Current Trends in The Formation of Mathematical Terminology on An Online Platform

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Abstract— **The paper touches upon topical issues of creation and refinement of mathematical terms in the Karakalpak language. The necessity of introducing new mathematical vocabulary, enhancing existing terminology and aligning it with the continuous development of mathematics and contemporary scientific demands is emphasized. Consequently, our research proposes to create an explanatory dictionary specifically tailored for secondary schools and higher educational institutions. Also, taking into account modern realities, when modern ways of access to information coexist with traditional sources of information, our research has led to the decision to develop an online platform dedicated to mathematical terminology. A detailed analysis of various database management systems has been done in order to determine the most suitable option for achieving our goal. In addition, an examination of the existing online platforms across the internet was conducted in order to identify weaknesses and deficiencies, which informed in the development process. After creating the necessary foundation, the process of forming the necessary requirements to the system is considered, addressing potential challenges encountered during the process of creation and proposing viable solutions. Further, the technology and process of creating the platform is described, highlighting its advantages over existing platforms. The outcome is an online platform with high overall performance and efficiency in addressing user inquiries, offering various options tailored to the needs of identified users.**

Keywords— **Mathematical terminology; Karakalpak language; online platform; relational database; MySQL; API architecture.**

I. INTRODUCTION

Science plays a key role in modern society, driving technological development and having a huge impact on various aspects of life. Innovations and discoveries made by scientists lead to the creation of new technologies, improvement of existing ones and empowerment of mankind. Forms of communication allow information to be communicated, transmitted and received in a structured and organised manner. Without the ability to communicate scientific data, the world would not be able to progress in the field of science. And the importance of language as a means of communication and knowledge transfer is invaluable, as the correct delivery of scientific information is vital. Although the main scientific language of the modern world is English, it is undeniable that scientific communication in several languages, particularly in the mother tongue, has a greater effect. Such a question has been considered in the works of many authors (see [1], [2], [3], etc.).

Scientific communication in the mother tongue allows the results of scientific research to be more accessible to a wider audience within the country. It is important for scientific discoveries to become part of the cultural and educational heritage of a society. It is also the basis for the development of a national scientific environment, stimulating interest in science among young people and fostering the growth of local research communities. The mother tongue often carries a cultural context and unique terms that can be difficult to translate accurately. Using the mother tongue helps preserve this cultural context and prevents loss of meaning or

misunderstanding. Particularly applies to scientific terminology, which is the conduit of scientific literature. In this paper we consider the issue of creating an online platform for mathematical terminology. Without a doubt, good mathematical terminology plays a critical role in successful communication, education, research, and the practical application of mathematics. It also directly influences the results of mathematics education and research, and this aspect is covered in the works of many authors. In the work of Peng Peng and Xin Lin [4], the relationship between mathematical vocabulary and mathematics performance among school students was indicated. The analysis of knowledge of mathematical vocabulary of school students and the connection with general vocabulary and mathematical calculations was studied in the work of S.R. Powell, M.K. Driver, G. Roberts, A. Fall [5]. It is also worth noting the works [6] and [7], where the issues of forming mathematical terminology among primary schoolchildren, as well as teaching and learning mathematical vocabulary, were studied. This paper is devoted to the issues of improving the base of mathematical terminologies in Karakalpak language and creating an electronic platform of such terminologies.

A. Problem STATEMENT

With the development of mathematics, new concepts, theories, and research methods appear, which require constant updating of mathematical terminology. Modern mathematics strives for strict formalization and axiomatization of observable processes, as well as integration with other sciences such as physics, computer science, biology, and economics. This leads to the emergence of terms that combine concepts from different fields. Additionally, classical terms are sometimes revised or supplemented with new aspects to reflect contemporary views and requirements.

With the collapse of the Soviet Union in 1991, the former Soviet countries which became independent began to make efforts on their own "self" and restore values. In 1993, the Parliament of Uzbekistan adopted a law to abandon the Cyrillic alphabet and switch to the Latin one, and by 2023 all document circulation in Uzbekistan would have been switched to the Latin alphabet. Taking all these factors into account, and also that the last voluminous explanatory dictionary of mathematics (see [8]) was published more than 30 years ago, the question of enhancing the existing explanatory dictionary and supplementing it with new terms that have appeared in mathematical science during this time naturally arose.

To solve these problems, it is proposed to develop the publication of two mathematical explanatory dictionaries and to create an online platform of mathematical terms in Karakalpak language. This will ensure uniformity and standardization of terms, as well as improve access to mathematical information for various categories of users. In the process of creating an online platform of mathematical terms, several challenges are expected, namely:

Extensiveness and diversity of mathematical terms. Ensuring uniformity and standardization of mathematical terms, taking into account possible differences in the interpretation of terms in different sources.

