Enhancing the Learning process: Engineering on Virtual Platform

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1 ABSTRACT

Education has now completely shifted from schools and colleges to smartphones and laptops. In the ongoing pandemic, virtual learning is playing a vital role in the educational sector by enabling students to obtain the knowledge and skills sitting right at home. Not only does this ensure the safety of the public, saves time, money and effort but also helps promote self-learning among students.

The Virtual Labs is a web-based platform designed to improve learning experience and understandability. It forms a hub for all the resources required to understand, analyze and absorb the concepts by students.

The proposed virtual learning platform brings the offline lectures and confined labs to a few clicks with hands-on and comfortable learning experience. Virtual Labs is aided with 2D visualization options in a desktop PC and a smartphone. The explained approach emphasizes on improving the current engineering education by considering all the aspects of learning process such as detailed theory explanations, visual representations, implementing innovative ideas and solutions, self-evaluation methods and tracking progress. Virtual Labs has proved to be an easy to use, extremely helpful and an enjoyable learning environment during the user trials. It helped students to grasp the concepts quickly, check their understanding and iterate multiple times through the same if necessary. In this self-learning approach, the students will acquire problem solving skills as the labs have inbuilt critical test cases so that the students think in all aspects to solve the particular problem. The teachers will also be able to keep track of the student's performance based on the quiz, so that they can guide each student to improve in a particular domain and help them understand the concepts better. The students will get a an additional benefits for students who do not have the internet access all the time and they can learn whenever they have access and re iterate through it.

2 INTRODUCTION

The rapid development in the field of computer science and information technology has made it possible to enhance and improve the learning and education process. Also, the use of technological tools effectively in the teaching process has helped change learning and communication methods for the better. Over the past two decades, the application of virtual platforms has resulted in a change in the educational process for students and teachers and has been confirmed to be effective for teaching complex topics.

Teaching in the field of computer science is a tedious task as most of the concepts have to be run or executed in order to gain the complete knowledge about it. The main barriers to make this teaching effective is the unavailability of resources, students not being able to practice coding due to the limited time period allotted for the lab hours, having to download multiple heavy software in order to run programs and implement the theory learnt as practical knowledge.

In this paper, a web-based platform called the Virtual Labs has been developed to aid students in the learning process and improve their knowledge and understanding. Virtual labs is an all in one platform where all the resources needed to understand the subjects are available in a single click. The resources include detailed module wise explanations for all the subjects, images and videos wherever necessary. Every module comes with a quiz to help students check their understanding. Virtual Labs have inbuilt code editors and do not require students to download any software to run their programs. Teachers can also access the platform to understand each student and check their progress.

The aim of Virtual Labs was to enhance, improve and ease the learning process for computer science students. This technology has proven to fulfil its purpose by helping the students to explore the programmatic concepts and transform their theoretical knowledge into programming. It has also pushed students towards self-paced and effective leaning.

Further reading will enlighten the details about the implementation, technical aspects and the limitations of the Virtual Labs.

3   RELATED WORKS

The use of technology in education plays an essential role in enhancing the learning process and increasing its effectiveness. It helps teachers explain and present information efficiently in an enjoyable way and helps students collaborate with their teachers, access other educational resources, and learn technical skills. The Virtual Labs is an educational environment that uses virtual technology and provides tools and visualizations that motivate the students to participate and collaborate within the class.

Early research of 1980s and1990s suggested that VLEs are open and democratic medium with a number of advantages over existing communication media for supporting collaboration. Marttunen and Laurinen (2001)suggest that online asynchronous discussion can facilitate argumentation skills because "these environments have been characterised as democratic and equal in nature."They report a study that showed argumentation skills can be facilitated by asynchronous discussions through computer. The intention, deployment and use of technologies for learning have fostered educational attainment, equality and social justice irrespective of space, distance or time via the various e-learning platforms. (Mncedisi Christian Maphalala and Olufemi Timothy Adigun 2020).

