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METHOD OF DETERMINING THE PARAMETER OF QUALITATIVE EVALUATION OF A WEB FORUM

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ABSTRACT

Context. The development of new types of virtual environments is an urgent task of informatisation of modern education, since such services allow enhancing the quality of educational services and contribute to a deeper assimilation of new knowledge by students. A web application proposed in this paper has been built using modern approaches to creating web pages using the .NET programming language, Bootstrap and ASP.NET MVC frameworks, Azure cloud solutions and Azure SQL databases, which has enabled the simplification of software development by distributing functions between the application modules and provided the flexibility, performance, and security necessary to work with relational data. The effectiveness of the application in the educational process has been experimentally tested using the method of determining the qualitative evaluation of the web forum usefulness parameter, which was developed by introducing an informative parameter of the discussion quality based on the *h*-index (sometimes called the Hirsch index or Hirsch number).

Objective. To build a mathematical model of a web forum and develop a method of determining the qualitative evaluation of the parameter of usefulness of discussions in the created web application, which would allow improving the quality of educational and scientific activities in a higher education institution.

Method. A method of determining the parameter of qualitative evaluation of a web forum using the *h*-index has been developed, which enabled analysing the interest in covering the trends of discussion on the forum pages and planning on its basis further work of the forum as a tool of a virtual learning environment.

Results. Based on the analysis of the results of the implementation of the web application in the educational process of the Department of Information Technologies Vasyl Stefanyk Precarpathian National University, the user activity of posts has been analysed and the effectiveness of discussions of the proposed topics on the forum pages has been determined using the introduced activity parameter.

Conclusions. A mathematical model of a web forum has been built, and the application has been implemented using modern approaches to software development using an optimised MVC architecture, which enabled simplification of creating a service by distributing responsibilities between the application modules and facilitating testing and technical support of the service.

The scientific novelty of the study is the development of a method of evaluating the usefulness of discussions in a web forum by introducing a new informative quality parameter, the use of which allowed broadening the scope of existing limitations in quantitative analytics of discussions and feedbacks in popular services. Experimental studies carried out on the basis of a higher education institution have confirmed the effectiveness of the method application to improve the quality of educational services. The practical significance of the obtained results is the development of a software product as a tool of the virtual learning environment of a higher education institution.

KEYWORDS: virtual environment, web forum, mathematical model, cloud technologies, activity parameter, method of qualitative evaluation of a web forum.

ABBREVIATIONS

HEI is a Higher Education Institution;
WBL is a Web-Based Learning;
LMS is a Learning Management System;
CC is a Cloud Computing;
SQL is a Structured Query Language;
MVC is a Model-View-Controller;
B is a Byte;
ZB is a Zettabyte.

NOMENCLATURE

$Forum_i$ is a mathematical model of the forum;

$ForumName_i$ is a name of a specific forum for discussion;

$CreatedBy_i$ is a forum member who created the discussion;

$Content(Forum_i)$ is a content of the discussion;

$User_i$ is a user model;

$N^{(User)}$ is a number of forum users;

$Email_i$ is a user's email address;

$PaswordHash_i$ is a user's password in the form of a hash;

$UserName_i$ is a username;

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$IsActive_i$ is a Boolean variable of the user activity;

$MemberSince_i$ is a date of registration on the forum;

$ProfileImageUrl_i$ is a path to the profile photo;

$Rating_i$ is a user rating;

$Topic(Forum_i)$ is a set of discussions that belong to the forum $Forum_i$;

$TopicName_i$ is a discussion title;

$TopicAuthor_i$ is a discussion author;

$TopicDate_i$ is a date of creation of the discussion;

$Post(Topic_i)=\{Post_i\}$ is a set of publications in the i^{th} discussion;

$Post_i$ is a model of publications;

$PostAutors_j$ is a set of users participating in the discussion;

$N_i^{(PostAutors_j)}$ is a number of publications of the j^{th} author in the i^{th} discussion;

$\{m\}=\{N_i^{(PostAutors_j)}\}$ is a set, each element of which indicates the number of publications of the j^{th} author in the i^{th} discussion;

H_i is a *h*-index of the discussion $Topic(Forum_i)$;

K_i is a parameter of the discussion activity $Topic(Forum_i)$.