- User Interface. Creating a modern and intuitive interface for users of the platform.

- Content management. Creation of an effective content management system ensuring accuracy and completeness of data.
- Database Requirements. Development of a reliable and efficient database capable of providing quick access to the created mathematical terms and their definitions.

To address these challenges, a team of mathematicians and experienced programmers representing various scientific and educational institutions has been formed. Our strategy involves a comprehensive analysis of modern online platforms for mathematical terms to identify the best approaches for shaping and extracting valuable lessons for our project.

It was decided to use the results of this analysis in the development of our platform, taking the diversity of represented terms and user needs into account. The choice of database management system, as well as platform requirements and design issues, were subjected to careful comparative and statistical analysis, to ensure optimal performance and user satisfaction.

The ultimate goal of our work is to create an innovative platform that not only ensures the accuracy and completeness of mathematical information but also be easily accessible and user-friendly for all user categories and open to third-party developers for improvement. We are confident that the methodology we employ, based on analysis and experience, will help overcome technical or conceptual obstacles encountered in creating an effective online platform for mathematical terms.

II. MATERIAL AND METHOD

In order to fulfil our objective, we have used the method of comparative and statistical analysis. We analyzed the characteristics of different database management systems to select the one more suitable for our purposes and also analyzed different online platforms to identify their advantages and disadvantages that will be taken into account in the development of the platform.

Selection of an adequate database management system. Database management systems used today in the development of information systems can be mainly divided into two groups. One is the relational database management system and the other is the non- relational or otherwise NoSQL systems. Each of these systems has its own advantages and disadvantages. The choice of one of these systems depends on the task at hand. For example, in the work of D. Damodaran B, S. Salim, and S. M. Vargese [9], devoted to this issue, it was proposed to use NoSQL systems for processing large amounts of data, as well as in situations where the importance of data integrity is not critical. And in the opposite cases, the application of relational database systems. Also, in [10], the features of applying relational systems for structured data and NoSQL systems for unstructured data were analyzed. There have been many studies in this area, which have given specific aspects of each system and cases where its application will be effective (see [11], [12], [13]). Based on this, it was decided to use a relational database in the design of our platform, taking into account the importance of data integrity and the fact that our platform does not need to handle large and unstructured data.

There are also many types of relational database management systems, from which it is important to choose the most effective one for a web platform. To select an effective management system, we decided to turn to statistical data analysis.

According to the information provided on the DB Engines website, which is engaged in forming a ranking of database management systems based on their popularity, the MySQL database management system has been in second place for the last two years [14]. A graphical diagram of this ranking is shown in the following figure (1). This statistic is also supported by the data provided by Statista, which has the largest statistical database [15].
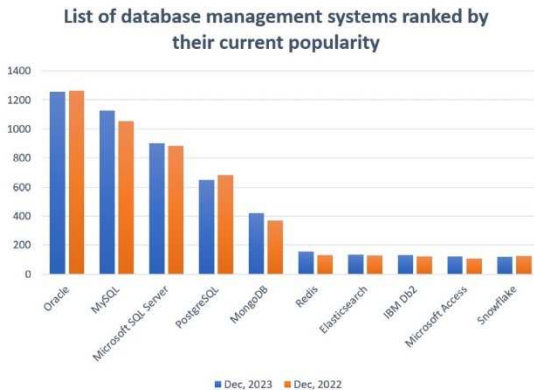

Fig. 1 List of DBMS ranked by their popularity

The main reasons for the popularity of MySQL are considered to be its ease of use, free of charge, high speed of operation and the availability of a wide public support audience. Also, due to the supported data types, table types, indexes and other features, MySQL provides options such as alternative systems [16]. In addition, Stack Overflow surveyed a total of about 74,000 users from 181 countries (of which about 54,000 are professional programmers) to determine the most popular databases for 2021, resulting in MySQL ranking first [17]. This proves that the audience of MySQL support is very wide. There have also been studies on the speed and efficiency of DBMS and one such study was conducted by Y. Bassil [18]. According to the results of several tests conducted during his study, it was determined that MySQL system, widely used today in the field of creating web applications, is inferior in speed to MS SQL Server system, and in terms of memory and CPU usage MySQL shows optimal performance.

Also, to use MySQL effectively, you need to pay special attention to its settings. By default, MySQL uses InnoDB table engine due to which the system is slow [19]. According to a study conducted in this area, all website builders and database developers were recommended to use MySQL table engine as MyISAM to reduce page load time [19].

