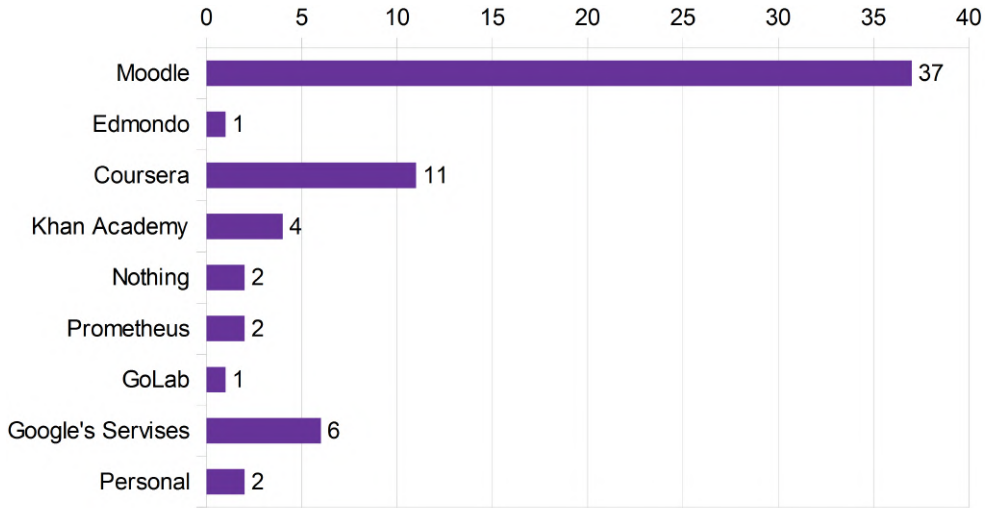


**Figure 2:** Tools for the organization of learning activities.

Google is most often used during the searching activities – 89.1% (figure 3).

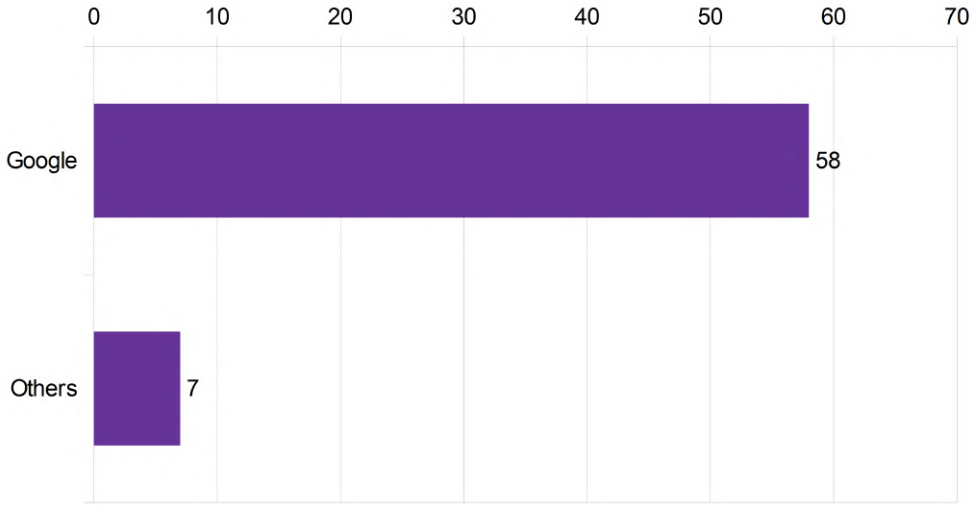


**Figure 3:** Tools for searching activities.

In order to carry out research, analysis, and statistical information processing respondents use different software, in particular, 87% choose QtiPlot, Statistica, StatGraphics, SYSTAT, MS Excel, STADIA; 21.7% mainly use online-calculators (figure 4).