INTRODUCTION

The past few decades, with the intensive development of modern information technologies and the availability of the Internet, have been characterised by unique opportunities for self-education that are constantly evolving and improving. The World Wide Web has become a source of intellectual activity for modern students and teachers, who have unlimited opportunities to gain knowledge, improve their skills and develop professional skills [1].

The educational process and the university management system are constantly being digitised, which are the main factors that allow not only enhancing the management effectiveness by automating various activity areas of a higher education institution (HEI), but also raising its social significance as a centre for generating and disseminating new knowledge and information, ensuring its competitiveness and the quality of professional development training [2].

One of the popular areas and trends in modern education is the introduction of web-based learning (WBL) and the use of various web-based learning environments, such as automated learning systems, web portals, and cloud-based LMS. Web forums are also a leading modern and relevant tool of informatisation, which are the resources that provide an opportunity to exchange ideas and opinions between users from different countries and regions on various topics such as education, science, technology, politics, sports, medicine, art, and others.

Such web applications appeared almost as soon as the Internet era began. The conventional approach to organising a discussion or forum began with standard online bulletin boards and has evolved smoothly in response to new user needs, having become an integral part of the World Wide Web. Today, forums serve as the main mechanism for ordinary users to express their opinions on any topic, as well as for teachers, students and researchers to find answers to relevant self-education questions.

Comments made in discussions are usually managed by those who are responsible for this and checked for compliance with the terms and requirements of the site. When a post on a forum receives a certain amount of attention and comments, you can see how its display resembles a tree structure. That is, a single post can be seen as the root, and each reply is like the beginning of a corresponding branch. Some trees are wide and shallow: everyone responds to the author's thesis; other trees are narrow and deep: when two people argue "back and forth" and only a few users participate in the discussion of a common topic.

Notwithstanding that such forums were created at the beginning of the Internet development, they are still popular among users and occupy one of the highest ranking positions among the most visited websites in the world.

Therefore, the development of new types of virtual environments as tools of informatisation of education, in particular, web forums that would account for the advantages of known solutions and eliminate their disadvantages to functionally improve the interaction of the web service with the user is an urgent scientific and applied task that requires in-depth theoretical and software research.

The object of the study is the process of developing a web forum as a model of a web-based learning environment.

The subject of the study is a method for determining the qualitative evaluation of the usefulness parameter of discussions on a web forum.

The aim of the work is to build a mathematical model, develop a web application on its basis to create a modern software product and study the effectiveness of discussions on topics using the method of determining the qualitative evaluation of the usefulness of discussions, which will improve the quality of educational and scientific activities at higher education institutions.

To achieve these goals, the paper solves the following problems:

– to analyse known software solutions for creating web forums, to identify their advantages and disadvantages and to account for them in own development;

– to build a mathematical model of a web forum for the implementation of the application software logic;

– to develop a method of qualitative evaluation of the usefulness of discussions;

– to programmatically develop the service using modern technologies for building web pages;

– to carry out an experimental test of the application of the proposed development during the organisation of

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the educational process in a higher education institution, and to substantiate the effectiveness of the research results and their feasibility in the educational sector.

1 PROBLEM STATEMENT

When creating modern web-based learning environments, developers face a large number of challenges related to the problems of how to account for the features of organising virtual communication between participants in the educational process, issues of software implementation based on the use of development tools and the choice of services for further deployment. In addition, a key stage for possible introduction of such services into the educational process is to substantiate the effectiveness of their use using both known and own developed research methods. Therefore, there is a need to both create new types of learning environments and to develop effective and reasoned methods for studying the feasibility of their use.

Assume that the model of discussion $\mathrm{Topic}(\mathrm{Forum}_i)$ started on a forum Forum_i by a user $\mathrm{TopicAuthor}_i$ is represented by the following characteristics:

$$\mathrm{Topic}(\mathrm{Forum}_i)=<\mathrm{TopicName}_i,\mathrm{TopicAuthor}_i,\ \mathrm{TopicDate}_i,\mathrm{Post}(\mathrm{Topic}_i),\mathrm{K}_i>. \quad (1)$$

To qualitatively evaluate the activity of the discussion $\mathrm{Topic}(\mathrm{Forum}_i)$, a parameter $\mathrm{K}_i=\frac{\mathrm{H}_i}{\mathrm{t}}$ was introduced (2), which is defined as the ratio of the *h*-index H_i of the discussion $\mathrm{Topic}(\mathrm{Forum}_i)$ to the time t, during which the activity parameter is evaluated [3].

