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Interactive Learning with a Digital Library Education in Science, Technology, and Engineering

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Abstract— Numerous extensive initiatives to create digital libraries have been spurred by the requirement for information systems to facilitate the distribution and reprocess of educational materials. Ideas like online learning are currently being applied to teaching and learning in education more often. But when it comes to adopting new technology techniques, STEM education is still lagging behind because of the nature of the subject matter. This discrepancy can be attributed to the fact that these areas frequently need laboratory exercises in order to effectively teach skills and offer practical experience. Making these laboratories available online is sometimes challenging. It is necessary to either reproduce the real lab as a totally software-based virtual lab or permit remote access to the real lab. New and developing technologies are presently being developed that can get around some of the possible challenges in this field. These comprise virtual worlds, computational dynamics, augmented reality, and computer graphics. The state of the art in virtual labs and virtual environments for science, technology, and engineering is compiled in this article. Therefore, many of the same learning processes may be observed in the usage of virtual labs for other scientific and non-robotic engineering purposes. This can involve encouraging the introduction of new ideas as part of studying science and technology, as well as the introduction of more general engineering knowledge. It can also involve encouraging more positive and cooperative training and education activities in the context of a more complex engineering subject, like robotics.

Keywords— Engineering Education Technology-Enhanced Teaching and Learning, Digital Library, Science Education, Technology Education.

I. INTRODUCTION

An unparalleled potential to create a complete infrastructure to support and promote Science, mathematics, Engineering, and Technology (SMET) education programmes is accessible by the World Wide Web and Networked Information Technologies. Online learning environments offer learners the flexibility to be anybody, anywhere, at any time. Despite the fact that educators are currently creating a vast amount of resources for use on the Internet, finding them, assessing their quality, and using them successfully present a difficult task for their prospective users. To properly take use of the chance these new tools have generated to enhance learning, we must comprehend and overcome this problem. Many fresh perspectives on the future of education, especially as it relates to the teaching of science, technology, and engineering, have recently surfaced in the literature. The following technological examples are particularly pertinent to this study: dynamics-based virtual systems, virtual labs, virtual reality and virtual worlds, avatars, e-learning, remote learning, and the novel idea of immersive education, which combines several of these concepts. Immersion education has been used to describe a extensive range of educational settings, including professional training in businesses, informal large-scale education, and formal institutional education.

In the past, the initial reaction to issues brought on by the trend of more globalisation of education was Internet-based distant learning. This movement called for the removal of all barriers to education, enabling everyone to pursue a degree regardless of location, individual disability, socioeconomic standing, etc. Significant progress has already been made in this regard with the establishment of entirely online universities.

Finding qualified volunteers who can address all the many issues in the project, nevertheless of where they live, is a crucial component of this. The adoption of novel strategies and instruments to facilitate cooperation and the online "co-creation" of new goods and technology is necessary for this unstructured approach to invention, development, and even production. Using new technologies that enable online experimentation and virtual labs is part of this. But as virtual reality, computer graphics, and virtual worlds technology advance quickly, the line separating what can only be done in the actual world from what can also be done in a virtual world is becoming less and less.

II. BACKGROUND

The ease with which support materials can be obtained and the success with which they can be utilised determine how well-prepared a teacher is to oversee a learning process in practically any topic. Simultaneously, with the fast reform

of teaching and learning settings and the constant evolution of educational technology, there is a need to expand the curriculum of all computer-related learning experiences to address computer ethics and societal effect. In the realm of ethics and social influence, the most accomplished educator is often the one with the greatest access to background materials and the most up-to-date knowledge of current events. Although textbooks can serve as the main source of information for a course, modern subjects necessitate the addition of fresh resources by an online reporter, analyser, and librarian.

Textbooks are a course's main source of information, but with today's themes, it's necessary for an online reporter, analyst, and librarian to add new resources as they become accessible.Newsgroup threads summarise comments into a single line, but in order to provide a learning experience, debates and circumstances must be analysed and evaluated. Surroundings in reference to the topic. Students have the ability to employ non-terminated collections of reports to strengthen their ethical standards and social effect in computer skills because of the themes' flexibility. Their own evaluation, analytical, and presenting abilities. Most computer science programs do not include instruction on the process of integrating resources into meaningful learning experiences and creating active learning scenarios that allow students to participate in their learning opportunities.

Each faculty member presents things in a unique way, blending their personal experiences and putting their own stamp, regardless of how well-written the notes, the resources, or the textbook is. It was crucial to modularise the digital library in order to provide teachers the freedom to arrange the resources anyway they see fit. As the library grew, it was discovered that the unique influence of the librarian/webmaster lessened and that learners' needs could be better met with a less structured approach when learning shifted from a lecture presentation mode to a self-paced, Web-based learning environment. Another benefit of this strategy is that it does not require a set structure, thus the contents may be easily altered when new issues come up.

