

# Web Application for Learning Mathematics

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**Abstract** – Web application which assists in the process of learning mathematics is presented in the paper. The application and its functionalities will be explained in detail. Also, there will be presented parts from the web application using diagrams such as the E-R diagrams and the UML diagrams.

**Keywords** - web application, professor, student.

## I. INTRODUCTION

In today's modern way of living, dependent on technology, mathematics has become more important than ever before. Mathematics is a critical tool in the modern world. A deep understanding of mathematics is required in many fields such as science, engineering, finance, medicine, and many other fields. Learning mathematics has many benefits for students in schools, but also in everyday life. Critical thinking, collaboration, communication, and creativity skills are very important skills required in the 21<sup>st</sup> century and all of them can be acquired by learning mathematics, [1]. Many real-life problems can be solved by using mathematical concepts, so the deep understanding of mathematical concepts can be very helpful. Being able to think logically can help to make analysis and separation of the problem into smaller pieces for better understanding, analysis and finding appropriate solution in detail, [2]. Despite the abstract nature of mathematics, its teaching is scientific thinking among students. The process of teaching should be taken very seriously by the teachers, and they should try to explain all mathematical concepts in an easy and understandable way. With the development of ICT tools created to satisfy the needs in education, the whole education system had changed [3,4]. ICT is a tool that supports the learning process and helps in finding new solutions to all the challenges that education is facing, [5]. Students have many difficulties with learning and understanding mathematical concepts. In [6] the authors have analyzed the types of students' difficulties in learning and understanding mathematical concepts in primary schools. Thus, the integration of the ICT tools in the process of teaching and learning mathematics is necessary in order to decrease and eliminate the difficulties for the students and teachers at the same time, [7]. The author in [8] has given examples of ICT-based activities developed in UK secondary schools. They use readily available software and other ICT tools and have proved inspiring for both students and teachers. In [9] the authors have compared the PISA test scores obtained by students using ICT more intensively with the PISA test scores of an appropriate control group and have showed that show that the number of activities irrespective of the

intensity of ICT use, is positively correlated with students' PISA scores in the three domains in the most countries. ICT supports mathematics teachers to improve their designation of lessons, teaching learning tactics, updated to subjective and pedagogical knowledge and expansion of other several relevant skills [10]. The use of ICT makes mathematics teaching healthier and helps to increase the achievement of students [11, 12].

For similar purposes many web applications for teaching and learning mathematics have been developed. The most of them have aim to provide proficiency in mathematics which stands at the top of educational priorities in many countries. Sophisticated web-based learning environments are being developed also for mathematics education, some offering authoring tools for creating courseware, assignments, and exams, some being used for training, assessment, and contests [13, 14, 15].

Many mathematicians, mathematics educators, and researchers have developed many web-based and web-assisted mathematics and mathematics education courses [16]. Web-based Virtual Learning Environments (VLEs) such as Web CT, Blackboard, and eCollege are programs that have been developed to provide online mathematics courses [17]. There are many web applications and educational platforms for teaching and learning mathematics and most of them improve learners' motivation, facilitate their search competence formation, and identifies gaps in basic knowledge of mathematics as a subject. Some of them are interactive [18, 19] and they are designed to help students learn Mathematics, with a focus on high-school algebra and calculus drills, [20]. In [21] the author has selected some mathematics learning applications. In much research it is concluded that the use of web and mobile applications in the educational process for teaching and learning mathematics helped enhanced students' achievement and learning mathematics, [22, 23].

In this paper we have described a web-based application for studying mathematics for students in secondary schools.

## II. FUNCTIONALITY OF THE WEB APPLICATION

The developed web-based application is devoted for students in secondary schools who are in the final year of secondary education and who are in the process of preparation for taking mathematics as subject for graduation exam. This web application has only been developed as a tool for learning mathematics and is not available for users to visit and use it. The web application covers the areas covered by mathematics's syllabus for graduation's exam at basic level. It is designed to

facilitate the process of learning mathematics and solving mathematical problems through solved examples, additional exercises for practice and necessary formulas.

On the Fig. 1, the home page of the web application is given. By clicking on the button "For us", can be read what is the intend of the page. Information for the administrator (teacher who maintains the page) can be found by click on the button "Contact". The login of teachers and login of students can be done by clicking on the button "Login teacher" and "Login student", accordingly.



Figure 1. Home page

#### A. Functionality for teacher

The web page is maintained by administrator. The role of the administrator is to full fill the content with solved examples and additional exercises for practicing for every topic which can be found at the graduation exam in mathematics. Also, the administrator gives ID code for every new professor who wants to be registered at the web application and to use it. The ID code of the professor has the following format: @0000\_0000.

For regular use of the application, the teachers should be registered first. After teachers' registration, they have the same privileges as the other registered teachers (can attach contents, solved examples and problems for exercises). For registration, the professor must enter the following data: Name, surname, age, sex, state, city, address, telephone number (in format (000)000-000), ID code, e-mail address and password. If the registration is successful, the message "Successful registration" will be written, else the message "Please, fill up all necessary fields" will appear. The teachers input email address and password for signing in. If username and password are valid, the professor can used web application (Fig. 2), else the message "E-mail address is not in database. Try again" or "The invalid password is input. Try again" will appear.