For further implementation of the software, a mathematical model of a web forum Forum_i is needed based on modern approaches to building web pages using the .NET programming language, Bootstrap, ASP.NET MVC frameworks and data storage in Microsoft Azure cloud services (Azure SQL, Azure Blob), and the effectiveness of the proposed service in the educational process should be studied based on the method of evaluating the proposed discussion usefulness indicator K_i.

2 REVIEW OF THE LITERATURE

The studies of both domestic and foreign scientists and developers show a growing interest in the creation of various web applications, which, owing to the use of an accessible and user-friendly interface, have become an indispensable source of information for modern people. Virtual subject communities have gained particular popularity, the number of which is constantly growing and reaching a wider audience [4].

The most quoted definition of 'virtual communities' among foreign and Ukrainian researchers is that of H. Rheingold: "Virtual communities are social associations of people that grow out of a network when a group of people hold an open discussion of a problem for a long enough time and do so in a humane enough way to form a network of their personal relationships in cyberspace" [5].

Scientific research aimed at studying virtual communities is reflected in the paper [6], the development of a classification of virtual environments is carried out in the paper [7], paper [8] analyzes the research of foreign scientists on this issue.

To create and maintain virtual environments, appropriate cloud technologies are required, the most common of which is cloud computing (CC). The concept of CC is to provide end users with remote access to dynamically scalable computing resources, services, and applications (including operating systems and infrastructure), which are maintained and updated by a service provider [9].

In 2023, about 50 ZB of information was stored in the cloud (1 ZB = 270 B). This figure is expected to reach 100 ZB by 2025.

According to the analytical resource *datereportal.com*, forums as tools of virtual communities are still at the top of the most visited websites in the world. In particular, the following forums are currently considered to be the most popular:

– *Reddit* [10] is one of the best known forums in the world today, founded in 2005, reaching around 330 million visitors monthly and up to 57 million unique active visitors daily;

– *Quora* [11] is an online forum designed to increase the knowledge level of programmers and other computer science professionals with an estimated 300 million users;

– *Stack Overflow* [12] is an online forum where discussions on various trends in programming are ongoing with the involvement of highly qualified experts.

As for forums in the education sector, the most popular forum in Ukraine is *Osvita.ua*.

The advantages and disadvantages of the most popular forums are summarised in Table 1.

Based on the analysis of popular forums, it was determined that despite so many positive aspects of each of them (for example, the creation of thematic forums, the possibility to filter posts, multilingual extensions, the availability of numerical analytics of views and posts), the main disadvantage is the lack of a qualitative parameter for evaluating each discussion, which can be used to determine the qualitative characteristics of the interest of users in the relevant topic.

Therefore, the result of this work is the development of a web platform where users can create their own forums, participate in discussions, share information with other users and study the effectiveness of its quality use using the method of evaluating the usefulness of web forum discussions.

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Table 1 – Advantages and disadvantages of popular forums

Forum name	Advantages	Disadvantages
Reddit	– the possibility to create your own thematic forums (*subreddits*); – the availability of a voting system; – the use of various moderation algorithms to ensure the comfort and safety of users; – the availability of statistics on the number of posts and participants at the current time.	– restriction of freedom of speech by the moderator; – difficulty in finding useful information (due to the large number of messages); – most information is available only in English.
Quora	– simple and user-friendly interface; – the possibility to use the division of questions into categories; – an edit function that allows users to edit and improve questions and answers in a foreign language; – multilingual extension; – availability of statistics on the number of positive and negative votes.	– the need for a continuous expert feedback channel to comment on current issues; – intrusive advertising and sending unnecessary emails that may annoy users.
Stack Overflow	– standard format and arrangement of questions and answers; – the possibility of publishing codes and program examples; – ensuring a plurality of options for answers to the questions posed; – possibility to filter publications (latest, active, unanswered).	– the quality of answers is not always high enough; – oversaturation of the site with questions from various areas; – high dependence on the number and qualifications of involved experts.
Освіта.ua	– access to the publication of posts and blogs for registered users; – the possibility of receiving answers to any questions related to education and training both in Ukraine and abroad; – the possibility of obtaining analytics on the activity of visitors (answers, views).	– oversaturation of the site with questions from parents and teachers, which do not always relate to the educational process; – the absence of a qualitative parameter for evaluating the activity of discussions.