This strategy also has the benefit of allowing for easy content updates as new issues emerge, legislation is passed, court precedents are set, or diversity across borders is acknowledged. This is made possible by doing away with a rigid framework. However, there is structure in every module; examples of this include a bibliography, class notes, a sample class outline, and a number of in-class tasks.

III. DISCUSSION AND FUTURE RESEARCH

Several virtual laboratories with a solid software foundation have been established in several sectors throughout the past ten years. They often don't provide opportunities for generalisation to a platform appropriate to a larger class of engineering disciplines because they are tailored specifically for an educational setting. The technological difficulty of these laboratories varies.

One observation is that the instructional design process involves many stages where resource reuse takes place. Additionally, each step places unique, often contradictory demands on the design of digital libraries. Another observation is that reuse occurs both inside and outside of the library, since it is a distributed process involving several artifacts. A usability line that includes the library system as well as the instructional resources themselves must be drawn in order for reuse to be effective. Reclaim is a dispersed procedure involving numerous artefacts, both inside and external the library, according to another finding. A usability line that includes the library system as well as the instructional resources themselves must be drawn in order for reuse to be effective.

There are three different levels at which interactions occur: the context, the collection, and the information resource. The emphasis on structured representations of interactive multimedia materials is the simplest way to define the idea of interactivities. Resources are also arranged in pedagogical collections and enhanced with contextual data, and they are created with rich learning challenges in mind.

An infrastructure to store, serve, manage, and host these materials is required for mobile devices to offer remote access to excellent educational resources that are not restricted by the classroom.

Digital libraries, like the “National STEM Education Digital Library”(NSDL) and the Engineering Pathway (EP) digital library, are rapidly taking the form of standard tools in the field of science, technology, engineering, and mathematics (STE&M) education, filling this need at various educational levels. Teachers may access digital resources through these digital libraries, and students can engage in community-building activities by exchanging and commenting on resources. The Engineering Pathway's Mobile Learning initiative aims to increase engineering digital libraries' reach through mobile learning.

To provide educators, parents, and students with tutorials, collaborative simulations, case studies, tools, and other educational materials for field trips and other mobile learning possibilities we started by identifying a wide range of excellent mobile learning resources. These resources were then categorised into the Engineering Pathway. On the community website for Mobile Learning at Engineering Pathway, the materials are arranged for both browsing and targeted searches.

The Simple Machines prototype aimed to test how mobile devices may be used to enhance pre-engineering education at the primary school level and technology literacy for all students. At this young age, maths, science, and technology education provide students with an introduction to the fundamentals of engineering. Pre-engineering education in these early years often comprises of experiential learning activities added to extracurricular scientific principles as they are applied to everyday technology.

Despite the fact that the age ranges and mobile platforms included in our research on the integration of mobile learning and educational digital libraries varied, the design principles—Connect, Contextualise Access, Capture, and Multimodal—obtained from earlier user surveys were beneficial. On the other hand, knowledge on the specifics of the many implementations was gained [15]. However, when they were in a stationary location, they were interested in having access to the instructional materials they had previously encountered in mobile scenarios. Additionally, we observed that the mobile learners were required to switch between actively learning and looking for evidence in the actual world, and just scanning the content on the little screen and their immediate surroundings.

The technologies that will enable our prototype systems to communicate with the learning community and smoothly transition between desktop and mobile contexts are currently under development. Our study emphasises the question of what information should be readily available in a mobile environment vs what information is best seen in a stationary setting from a larger screen. Our study indicates that a mobile learning tool should present just enough information on the screen to enable the learner to spend valuable time exploring the real world. This speaks to our architecture for mobile learning. It is crucial to remember that too much information on a mobile device might make a student less engaged with the outside world. When the learner returns to being sedentary, these materials should be easily accessible on a PC in a logical, personally applicable manner. Future research will primarily focus on more organic methods for locating relevant, motivated, and context-sensitive learning materials [16]. We'll evaluate the relative advantages of using augmented reality.

The information architecture design concepts for an educational digital library are shown in Table 1. These guidelines clarify the distinction between creating for education especially and creating for information retrieval in general.

Table1. Design Principles for the Information Architecture

Principle 1	Arrange material such that opposed than only having students and teachers passively absorb knowledge, they have the chance to create, synthesise, modify, or discuss it.
Principle 2	To highlight instructional purposes, label materials with pedagogical identifiers such as age group, teaching technique, and academic criteria.
Principle 3	Direct the gathering and modification of educational resources in order to meet the needs of each learner.
Principle 4	Optimise search to take into account users' responsibilities as students or instructors, as well as their interests, knowledge, comprehension, talents, and experiences.