At the web application the teachers have the following options:

- to write notes;
- to take student's search;
- to create list of the enrolled students;
- to enter a new student;

- to write statements;
- to answer to the students' questions.



Figure 2. Home page for teacher

The teacher can use the option "Notes" as reminder. By using of the option" Student's search", the teacher will be able to search each student who uses this application. By using of this option, the teacher can do quick and precise searching for every student. If the written student's name exists in the database, the following information for the searched student will be displayed: name, surname, city, mobile phone, e-mail address and password. The option "Student's list" at the web application will show all the students who are in the database, and all data for them.

For registration of a new student, the teacher needs to choose the option "Enter a new student". All needed data for enrolment of a new student are name, surname, date of birth, address and password. The teacher can delete a student if needed. After deleting, the deleted students are not members of web application anymore. For deleting of student, teacher should input his name, surname, and date of birth.

With the option "Student", the teacher will have access to the student's home page. Here, the teacher can read the discussions of the students and the solutions of the exercises. Also, the teacher can give answers to the students' questions.

In option "Statement", the teacher posts a statement to the students. It can be a useful link, information for lessons, additional literature, etc. In the field "Statement Title", the teacher writes the title of the statement. There is a button "Send statement", and by clicking of this button the teacher sends the statement to the enrolled students at the web application.

By choosing the option "Answer the questions", the teacher reads a question from the student in the "Title" field and answers the question in the "Answer" field. After this, the teacher sends the answer to the student by clicking on the "Send answer" button.

## B. Functionality for student

This web application is designed for students who are preparing to take graduation exam in secondary school for the subject mathematics. On this web application, students can easily find materials for learning and exercises for practice. Also, the web application gives the students opportunity to communicate with their teachers (Fig. 3).

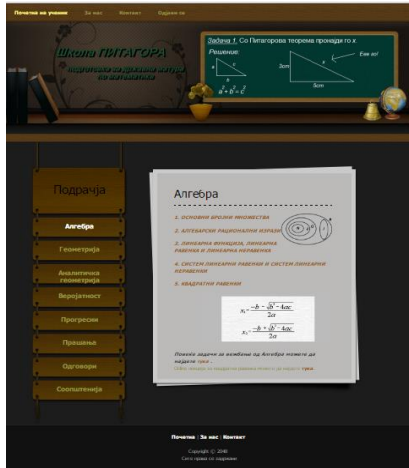


Figure 3. Home page for student

The students can use this web application, only if they are registered by the teacher. For login, the student should write his e-mail and password. After login, the student has access to all topics for preparing the graduation exam in mathematics from a secondary school. By choosing any topic, all the materials in that topic will be opened together with solved examples and additional exercises for practice.

The topics which are included at the web application are the following:

- *Algebra* contains the following topics:
  - Basic number sets.
  - Algebraic rational expressions.
  - Linear function, linear equation and linear inequalities.
  - System of linear equations and system of linear inequalities.
  - Quadratic equations.
- *Geometry* contains the following topics:
  - Geometric figures in a plane.
  - Perimeter and area of 2D figures.
  - Geometric figures in space.
  - Surface area and volume of 3D shapes.
- *Analytic geometry* contains the following topics:
  - Coordinate system.
  - Equations of (straight)line.
  - Relative position of two lines.
- *Probability* contains:
  - Experiment and event.
  - Statistical probability and random events.
  - Operations with random events.
- Discrete probability space.
- Classical definition of probability.
- Properties of probability.
- Formula for probability of random events.
- *Progressions* contains:
  - Arithmetic progression.
  - Geometric progression.
  - Infinity geometric progression.

Also, the web application has the following options:

- *Questions*.
  - In the field “Questions” students can ask questions. The web application does not show which student sends the question. On this way, students have more freedom to discuss for some problems related to the exercises.
- *Answers*
  - After clicking on the field "Answers" the question from the students and the appropriate answers from the teacher will be shown.
- *Statements*
  - By clicking on this field, the fields "Title", "Statement" and “Date and time” that are previously filled by the teacher will be displayed.

## C. Functional requirements

- Registration of a new member is done by entering the following basic data for the potential member: name, surname, date of birth, country, city, residential address, telephone number, e-mail and password.
- Login of an existing member is done by entering the two basic data username and password. With this data the system will recognize the member.
- Student’ search. The system searches by student’s name. So, it is enough for the teacher to write the student’s name. In the table, all students with this name will be displayed.
- Questions and answers. To solve some exercises, the web application allows the student to write the problem in filed "Questions" and send this question to the teacher. In the field “Answers” student can search solution of some previously asked question from the other students.

