Microprocessors and Microsystems 83 (2021) 104030

Contents lists available at ScienceDirect

Microprocessors and Microsystems

journal homepage: www.elsevier.com/locate/micpro

# An educational tool for enhanced mobile *e*-Learning for technical higher education using mobile devices for augmented reality

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ARTICLE INFO

*Keywords:*
Mel
Mobile devices
Technical higher education
e-Learner
Smartphone

ABSTRACT

In all dimensions of education and all subjects, Smartphones have turned out to be broadly acknowledged technology. It plays an essential task in advanced online education systems. Because of smart devices' effortlessness and extension property, it is getting to be mandatory for portable applications. This paper analyses the research on Smart Devices (SD) to incorporate visual simulation into *e*-learning. The researchers created an Augmented Reality (AR) platform for e-learners to expand the coursebook with graphics and virtual multimedia applications. This paper recommends a Mobile *e*-Learning (M*e*L) application termed "MeL app". The advanced MeL app methods have been tested using Mann-Whitney 'U' Test in the lecture hall using real-time learners. The proposed M*e*L app planned to create the learning practice easier, focusing on *e*-learner's requirements by encouraging *e*-learners and instructor relationships to maintain communicative development-based *e*-learning for Technical Higher Education (THE). Software engineering learners assess this proposed framework in THE. Future work in this investigation incorporates new highlights, testing the device in extreme situations, evaluating the instructive perspectives utilizing more significant and increasingly various understudy and beginner inhabitants, and at last, extending the application space.

## 1. Introduction

Reconciliation of information with authentic logical practice has turned into a new structure for the future generation of science and teaching measures formed around significant settings and simple-to-relate networks for learners [1]. In the financial improvement of society, Technical Higher Education (THE) assumes an important role. The issue caused the absence of Communication, cooperation, and unswerving commitment among instructors and students. It is difficult for guides to focus on several learners, and learners cannot ask inquiries or give criticism in the given lecture time. Along these lines, mobile *e*-learning is presently a new pattern in such THE. Due to its development and convenience worldwide, the system provides fast access to various fields of interest. Due to the M*e*L application's strength, an institution of higher education and foundations endeavors to create different M*e*L responses to support their various courses. This paper demonstrates investigational proof in Mobile-e-Learning (MeL) field through an examination performed to check the MeL application's appropriateness to display necessities accumulation and investigation at the tertiary coaching level.

This work has been donated to the M*e*L in THE. The framework causes learners to concentrate on course materials and take care of the course's goal issues. M*e*L improves their critical thinking aptitudes, synergistic and informative abilities, and investigative reasoning

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https://doi.org/10.1016/j.micpro.2021.104030
Received 6 November 2020; Received in revised form 28 December 2020; Accepted 14 January 2021
Available online 16 January 2021
0141-9331/

procedure. The framework also considers the student's brainpower by moving the students from the lower level to a more elevated amount while resolving the inquiries to adjust as far as anyone is concerned. This research's primary motivation is to create an application based on machine learning to make the instructor and learner in an automated system to the current world. The AR provides incredible delivery of contents and to create more interest in e-Learning. Continuous monitoring of the course will create biological effects in the eyes, brain, etc. This will help overcome by providing real results in *e*-learning for the end-user.

The students can convey various thoughts and inquiries in the group discussion module, discuss the problem's measures and work together. Likewise, they can take an interest in the instructive procedure by sending their inquiries to the educator to be added to the questions bank. After that, the educator adds four different responses to the questions utilized in the examinations.

The educator's job is to coach the learning, empower oneself doubting practices, deals with the learning procedure, monitor the commitment, and give guidelines and significant declarations for the learners. M*e*L is highly supportable for easy access and quickly reaches because people are moving towards the digital world. In this fast-growing environment, people need to learn skills as soon as possible and search for new technologies. The communication between instructors and learners are established well by using an *e*-learning app. Likewise, it can make an educational change from classroom-based book learning to collaborative and constructivist *e*-learning. Also, SD and technologies-related to wireless networks are improving persistently with time. The advancement of these innovations helped *e*-learning to reach out to M*e*L.