3 MATERIALS AND METHODS

A web forum is a type of virtual learning environment in which the information content consists of a set of forums, a set of discussions, and a set of messages. A mathematical model of a web forum is organised as a hierarchy, with the forum itself at the top level.

The structure of the web forum platform is as follows:

$$\text{Forums} = <\text{Forum}_i, \text{User}_i>. \quad (3)$$

Consider the model of a web forum (3). A forum, as an integral part of a service, has its own topic and target audience. It is characterised by the following parameters:

$$\text{Forum}_i = <\text{ForumName}_i, \text{CreatedBy}_i, \text{Content}(\text{Forum}_i)>.$$

A user of a web forum can be considered any person who visits the site, reads or interacts with its information content in the form of discussions and answers to questions. The model of a web forum user User_i is given in the form:

$$\text{User}_i = <\text{Email}_i, \text{PaswordHash}_i, \text{UserName}_i, \text{IsActive}_i, \text{MemberSince}_i, \text{ProfileImageUrl}_i, \text{Rating}_i>.$$

Then a set of the forum users is represented as:

$\{\text{User}\} = \{\text{User}_i\}_{i=1}^{N(\text{User})}$ is a set of the forum users.

The information content of the forum discussion (topic) $\text{Content}(\text{Forum}_i)$ is as follows:

$$\text{Content}(\text{Forum}_i) = <\text{Topic}(\text{Forum}_i), \text{PostAutors}_j>.$$

Each discussion $\text{Topic}(\text{Forum}_i)$ is described by the following parameters:

$$\text{Topic}(\text{Forum}_i) = <\text{Post}(\text{Topic}_i), N_i^{(\text{PostAutors}_j)}, m>.$$

A discussion is actually a key part of a forum, which can be created by the administrator or another registered user. It is a collection of messages related to a single topic and arranged in a chronological order, as shown in (1).

In each discussion, users expect that there will be some kind of post from other forum participants. Forum posts can be considered as the smallest piece of information content that has an atomic structure.

The *h*-index H_i for the i^{th} discussion will be calculated similarly to its calculation for scientific papers, i.e. as a function of the number of publications and their authors. Assume that 10 forum users took part in the discussion of the i^{th} discussion, each of them published a certain number of posts. For example, user 1 posted 1 post, user 2 posted 2 posts, user 3 posted 4 posts, ..., user 10 posted 7 posts. Then the set $\{m\}$ for this example will include the following elements:

$$\{m\}=\{1, 2, 4, 5, 3, 1, 6, 6, 2, 7\}.$$

The *h*-index H for this discussion, will be equal to 4, as this is the minimum number of posts that have been made by users with at least 4 posts (in this case, the number of such users is 5). The index cannot be equal to 5 because the number of users with at least 5 posts is 4.

To determine the *h*-index according to the described method, an algorithm has been developed that calculates the value of H depending on the number of users p_k and their publications m_k in a specific discussion (Fig. 1):

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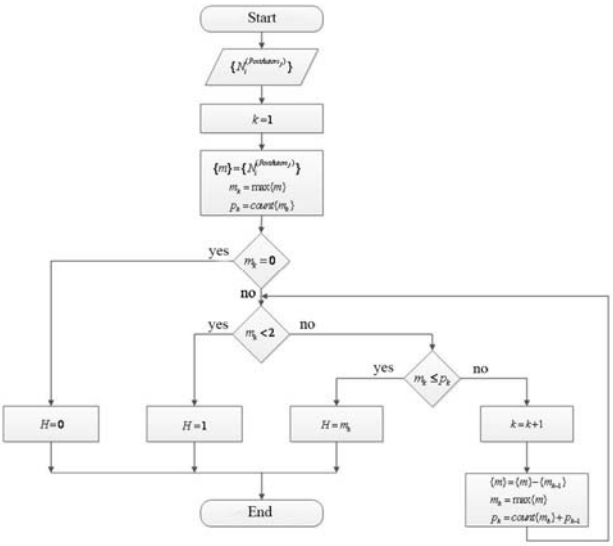

Figure 1 – Algorithm for determining the *h*-index for discussion

The activity indicator of the i^{th} discussion over time t according to formula (2) will be determined as the ratio of the calculated index H to the time during which the discussion is being analysed.