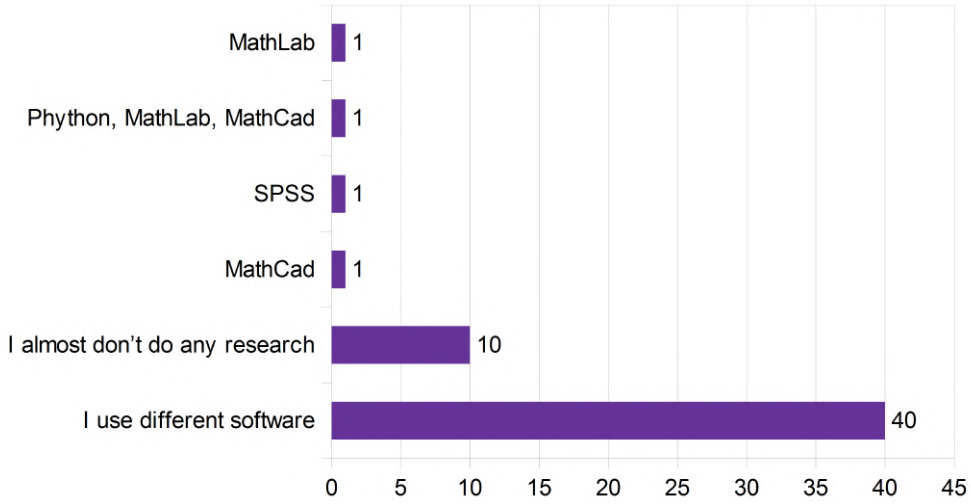


**Figure 4:** Tools to carry out research, analysis, and statistical information processing.

In order to carry out calculations, 73.9% of respondents use different software such as MathCad, Maple, MATLAB, Cantor, KAlgebra, Mathomatic, Scilab, Maxima, Octave, FreeCAD, PythonCAD, QCAD, Varkon, Linuxcad, Varicad, Cycas, Tomcad, Thancad, Fandango, Lignumcad (figure 5).

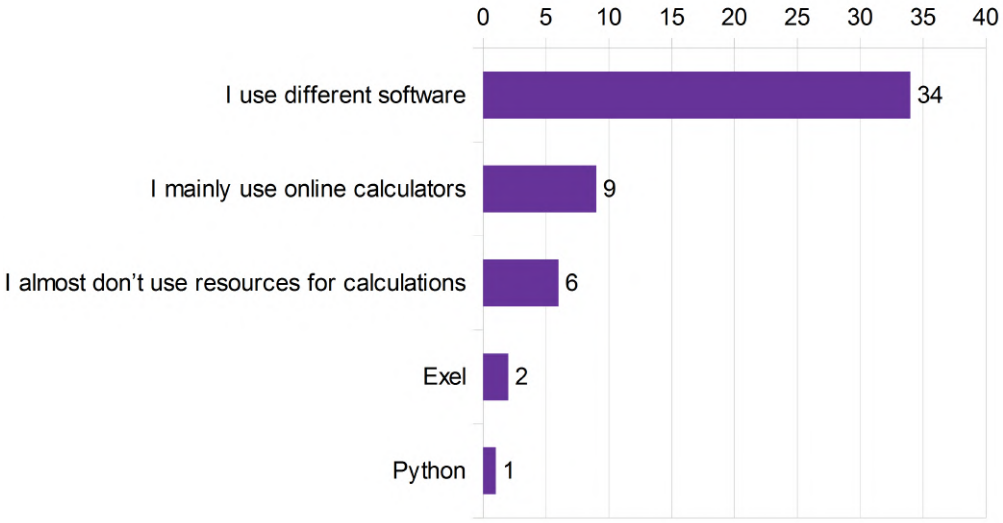


**Figure 5:** Calculation tools.

More than half of respondents don't use any tools for publishing scientific–popular materials; others prefer YouTube (21.7%) (figure 6).