Stonebreaker and Hazeltine (2004) describesVirtual learning as the delivery of learning through electronic mediation that reduces the gap when the instructor and the learner are separated in either time or place. According to Wilson (1996),Virtual Learning Environments (VLEs) are, computer-based environments that are relatively open systems, allowing interactions and encounters with other participants". This definition widens the conventional understanding of the learning environment as it adds three more dimensions viz. interaction, technology and control (Piccoli, Ahmad and Ives, 2001). VLEs can support both blended and online (distance) learning.

In Greece, the lack of resources and time needed to construct labs in secondary schools has been solved by using a web-based platform that simulates real labs (Alexiou et al.2005).Thousands of technical and management courses are now being offered by universities, for-profit professional development centres, and industry training facilities worldwide .

There are virtual platforms like LeetCode, Hackerrank etc, that mainly focuses on coding skills. However, these platforms are not equipped with theory related resources. Virtual Labs on the other hand combines concepts of virtual learning courses and coding platforms. Thus making the learning process more efficient and easy for aspiring students.

4   IMPLEMETATION

The main aim of Virtual Labs was to develop a platform with all the resources at one place. This required a complete transformation from offline classrooms to an online virtual website. Since computers and smartphones are not a barrier anymore, this transformation was quite simple.

Virtual Labs is a web-based e-learning application designed especially for college students in order to cope up with the pandemic situation and to promote self-learning among students. Virtual Labs contains module based detailed explanations for almost all the subjects, supporting images and videos for better interpretations and self-evaluating quizzes after every concept for students to check their understanding about the same. Also, teachers are equipped with the tools that give information about the learning rate of each student, tested through quizzes.

Students are required to register using their University Serial Numbers, semester, email ids and create password which will be later used for login purposes. Similarly, teachers can register themselves with the subject they handle and their email ids. This would be helpful in monitoring each student in each of the subjects. The user data is secured by saving the encoded passwords in the database and not the actual passwords itself.

Once registrations are complete students and teachers can login at any time and from anywhere. Teachers can then add any new materials and also update the quiz questions. Students are required to attempt the same after going through the explanations and videos. Students can attempt a quiz only once. This helps teachers understand and analyze the difficulty of the questions and concepts.
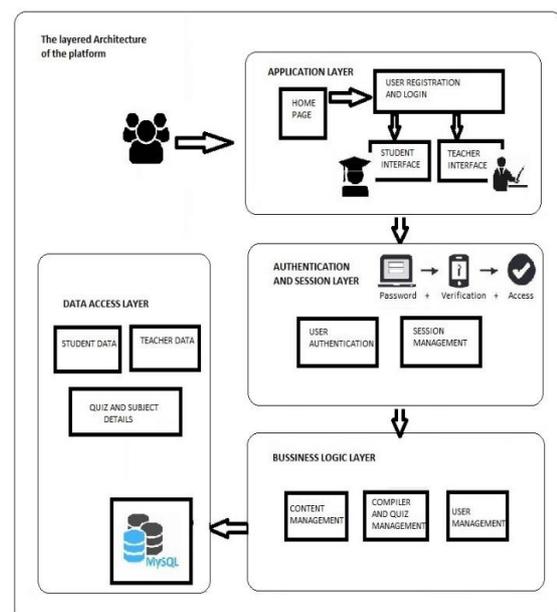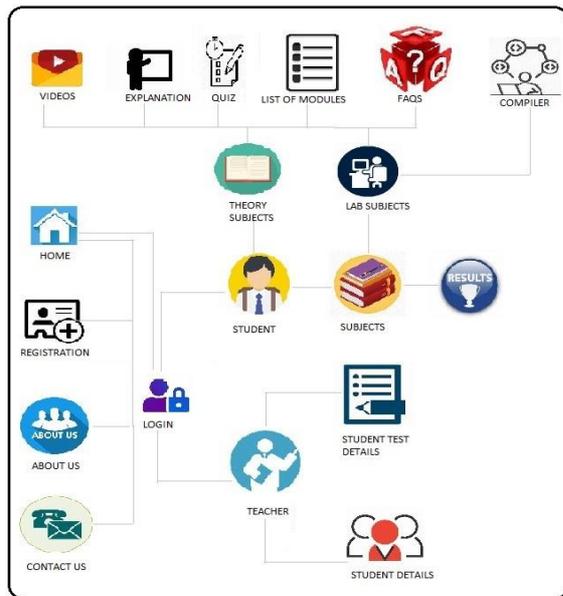

Fig1 Layered architecture

Fig 1.2 Component diagram

5   TECHNICAL DETAILS

Virtual platforms make it possible for students to get the best education at an affordable price. Virtual Labs help overcome difficulties such as poor teaching faculty in colleges, ineffective teaching methodologies, time constraints, resource requirements etc. Virtual Labs is a virtual space for students to improve upon their skills and experiment with different ideas and concepts.