The mathematical model built in this way serves as the basis for the software implementation of the web application, which is made using a number of modern development technologies and cloud services.

In particular, the front-end part of the service was implemented using the Bootstrap framework, which is a powerful tool for creating a user interface [13].

Asp.NET MVC, a reliable and flexible framework for creating web applications running on .NET, was used on the back-end of the application [14]. MVC is a design pattern that divides the logic of the application into three main components: a model (*Model*), a presentation (*View*) and a controller (*Controller*). This architecture provides built-in support for scaling, which allows expanding the forum with the growth of users and requests, and facilitates the division of functionality into separate components, which makes it easier to develop, test, and maintain the project [15].

The use of cloud services allows developers, on the one hand, to focus directly on coding, without worrying about the support and maintenance of the infrastructure, on the other hand, the services provide high flexibility, scalability, and performance of the application [16].

Based on the proposed mathematical model of the forum (3) and in accordance with the MVC architecture, a graphic model of the logical structure of the service is presented (Fig. 2).

This model includes properties that describe various aspects of the forum, its characteristics and relationships with other models (for example, *PostModel* for describing the structure of posts, *PostReplyModel* for a described structure for replies to posts).

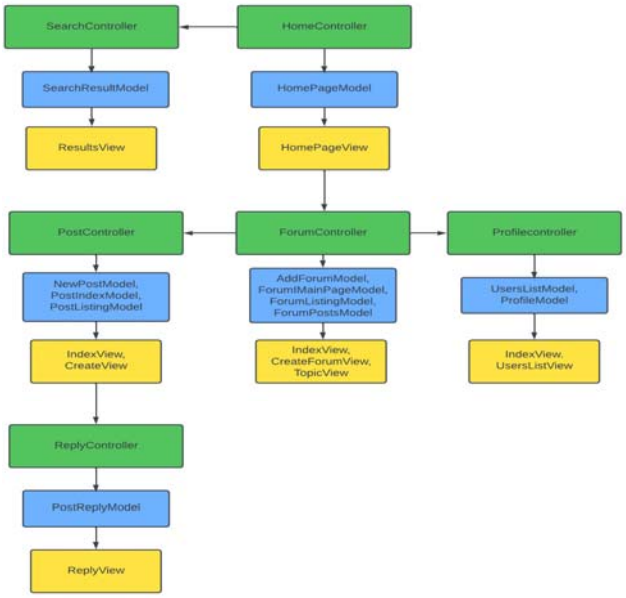

Figure 2 – Graphical model of the MVC logical structure of the *ForumModel* web forum

For each user, after visiting the platform, to be able to receive a list of forums in a proper form (Fig. 3), a controller *ForumController* was developed. It describes the logic of how forums should be displayed. First, there is a request to the database, which is structured according to an additional *ForumListModel* model.

To calculate the efficiency ratio, the *PostReplyModel* module was used, the use of which allows implementing the functionality for calculating the efficiency ratio of each discussion according to the algorithm presented in Fig. 1.

In particular, Fig. 3 shows the view of the forum for an ordinary user, which displays the list of existing discussions and the numerical values of the corresponding usefulness coefficients K_i:

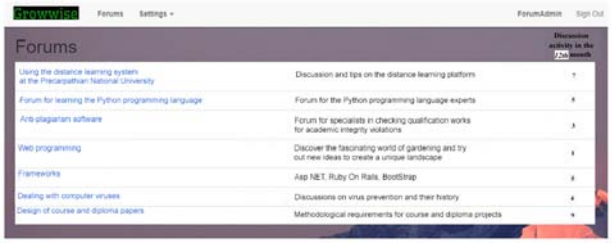

Figure 3 – Screenshot showing the list of existing discussions and indicators of their activity

Thanks to the MVC philosophy, each element harmoniously interacts with other components of the model. The example page in Fig. 3 demonstrates how, after the user opens the list of forums, a view activates the controller and interacts with the model to provide the user with the necessary information about the activity of each discussion.