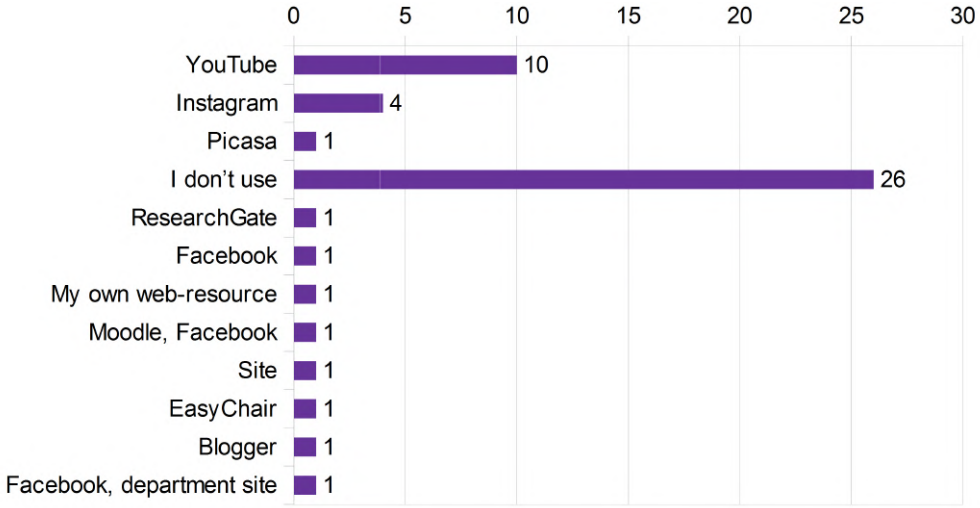


**Figure 6:** Tools for publishing scientific-popular materials.

95.7% of the participants publish scientific articles in specialized publications, 80.4% publish in publications indexed in Scopus and Web of Science; 89.1% of the respondents participate in conferences and publish theses (figure 7).

80% of the teachers choose PowerPoint among the tools to create presentations of speeches and materials, only 31.1% of the participants search for its alternatives (figure 8). 67.4% of the teachers