Analysis of existing online platforms of mathematical terms. When creating a web-platform, which is the main goal of our work, it is first necessary to conduct an initial analysis of the websites on this topic that exist today on the Internet. The analysis is necessary to identify their shortcomings, and take them into account when creating our platform. With the appropriate search for such platforms in the Uzbek, Russian and English segments of the Internet, various websites dedicated to this topic were found, in particular [20], [21],

[22], [23], [24], [25], [26], [27], [28] and as a result of the primary analysis of all of them the following main drawbacks were identified:

- All of them are developed using outdated web technologies;
- The user interface is inconvenient and does not meet modern requirements;
- There is no ability to search for terms in a convenient way;
- Users are not given the opportunity to leave comments on specific terms, which would make it possible to find out their opinion;
- There is no registration option for users and consequently no additional features for registered users;
- There is no possibility to generate a ranking of terms by the number of search queries and views, showing the demand for a particular term;
- And also it was found that none of the considered web platforms has an API interface available in open access for interaction with other programs.

Based on the data analyzed above, it was decided to use a relational database management system, in particular the MySQL system, also taking into account the shortcomings found as a result of the initial analysis of online platforms on this topic.

III. RESULTS AND DISCUSSIONS

In this section we will describe the process of creating an online platform for mathematical terms in the Karakalpak language. Work on creating such a platform begins with determining the requirements for the database being developed and how to design it.

A. System Requirements Formation and Database Design

Formation of requirements to the system is one of the main processes that precedes to the database design process, which results in the development of system modules, functionalities, interface and other elements. In the process of platform development, the following requirements for the development of the system to be created were formulated:

- Develop a system based on API architecture and make it publicly available to other developers;
- The presence of a super_admin user, who has the right to add and edit additional administrators in addition to the rights granted to administrators in the system;
- Creation of 3 more types of user roles and 4 types of rights granted to them with the ability to perform other tasks in the system;
- Creating the ability to leave comments, but providing this opportunity only to users who have the appropriate rights;
- Create the right to add new terms and edit existing ones in the system and grant this right only to the administrator;
- Categorization of terms using letters of the alphabet;
- Provide the ability to flexibly expand the system if additional functions and capabilities need to be added in the future.

The process of careful database design in order to develop a system that meets the requirements is the main criterion for fulfilling all the set requirements for the system.

Depending on the requirements for the database, there are 4 main entities and the relationships between them (Fig.2).
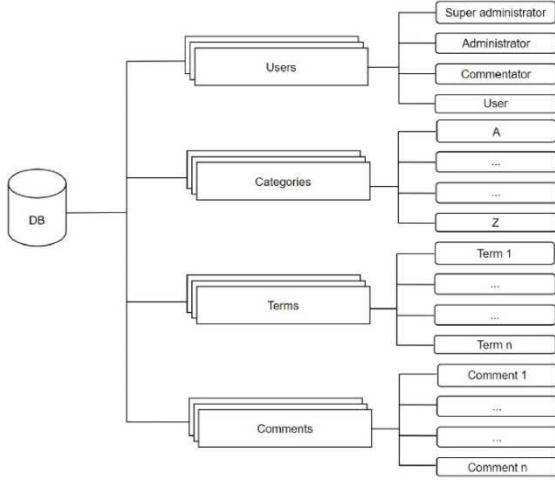

Fig. 2 The main entities in a database

The first entity is the users, as in any system, all their details are stored in a table called 'users'. This table also stores information about the role of the user. This is so that we can grant appropriate rights to users based on their role in the system and not grant those that do not belong to them. This table is linked to the 'terms', 'comments' tables using a 1:N (one-to-many) relationship.

Each generated term is categorised alphabetically. This requires us to have a separate entity to store the categories. For this purpose, we create a table 'term_categories' in the database and store the category ID number and name in it. Storing categories in a separate table simplifies the process of adding new categories and editing, existing ones later. This table is linked to the term table using a 1:N (one-to-many) relationship.

Our next entity is mathematical terms, for storing which the 'terms' table has been created. All the information related to the term is stored in this table. Also, to keep statistics of term views, information about how many times a term has been requested to be viewed is also stored. This table is one of the most related tables and is linked to the 'terms', 'comments' and 'users' tables by a 1:N (one-to-many) relationship.

We need comments to collect opinions about a term, which is one of the main purposes of the system. For this purpose, we will create a table called 'comments' and store the comments left by users in this table. This table is linked to the 'terms' and 'users' tables using a 1:N (one-to-many) relationship.

We have also created a table called 'favorites' so that users can save terms in their favourites list, and store user ID number and term ID numbers in this table. This table is created using a many to many relationship and is linked to the 'terms' and 'users' tables.