Also, the developed web forum enables implementing the following functionality:

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1) search requests – implemented using a *HomePageSearchController* controller, in which a method has been added that performs the search function among existing forums and discussions;

2) the possibility to display a dynamic navigation menu for different user roles. To do this, a *ProfileController* was created, which describes a function about where the information for this page should come from;

3) the possibility of participating in discussions and publishing answers. To implement this functionality, a *ReplyController* was created, which describes a function that processes a new reply according to the *PostReplyModel* that was created earlier.

In the first release of the project, the MySQL database was used to ensure the necessary storage and organization of data, the use of which allows working efficiently with data and ensures stable and scalable development of the application (Fig. 4):

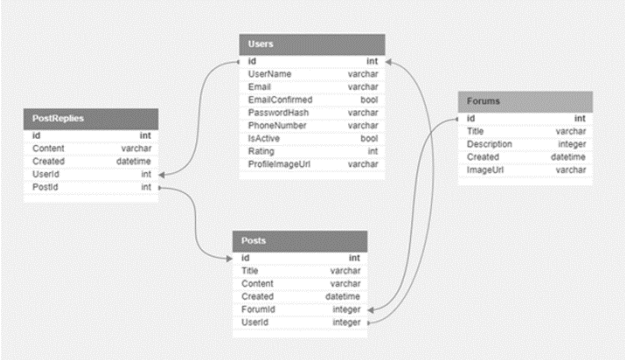

Figure 4 – Data schema diagram with corresponding relationships between the tables

In the process of testing the development, a transition to Azure SQL was made, which is a fully managed database service in the cloud and provides high data security. This transition allows using all the advantages of an Azure account and provides more flexible and scalable database management, as well as improved performance and availability of the application [17].

To successfully prepare data for migration, special tools such as Azure Database Migration Service or Azure Data Migration Assistant were used, which enabled performing both the analysis and planning of the data structure and the conversion of data types, as well as ensuring compatibility between MySQL and Azure SQL [18] (Fig. 5):

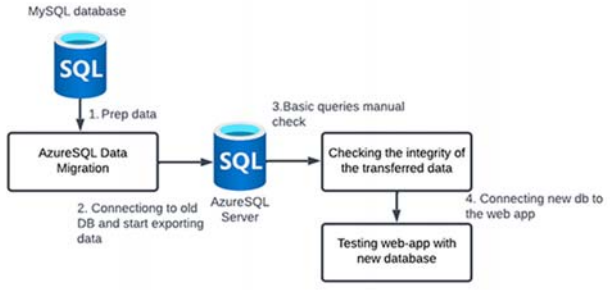

Figure 5 – Database migration scheme in Azure SQL Cloud

As soon as the migration was completed, the correct functioning of the application was tested and verified using the Azure SQL database.

4 EXPERIMENTS

The proposed service has passed the testing stage and has been successfully implemented in the organization of the educational process and scientific activity by teachers and students of the Precarpathian National University. This enabled realizing the creative ideas of contributors and to use non-standard approaches to solving problems in the process of studying at a HEI, to activate scientific and educational and cognitive activities of teachers and students.

Thanks to the involvement in the discussion of an increasingly wide range of users, both from the side of teachers and the student community, in a relatively short period of use (6 months), a number of important topics from the field of programming, problems of distance education, passing of educational and practical training by students, finding a place of employment and a number of others were covered and commented on the pages of the application (Fig. 6.):

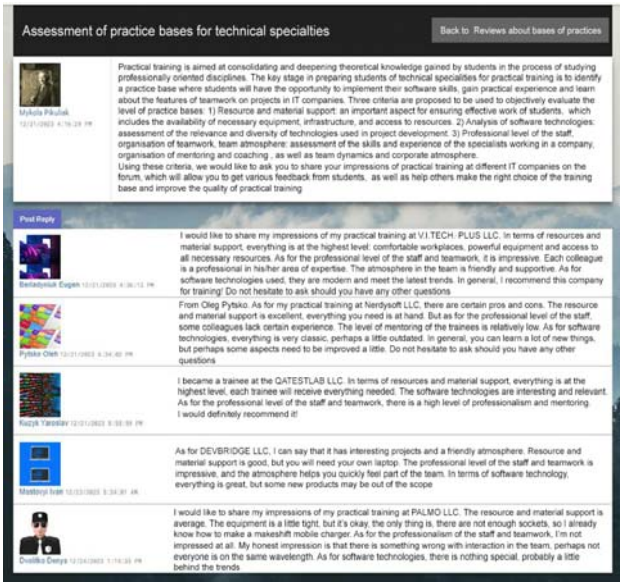

Figure 6 – View of the page with the published posts for the discussion

5 RESULTS

Based on the obtained indicators of activity, the interest in the topic of discussions at the forum was analysed over several months.