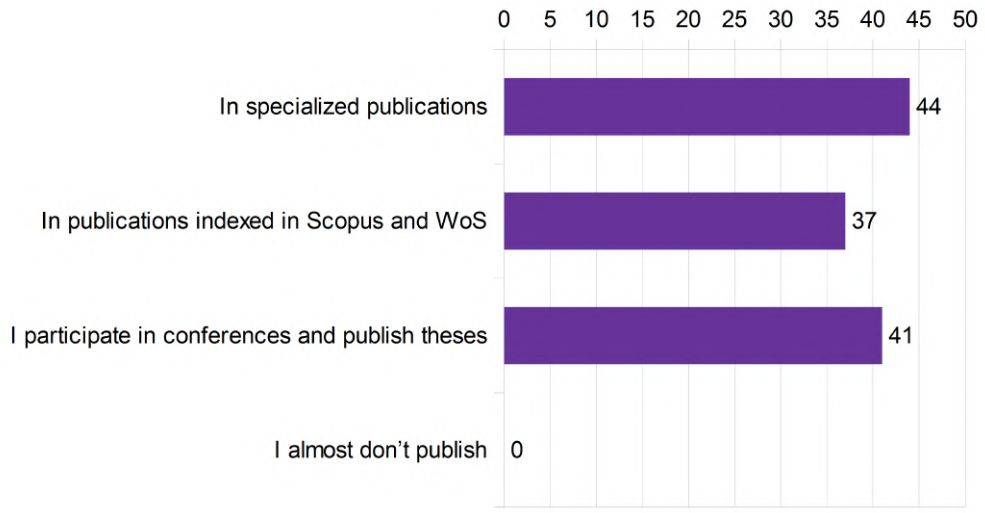


**Figure 7:** Publication level for publishing scientific articles.

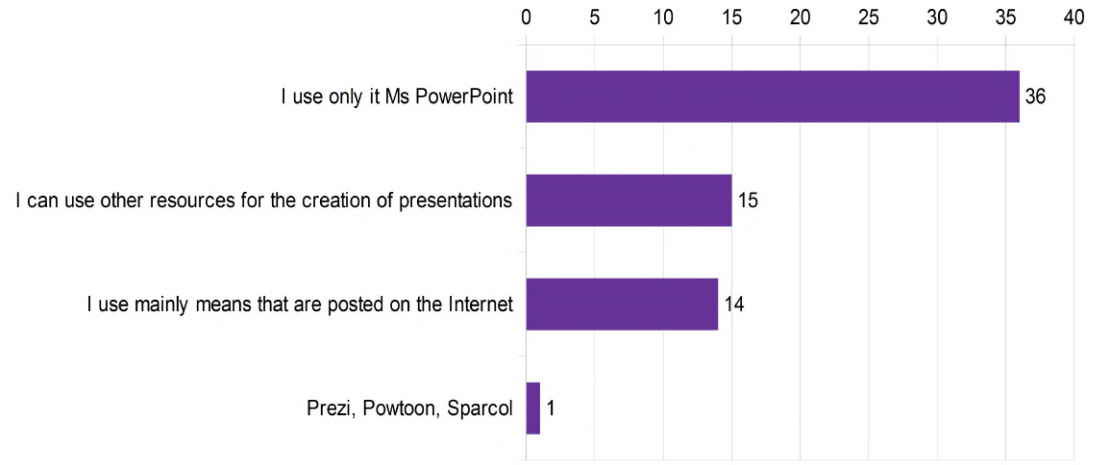


**Figure 8:** Tools for creating presentations.

use Google Docs for cooperation, notes, common work over the documents (figure 9). 93.5% of the surveyed teachers use email for communication, 89.3 % of respondents use communication tools messages WhatsApp, Viber 80.4% of respondents use Facebook (figure 10).

Google Drive is popular for storing data among the majority of respondents (84.8%) (figure 11).

Thus, this survey has shown that university Mathematics teachers are not knowledgeable enough in using PLE tools for different types of activities. In most cases, teachers use the same means for years. It is also proved by the fact that 39.1% of the respondents agreed to take a test according to the program "Survey of Adult Skills" [34] that assesses adults' knowledge in key skills of processing information, in particular, the use of their skills at home, at work and in public (figure 12).