Virtual Labs are designed to give the best experiences for its users and also an interface that can be used by anyone with little or no prior training.

SYSTEM DESIGN

Virtual Labs uses a layered architecture where the application interface forms the first layer and interacts with the users, session and user authentication layer takes the information from the above layer to process the data, which is then used to display appropriate contents. The last layer is the data access layer which connects to the database to store the data. Fig1.1 shows the architecture used to implement the same where each requirement is broken into a stand-alone module and each module passes the requirement phase, design phase, development phase and the testing phase.

Hueroko, a cloud platform is used to run and scale the application. The UI and UX is designed using HTML, CSS and JavaScript. Frontend is developed using PHP which connects to the MySQL backend database.

USER INTERFACE

Virtual Labs is a simple, easy to use and an extremely useful application. Users can navigate from home page to the login and registration pages, where the users can then be associated to their respective categories. Students can access the study materials regarding the subjects that align with their semester. The contents in each subject is divided into required modules which in-turn is divided into introduction, theory, videos and quiz. Code editors are embedded into the website for the necessary subjects such as cloud hosted Jupyter notebook for python, C compliers designed for C programming, etc.

Fig 1.2 shows the components diagram with a neat and clear pictorial representation of the interface and navigation of the website.

6   EVALUATION

A test was conducted to evaluate the efficiency of the platform, a group of 20 students were selected and their knowledge was evaluated based on a quiz and it was recorded, and then we let them train on the platform where they had to go through the theory and some videos related to each topic in the module and after this a quiz was conducted and the students were evaluated, we found that the students score has improved and almost 85% of the students were able to easily understand the concepts and attempt the quiz accurately and with less time.

There was a huge difference in the performance of the students before training on the platform and after training The students also had track of all the syllabus, as there had easy access to different modules in each subject and each topic in every module was explained in detail with the help of videos and there was a quiz to evaluate them module wise.

A feedback from students was taken in which they said that the provided interface was user friendly and it was easy for them to navigate between different modules in each subject as they were divided accordingly. It helped them prepare for examinations too.

We had an evaluation for online virtual labs of data structures in c, where a group of 20 students were selected and they were allowed to execute programs on the platform, it had standard test cases which an efficient program must pass. Since in the practical offline labs students are not aware of the corner test cases and do not have any restrictions of the time and efficiency of the program, students were extremely benefitted from the Virtual Labs.

7 CONCLUSION AND FUTURE ENHANCEMENTS

The latest technologies have enhanced the learning process and it is also helping students get better education with effective cost, the virtual platform provides opportunities to students to learn concepts taught in college effectively with clear understanding and implementation. This also helps students think in different perspectives.

Virtual Labs reduces the time, effort and cost of installing software as it provides the required IDE within the website.

This software which is developed only for computer science students can be implemented in other fields.

Virtual Labs can be expanded by incorporating Augmented Reality and Virtual Reality concepts for better visualization and a greater user experience.

8 LIMITATIONS

One of the limitations of this platform is that we couldn't make online compilers for subjects like Data Base Management System, as it requires an entire management system to be brought on to the cloud and that might result in server crash, we can add an additional link that directs the students to an online platform where the code can be executed. For labs like linux the compiler couldn't be implemented as the entire OS has to be programmed which would take a longer time, and as we need to implement this platform as soon as possible.

Another limitation could be that few students who live in remote areas where there are no proper facilities and who do not have access to internet would have trouble in using this platform.