Fig. 7a and 7b present graphs of the analysis of the activity indicator for the months of December 2023 and January 2024, respectively.

The result of the implementation of the proposed service was not only an increase in the level of knowledge of students and the activation of scientific cooperation of teachers, but also concrete practical results of using the forum, which indicates an improvement in the quality of the educational process.

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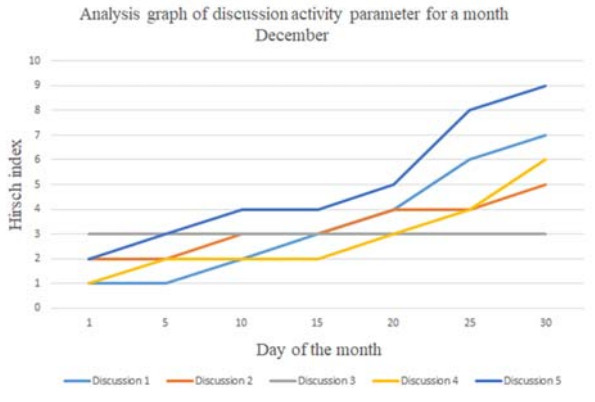
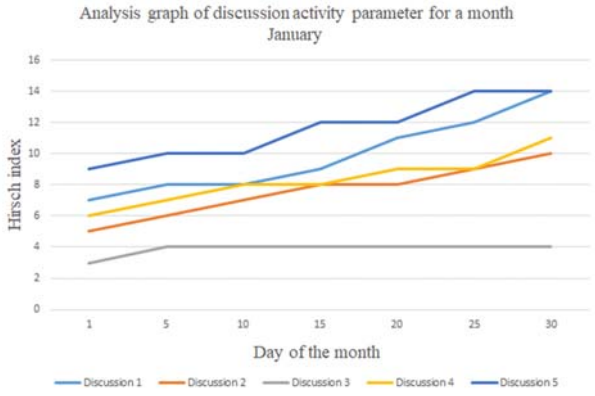


a



b

Figure 7 – Analysis graphs of activity indicators:
a – the month of December, b – the month of January

Thus, according to the results of the discussion by the students of the 4th year of the "Software Engineering" program on the topic of the quality of resource and information support of practical training bases, significant deficiencies were found in three practice bases in terms of providing the students with proper conditions for the implementation of the practical training program and the participation of the students in the development of software projects.

As a result of the analysis of the students' posts at the meeting of the Department of Information Technologies, a decision was made about the impracticality of further sending the students of the department for the training to the companies designated in this way, which will improve the quality of practical training of students.

Also, the discussion on the proposed service helped five 4th year students (which is 18% of the total number of students of the SE-41 group) to decide on the place of further employment, because as a result of the training, the students received invitations to work in corresponding IT companies.

For today, teachers and students of other programs are being involved in active discussion on the pages of the forum on various topics, which changes the role of participants in the modern educational process and promotes the search for new non-standard solutions in the field of education.

6 DISCUSSION

The development of web forums is an ongoing process, in which attempts are actively made to improve both the design and the introduction of new functionality, which contributes to the further development of this platform.

The use of the introduced qualitative parameter of the discussion activity allows constant monitoring the analytics of the user activity on the web forum and the level of interest in the corresponding discussion topics. Owing to this, the administrators of the services have the opportunity to organize and plan further work of the application, both in terms of expanding the range of topics and improving the functionality and user experience of the proposed web application of the forum.

A feature of the application of the proposed web forum in the future will be the use of the model *Software as a Service* (Saas) [19], which will allow providing software in the format of a service. Within the framework of this model, it will be possible to use the forum builder as a platform on which the users will have access to powerful tools for creating and managing posts, that is, they will be able to configure their own forums, adjust their functionality, design and adapt them to personal needs.