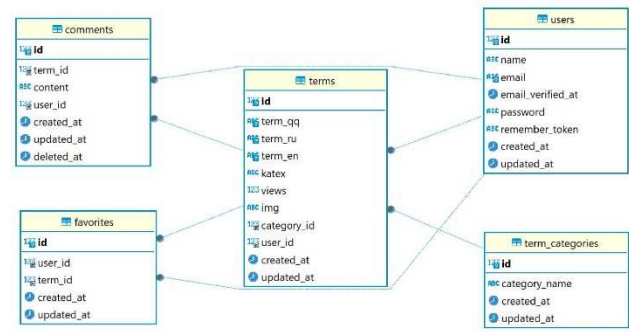The infographic model of the created database is shown in the following figure.

Fig. 3 Infographic model of the created base

B. Description of the online platform

Today, when developing web applications, it is common to divide them into two parts: frontend and backcend. In this case, the backcend part of the application performs the function of presenting information, compatible with several programming languages and platforms, and the frontend part provides interaction with users. This ensures efficient system management and reduces the dependency of the web application on a particular platform or programming language.

The PHP programming language was used to create the backcend part of the platform and it is hosted on a server under the domain https://mathlexicon.uz. API of our platform is publicly available, and third-party programmers can create on its basis elements of the user interface and interaction with them, using different programming languages.

The react.js library was used to create the frontend part of the platform. React.js is highly efficient and easy to develop due to its declarative nature and component structure, which facilitates the creation of scalable and fast web applications. Based on these reasons, this particular library was chosen.

Figure 4 shows the result of retrieving the term information corresponding to the user query using react.js library based on the API provided by the server.

Fig. 4 Display of a term matching a user's query on a web page

Thanks to modern technologies used to create the platform, overall system performance and efficiency in responding to user requests has improved by 12 percent compared to other similar platforms.

To avoid the shortcomings identified through a comparative analysis in the system we were developing, appropriate measures were taken, namely, when creating the platform, modern, widely used web technologies were used today, in particular, the react.js library and the Laravel framework based on the PHP language. The platform

interface is created in a modern and intuitive way for users. And also, for simplicity and convenience in the interface, it was decided to place a minimum number of elements on the pages. In order to efficiently search for terms, a special field was allocated, and data caching methods were used to provide search results as quickly as possible.

The system developed by us has a number of advantages, some of which are given below:

1) Authorized users were given the opportunity to leave comments on terms. This allows receiving feedback from users about errors made in the process of term generation;

2) In the system was implemented the possibility of registration for users, which allows registered users to save favorite terms in 'favorites';

3) The rating of terms by the number of search queries and by views was realized. The list of the most popular terms is placed on the main page of the system;

4) API interface of the platform is left open. It provides participation of communities of third-party developers to realize their ideas on system improvement and create conditions for integration of the platform with other systems that provides popularization of the platform.

The web platform created with the use of modern technologies, taking into account the shortcomings of the websites analyzed above, meets all the requirements for information systems today. At the same time, the developed system is user-friendly and helps third- party developers to improve and expand the system, realizing their ideas.

IV. CONCLUSION

In this paper, the issue of creating and improving mathematical terminologies in Karakalpak language has been considered. Taking into account the widespread use of the Internet and mobile technologies along with the creation of a paper version of such an explanatory dictionary, it was decided to create also an electronic platform of mathematical terminologies, which is able to give quick access to the necessary terminology (information).

For the development of the online platform, the initial step involved selecting the main technologies and tools used in its implementation. Primary attention was given to widely used types of databases and programming languages for creating such systems. Specifically, a comparative analysis was conducted between relational and non-relational databases, as well as database management systems. Based on the analysis results and requirements of the platform, a relational database model and the MySQL relational database management system were chosen. Additionally, considering the goals and requirements set for the system, the platform was divided into two parts, and based on the conducted research and analyses, the most suitable and efficient programming languages for each part were selected.

A comparative analysis of online platforms for mathematical terminology has also been conducted, identifying shortcomings and weaknesses of such platforms based on the Uzbek, Russian, and English segments of the global network. All these shortcomings were taken into account during the platform's creation process, resulting in improved operational efficiency: the overall system performance and responsiveness to user queries increased by 12 percent compared to other similar platforms. The developed platform has been hosted under the domain https://mathlexicon.uz, and API of the platform has been left open so that third- party developers can contribute to further improvement of the platform.

In conclusion, it is worth noting that an online platform for mathematical terminology in native languages, particularly in Karakalpak, can be a valuable and versatile tool for education, scientific research, and the popularization of mathematics. The openness of the created system allows interested users to contribute to the development of the platform by proposing new terms, discussing them and making decisions about their inclusion in the database. This enables the resource to continuously update and expand, serving as a dynamic hub for mathematical knowledge dissemination.

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