9 DEMONSTRATION

Fig 1.3 Snapshot from the website that shows the subjects the student is enrolled for. By clicking on each subject, students can navigate to the respective subject panel.
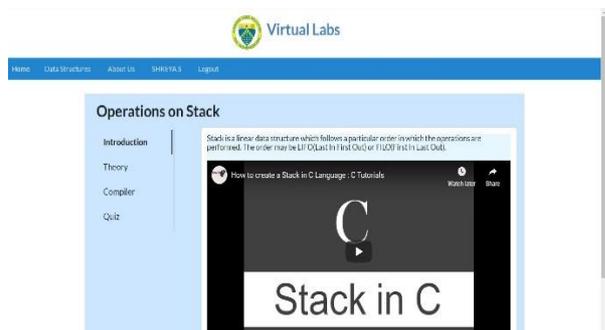

Fig 1.4 Snapshot from the website that shows a subtopic from the subject Data Structures with video enabled for visual representations and better understanding.
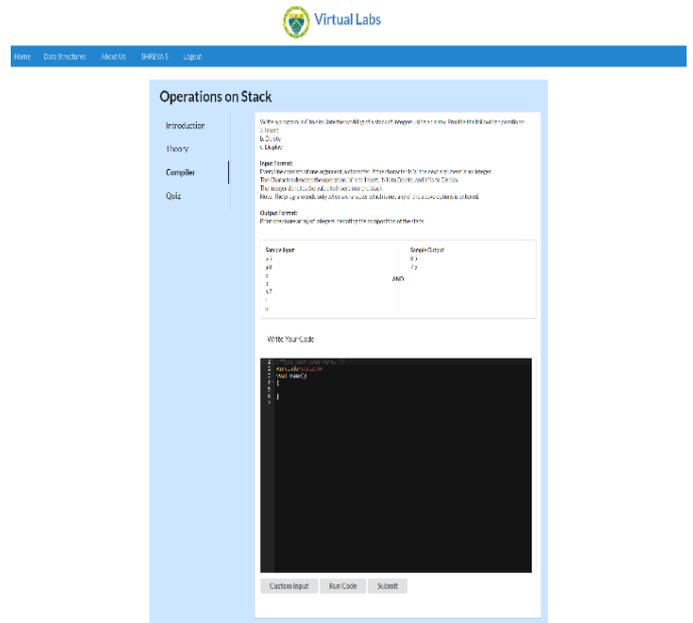

Fig 1.5 Snapshot from the website that shows the internally embedded code editor with detailed explanation of the problem statement and predefined test cases.
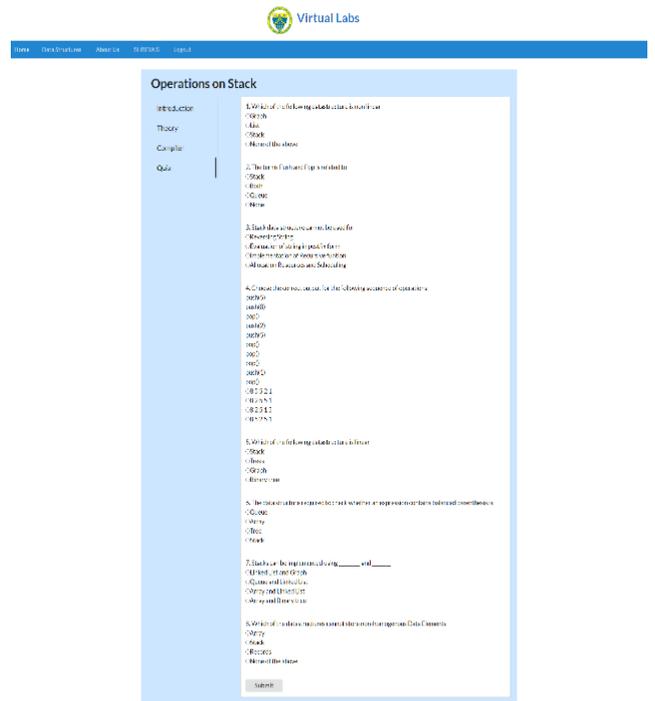

Fig 1.6 Snapshot from the website that shows the quiz from the Stacks in the topic Data Structures.

Demonstration link: https://virtual-lab-dsce.herokuapp.com/

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