The goal of the paper is to deal with the structure and execution of the M*e*L framework. This paper invents the objective by addressing the accompanying research questionnaires:

(1) How do learners take an interest in the instructive procedure and test improvement?
(2) How to cause the instructors to speak with the learners and vice versa?
(3) How to change the question's aspect in the test and adjust, as indicated by the student's understanding?
(4) How to cause learners to pose inquiries effectively and team up with one another?

The paper has the accompanying segments: evaluating the earlier work that discussed the observational proof assembled among a writing inquiry related to M*e*L and prerequisites gathering and investigation. The information acquired from the mobile technology survey discussions about strategies utilized, members, and the material used.

## 2. Literature background

Educationalists study learning as a lively practice, leading to awareness, which is continuing, measurable and accurate to developmental variations. The critical role of learning is to inspire the individual to solve a critical problem and improves creative thinking. *E*-learning develops the environmental awareness of individuals. Using AR, the user can view the entire process, making learners concentrate many on digital technologies. This creates high curiosity towards the listeners in the proposed system and develops new innovative ideas towards recent future technologies.

Numerous theories support the learning and instructing process. For instance, Paivio's Dual Coding Theory [2] proposes that graphics and verbal codes for speaking to data are utilized to arrange approaching data into learning that can be followed up on, kept, and recovered consequent use [3].

The neurological methodology considers figuring out the consequence of necessary alterations inside the cerebrum when coordinating all the apparent and prepared data. The mind has two different sides or hemispheres, isolated into sections (i.e., occipital, parietal, transient, and frontal). The teams are in charge of various assignments: our language, thinking, individual capacities, feelings, insight, inspiration, and memory [4].

Experimentation has demonstrated that the hemispheres of the cerebrum are in charge of various thinking methods [5] (Funder standing, Neuroscience), i.e., the left side is in charge of rational, successive, balanced, scientific, target thinking, while the right side is in order of arbitrary, natural, comprehensive, orchestrating and emotional reasoning. As indicated by the reference [4], "*today, it is helpful, even fundamental, for instructors and any other person worried about training to pick up a comprehension of the logical premise of the learning forms.*"

Mobile-*e*-Learning's responses for advanced education should strengthen meaningful learning and inspire learners to think about the technology [6]. [7] Found that mobile applications that are intended for knowledge are hard to come by. An overview of M*e*L inclines in software engineering instruction demonstrated that M*e*L builds learners' emotional attributes [8].

NetLuke made a visualization tool for quick calculations and information structures. The NetLuke aids the client's direct information contribution, the stacking of perception tests, and dynamic computer graphics [9].

The term of MD to improve learning has not been precisely characterized; for example,

- Learning over various settings, through social and substance communications, utilizing personal electronic gadgets, worried about a general public progressing, especially with education.
- A way students' versatility expanded individual and open technology adds to increasing new information, aptitudes, and experience [10].
- Digital learning techniques acknowledged through Intelligent Apparatus equipment incorporate smartphones.
- Methods ready to utilize the assignment hardware to gain learning whenever and wherever required [11].

### 2.1. *Mobile-e-Learning application Elucidations in THE*

The researcher [12] exhibited the structure and usage of an SD-based intuitive training model with in-class and off-class segments supported by a Socrative online feedback framework to improve the learners' commitment to a Malaysian institution of higher education. [13] planned a mobile device for educating designs and information structure courses to learners. A review has been made [14] to identify, evaluate and find which technology provides more effective learning methods through electronic searches. This creates motivation for future automated systems based on AR. This survey [15] produces the findings of social learning spaces and various learning processes through social cognitive theory and activity theory through the CSCL lens to create a theoretical foundation for future technologies.