The primary goal of information architecture and design principles is to provide user interfaces that let users access the educational resources in the digital library. Students should be more in charge of their own education thanks to the digital library's information architecture, which allows them to plan their own study sessions and take charge of their behaviour and interactions. Simultaneously, the design must to enable the teacher to mentor the pupil throughout this learning journey. Our primary objective for the digital library's educational impact is to engage students in the process of creating a shared conceptual knowledge of science, math, engineering, and technology in its entirety.

IV. THE RENEWED MISSION FOR DIGITAL LITERACY IN COVID-19

Throughout history, humanity has encountered several challenging pandemic scenarios, some of which posed a greater threat to the human race as a whole. Once more, every nation is battling a covert foe known as the coronavirus (COVID-19), which is putting them in a very difficult predicament. The COVID-19 epidemic shocked the globe, changed the nature of all learning activities to online learning, and raised demand for online education platforms. Educators must exercise caution when selecting online learning environments, since several programmes may appear captivating on the surface but fail to provide pupils with substantive instruction.

Pear Deck is an add-on programme for Google Slides or PowerPoint that helps teachers include their students in meaningful and active learning even when the learning environment is virtual. According to the responses of over 75% of students, utilising Pear Deck for teaching and learning not only increased teacher-student engagement and interaction but also gave them the opportunity to expand and improve their knowledge through the learning activities. The use of digital libraries, dependency, maintaining educational activities, and improved reading habits during the Covid-19 epidemic were found to be strongly and significantly correlated. The results, however, categorically disregarded the influence of prior experience on improved reading habits and dependency on digital libraries. Experience helps library professionals demonstrate their competence in addition to the variety of abilities they require. Professionals in libraries may offer e-contents, informational linkages, and their dedication to client service.

Electronic information is easily accessible to educators, parents, students, and teachers through a range of devices, such as tablets, smartphones, and desktop computers. The learning resources are accessible in English, Hindi, and Urdu. As many books as their storage device will allow them to download are available for download. Many built-in features allow users to digitally zoom, pinch, bookmark, pick, highlight, navigate, share, and take notes. Accessing eResources is made simple by scanning a QR code.

V. SOME POPULAR E-LEARNING PLATFORMS THAT ARE USED TO ACCESS ONLINE RESOURCES FOR E-LEARNING

A. DELNET (http://www.delnet.in/): The Department of Scientific and Industrial Research (DSIR) of the Government of India, together with the National Information System for Science and Technology (NISSAT), initially contributed to its development. It had full backing from the National Informatics Centre (NIC), Department of Information Technology, Ministry of Communications and Information Technology, Ministry of Culture, and Government of India.

B. National Programme on Technology Enhanced Learning (NPTEL) (http://nptel.ac.in/): It is a collaborative effort between IISc and the esteemed Indian Institutes of Technology.

C. Study Webs of Active-learning for Young Aspiring Minds (SWAYAM) (https://storage.googleapis.com/uniquecourses/online.html) : Launched by the government, it is the first massively open online course platform in India, designed to explicitly fulfil the core objectives of the country's education strategy.

***D. Khan Academy (https://www.khanacademy.org/)*:** Learners may access practice problems, video lectures with an emphasis on application, and a clear curriculum-based learning environment through this private portal, which is managed by a private corporation. These characteristics facilitate faster and more independent learning. A broad range of academic subjects are covered, such as math, science, computer programming, social science, history, and economics. To supply digital content, it has also collaborated with other prestigious institutions, like MIT, NASA, and several more. This institute had recently partnered with the Delhi government to provide government school children with training during the lockdown.

E. Online Labs (http://www.olabs.edu.in/): The Online Labs were launched by Amrita University and CDAC Mumbai. The funding for this project comes from the Department of Electronics and Information Technology (Deity). This lab conducts experiments to provide education via a digital platform.

VI. CONCLUSION

This presentation presents the findings from our continuing research and assessment of a prototype for a mobile digital library architecture that would facilitate mobile device learning. Learning resources may be contextualised by mobile technology so that they are relevant to the immediate visual surroundings. Tools to identify current patterns and offer a solid foundation for further research in the area of fully software-based virtual laboratories. Our mission is to eliminate any remaining barriers to the eventual general acceptance of e- and distance learning through the use of immersive education, virtual worlds, and other technologies. By providing beginners with context-relevant information, actively involving students in a variety of informational and investigative activities, and tying their mobile experiences into the larger community conversation, they may aid in the development of expert viewpoints. The student may be anybody, anywhere, at any time, thanks to the mechanisms offered by internet-mediated learning settings. Teachers are creating a vast amount of resources for use on the Internet, but finding them, assessing their quality, and making good use of them can be extremely difficult for potential consumers.

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