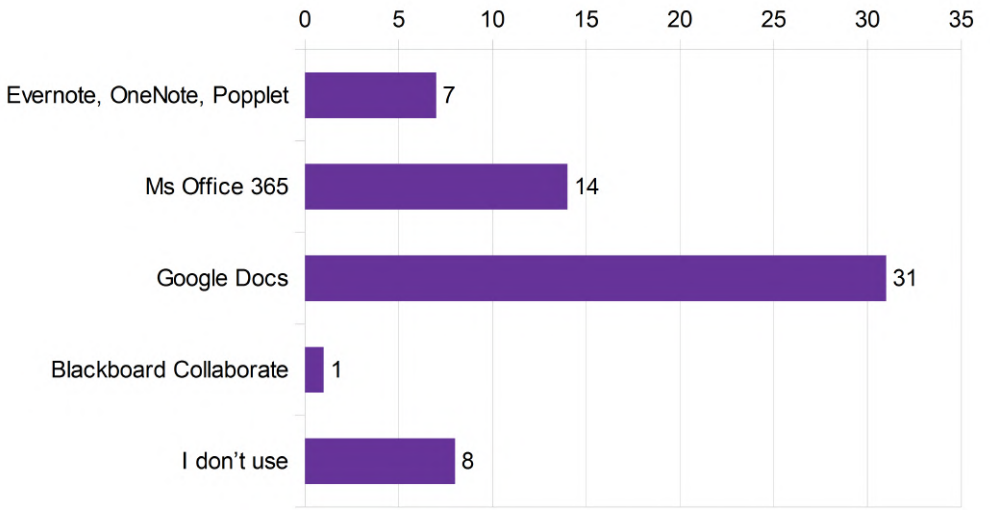


**Figure 9:** Tools for cooperation organization.

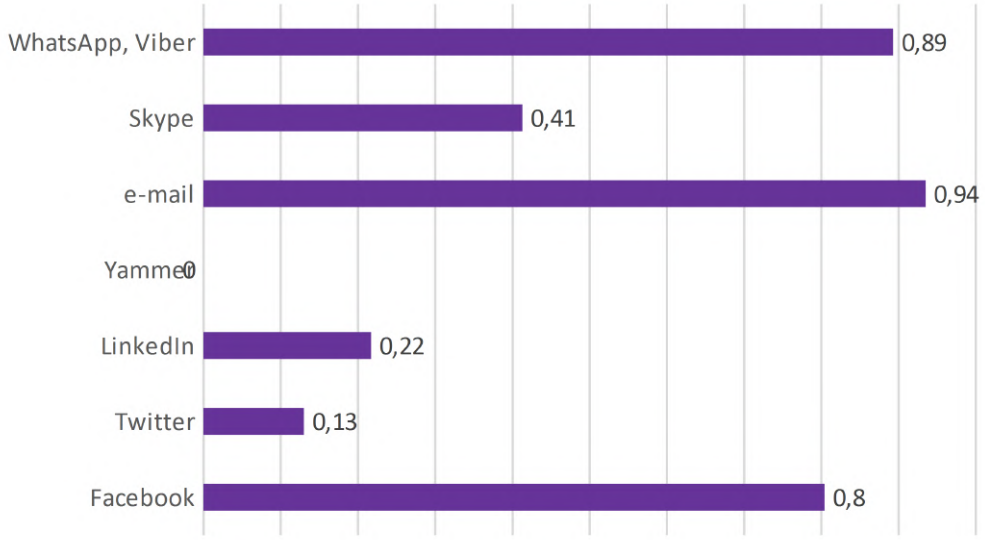


**Figure 10:** Communication tools.

The survey shows that university Mathematics teachers require support in using PLE tools for different types of activities.

## 4. Discussion

Identifying the activities of University Mathematics teachers, the researchers in this study also consider the opinions of Shaikh and Khoja [32], Vlasenko et al. [45] who believe that the