CONCLUSIONS

A mathematical model of the web forum was built, and the application was implemented using modern approaches to software development using the optimized MVC architecture, which enabled simplification of creating a service by distributing responsibilities between the application modules and facilitating testing and technical support of the service.

As a result of the analysis of well-known analogues, the requirements for the software implementation were determined and the main aspects of own development were formulated, which has convenient functionality, high reliability and meets the modern needs and requests of users.

The scientific novelty is the development of a method for evaluating the usefulness of discussions in a web forum based on the introduction of a new informative quality parameter, the use of which allowed broadening the scope of existing limitations in quantitative analytics of discussions and feedbacks in popular services.

The *h*-index was further used to evaluate the interest of users in the topics of discussions on the web forum.

An experimental verification of the use of the service in the educational process of the Precarpathian National University was carried out by evaluating the parameter of the usefulness of discussions, which enabled significant diversification of educational activities, increasing the level of practical training for students and improving the exchange and discussion of relevant programmatic and scientific issues for both teachers and the student community.

The practical significance of the obtained results is the development of a virtual educational tool, which enables

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improving the quality of the provision of educational services in a higher education institution.

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МЕТОД ВИЗНАЧЕННЯ ПАРАМЕТРА ЯКІСНОЇ ОЦІНКИ ВЕБ-ФОРУМУ

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АНОТАЦІЯ

Актуальність. Розробка нових типів віртуальних середовищ є актуальною задачею інформатизації сучасної освіти, оскільки подібні сервіси дозволяють якісно підвищити рівень надання освітніх послуг та сприяють більш глибшому засвоєнню нових знань студентами. Запропонований в роботі веб-застосунок побудований з використанням сучасних підходів створення веб-сторінок за допомогою мови програмування .NET, фреймворків Bootstrap і ASP.NET MVC, хмарних рішень Azure та баз даних Azure SQL, що дозволило спростити розробку програмного забезпечення шляхом розподілу функцій між модулями програми та забезпечило гнучкість, продуктивність та безпеку, необхідну для роботи з реляційними даними. Ефе-

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ктивність застосування у навчальному процесі експериментально перевірено із застосуванням методу визначення якісної оцінки параметра корисності веб-форуму, який розроблений за рахунок введення інформативного параметра якості дискусії на основі використання індексу Гірша.

Мета. Побудова математичної моделі веб-форуму та розробка методу визначення якісної оцінки параметра корисності дискусій у створеному веб-застосунку, що дозволило підвищити якість проведення освітньої і наукової діяльності у закладі вищої освіти.

Метод. Розроблено метод визначення параметра якісної оцінки веб-форуму з використанням індексу Гірша, що дало можливість виконати аналіз зацікавленості висвітлення напрямків обговорень на сторінках форуму та на його основі проводити планування подальшої роботи форуму як інструменту віртуального навчального середовища.

Результати. На основі аналізу результатів впровадження веб-застосунку в навчальний процес кафедри інформаційних технологій Прикарпатського національного університету імені В. Стефаника виконано аналітику користувацької активності дописів та за рахунок введеного параметра активності визначено ефективність дискусій запропонованих тем на сторінках форуму.

Висновки. В даному дослідженні виконано побудову математичної моделі веб-форуму та програмно реалізовано застосунок із використанням сучасних підходів до розробки програмного забезпечення за допомогою оптимізованої архітектури MVC, що дозволило спростити процес створення сервісу шляхом розподілу обов'язків між модулями програми та полегшити тестування і підтримку сервісу.

Наукова новизна полягає в розробці методу оцінки корисності дискусій у веб-форумі за рахунок введення нового інформативного параметра якості, використання якого дозволило розширити обмеження щодо кількісної аналітики обговорень та відгуків у відомих сервісах. Експериментальні дослідження, проведені на базі закладу вищої освіти, підтвердили ефективність його застосування для підвищення якості надання освітніх послуг. Практичне значення отриманих результатів полягає в розробці програмного продукту як інструменту віртуального навчального середовища вузу.

КЛЮЧОВІ СЛОВА: віртуальне середовище, веб-форум, математична модель, хмарні технології, параметр активності, метод якісної оцінки веб-форуму.

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