## D. Non-Functional requirements

- **Requirement of simplicity.** This application should be structured in such a way that can easily satisfy the requirements of its users. So, the login and registration fields should be clearly located for easily finding. Also, the option

“Student’ search”, should take central place. Also, the results should be based without much additional information. On this way the web application can perform the requests precisely and correctly.

- **Requirement for speed.** It is expected that the system will perform the actions with a satisfactory speed, with a maximum response time of a few seconds. It should be considered that the database grows with the increasing number of teachers and students. So, the system needs to work with large capacity (in gigabytes) and according to the size of database and speed's performance.
- **Implementation requirements.** Following the world trends, the largest number of internet users work on the Google Chrome browser. So, the application is expected to have the best functionality and adaptability using this browser.

### III. DIAGRAMS

With the use of diagrams, various components of the web-based application will be presented.

#### A. UML diagrams

The Unified Modeling Language (UML) enables the organization of the design process in a manner that allows for clear understanding and agreement among all parties involved in the development of the software, including the client, analyst, programmer, and others.[24]

Use case diagrams illustrate the connection between an actor and a use case. These diagrams are utilized to represent the system's functions, processes, and the framework in which a solution to a problem is being sought. In Fig. 4, Use Case diagram illustrating the interaction and exchange of information between the student and the teacher through the implementation of a question-and-answer functionality is shown.

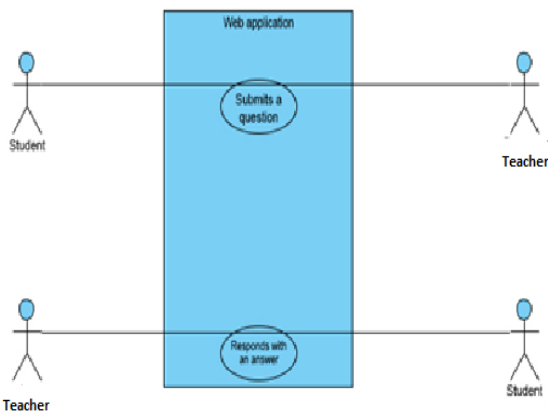


Figure 4. Use Case diagram for question and answer between the teacher and the student.

An activity diagram shows the steps that must be taken (each step is called an "activity") in a specific user scenario to achieve a certain goal or functionality. Activity diagram for functionality user login is shown on Fig. 5.

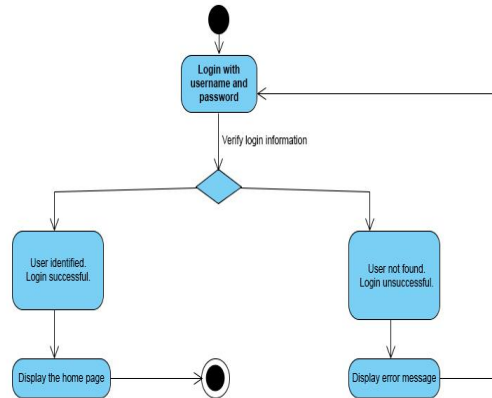


Figure 5. Activity Diagram for the user login functionality

The Entity-Relationship (E-R) diagram define conceptual view of the database and it is utilized in the early phase of database design, known as stage of the conceptual modelling of data.[25] Entity-Relationship (E-R) diagram is shown on Fig. 6.

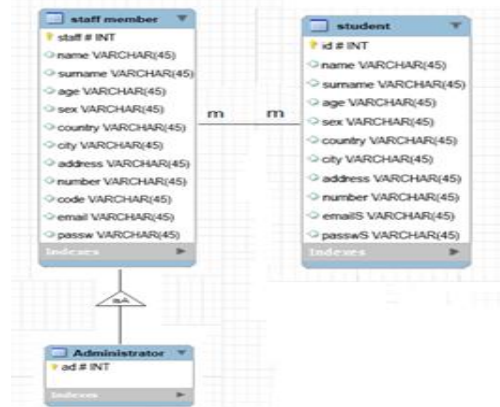


Figure 6. Entity-Relationship (E – R) Diagram

### IV. CONCLUSION

In present times, people are gravitating towards utilizing the benefits of new technologies that simplify their daily lives. Computer-aided communication has a crucial place in both individuals' and companies' daily activities. With such advancements, the amount of information and data being stored and exchanged is growing at a big speed rate. Although these technological advancements provide countless advantages, they also pose new challenges to both individuals and organizations. Organizations must continuously evolve

and adapt to these developments in order to maintain their effectiveness.

The Internet, as a global network, holds a crucial place in ensuring the smooth and efficient functioning of various processes. It has revolutionized our lifestyle in every way. Not only has it made various tasks easier, but it has also altered the way people perceive things. The Internet has become an indispensable part of our lives and there is scarcely any task that does not involve modern technology and the Internet in some manner.

The presented web application aims to simplify the work of students through the utilization of the Internet. By utilizing this system, the amount of time and effort required to achieve the same results as with traditional methods is reduced. Also, this web application facilitates the process of learning mathematics which is one of the not very popular subject between the students. This application is integrated with a database that stores information for both students and teachers.

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