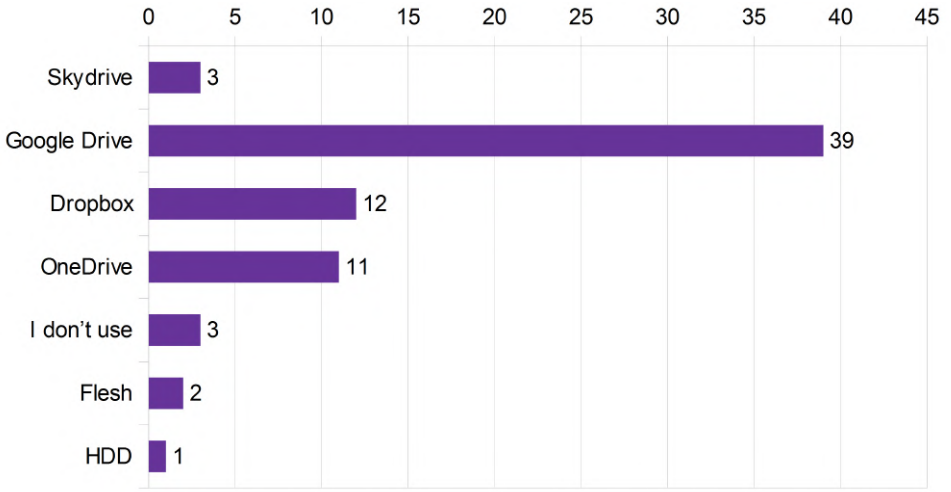


**Figure 11:** Tools for storing data.

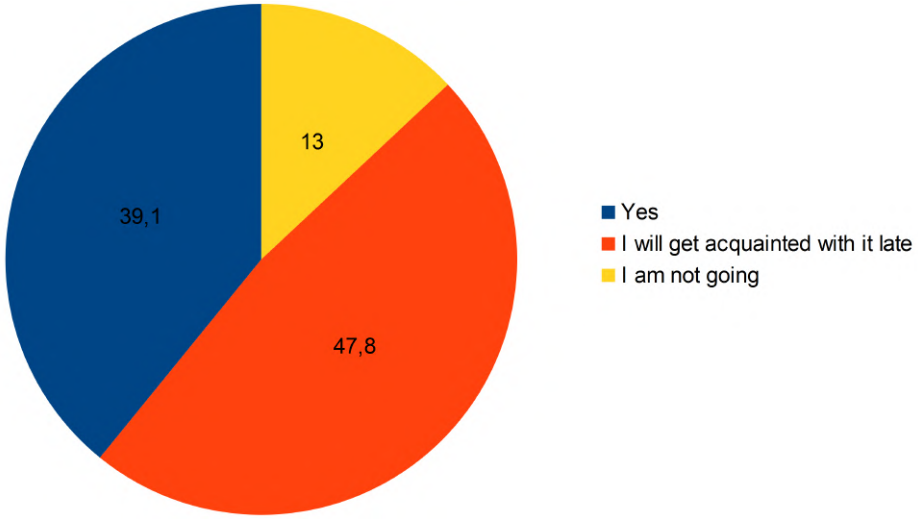


**Figure 12:** Teachers' distribution according to their agreement to take a PIAAC test (in%).

teacher's professional activity is so various, as it comprises a lot of roles, for instance, Instructive Role, Cognitive Role, Designing Role, Planning Role, Social Role, Managerial Role.

Analyzing the results of the research by Bennett et al. [4], Perikos et al. [24], Yadav and Patwardhan [53], as well as responses of Ukrainian University Mathematics teachers, the authors of this paper concluded the deficient level of awareness of Ukrainian University Mathematics teachers about Web 2.0 tools usage.

Taking into account the conclusions of the researches by Scherer Bassani and Ferrari Barbosa [29], Tautkevičienė and Dubosas [35] about the limited involvement of Web 2.0 tools by teachers, we completely agree with Alhassan [2] 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 Yadav and Patwardhan [53] has proved our idea about the necessity to carry out a theoretical analysis of the technical capabilities of Web 2.0 technology, the use of which can interest teachers.

Ranking Web 2.0 services and their distribution following the types of activities carried out by a Mathematics teacher ensures the development of a useful personal environment that will enable the teacher to use different learning strategies and technologies during students' training. Searching for a solution to this problem, Perikos et al. [24] proposed developing online courses for non-formal teachers' education. The idea of developing online courses aligns with the conclusions by Lovianova et al. [18], Vlasenko et al. [42, 47, 48, 49, 50] that studied the matter of developing online courses.

## 5. Conclusions

The analysis of the resources and research papers supported the assumption, made by the authors of the present study concerning the necessity to use a wide range of Web 2.0 tools for carrying out various types of activities by teachers and students. Relevance and timeliness of designing a PLE model of a University Mathematics teacher result from specificities of a Mathematics teacher's professional activities, and from the necessity to constantly improve their ability to use new resources.

Using deductive content analysis and taking into consideration the results of the survey, conducted among the Ukrainian teachers made it possible to identify the types of activities carried out by a University Mathematics teacher. With the help of the inductive content analysis method, the authors of the present paper processed the data on ranking Web-tools by demand, popularity, and prevalence. The respondents' answers to the survey questions and identifying awareness of Ukrainian teachers about the use of Web-resources for each type of activity became determining in designing a PLE model.

The authors of the present study are concerned that the solution to this problem lies in developing an online course for University Mathematics teachers to show them the advantages of using a personal e-learning environment and methods for designing it. The course can also be used by Master students majoring in Mathematics and all those who are interested in designing a personal e-learning environment.

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