An application was built to help prerequisite designing by utilizing the precise diagram application on MDs for displaying UML frameworks [16]. As one more model, [17] executed a micro-lecture system on mobile. The handy mobile causes *e*-learners to see recordings and other resources. The energized thought has numerous preferences. However, non-existent activities occurred between students. Also, there are no tests for learners to test their abilities after reviewing the micro-lectures.

Displaying the plan and advancing mobile learning applications on the Android platform utilizing Java programming language helps e-learners in PC courses at the Computer Engineering Department [18]. The methodology encountered between interactive media ideas and order language is to make another learning condition utilizing the SD learning application. The point of the versatile learning application was to supplement conventional learning and *e*-learning frameworks.

"RoboRun" was created for mobile learning games by [19]. The stage

**Table 1**
Summary of the researcher's study based on MeL methods.

| Researchers | Outcomes of Investigation | Drawbacks |
|---|---|---|
| Lim et al. 2017 | Socrative Online Teaching is based on the mobile system. | Discussion of peer and tools assistance usage is needed. |
| Moreira et al. 2016 | Engineering helps in iOS application | UML course is only for learning and won't help in different classes. No activities between e-learners. |
| Wen et al. 2015 | The mobile learning system is by the method of micro lecture | The relationship between e-learners and educators has no effort. |
| Tamhane et al. 2015 | Computer engineering students can learn Mobile applications on Android. | Modules based quizzes and games are needed. |
| Prenner et al. 2014 | 'NetLuke' is used for the structured courses for data and teaching algorithm in a mobile environment. | Different courses do not support here. A collaboration module between e-learners is needed. Well-known platforms like Android and iOS should keep it. |
| Vinay et al. 2013 | "RoboRun" is a mobile learning game. | Collaboration activities have to be supported on other platforms. |
| Boticki et al. 2013 | "Sortko" is an application based on Android to help algorithms for sorting existing body knowledge dealing for the learning and teaching application in animation. | Need to assist in different stages like iOS and Windows phone. |
| Mbogo et al. 2013 | The Scaffolding technique is used for Android mobile learning application to learn program. | We need to help different stages to acquire a group of listeners. |

permits input devices for coding and learning conditional programming and algorithm sequence order. [20] proposed a learning application in android mobile created by five-dimension platform systems helps to write the Java program. African context has been made in this work. They found that the MeL technique could offer chances to limit the trouble observed in the learning of programming. The disadvantages are that it is an application for a particular programming language and doesn't support other programming languages. In this case, coordination does not exist between the *e*-learners and self-learning application is considered. The absence of Communication exists among teachers and *e*-learners. [21] In this, learning of the sorting algorithm has been built up by an Open-Source application. They found that *e*-learners are supported by utilizing SD for education. Table 1 summarizes the analysis based mobile learning from the collected works with their limitations.

## 3. The proposed MeL system

The core functional necessity for the "Mobile-*e*-Learning" framework is the capacity to help the learning and commitment of an enormous number of students. One approach to support students' responsibility to MeL is to utilize mobile correspondence capacities, such as exchange gatherings, declarations, warnings, and self-practice materials. Every one of these capacities is accessible on MeL, making on-request access to data.

MeL framework maintains the transferring of study materials. Along these lines, MeL causes students to access learning materials in various configurations, for example, PDFs, *e*-books, and videos. View declarations, enter dialogues discussions, comprehend versatile situation-based tests, and get warnings. Fig. 1 represents the proposed structure, which uses various web administrations. The structure centres on giving collaborative scenario-based figuring out to the learners. It is based upon instructive, innovative, and social viewpoints.

## 4. Proposed system design

Fig. 2 is MeL App engineering, a model representing the structure, association, and general behavior of a particular system. The writer's pilot study included the plan of a context-aware MeL visual recreation application to convey on-request additional data about the materials exhibited in an ordinary engineering reading material to learners. The main aim of this research was not to completely replace conventional lecture methods with MeL-based data conveyance. Moderately, the goal was to test in, giving learners this extra layer of visual data to encourage more cooperation among learners and cultivate further progressively complete learning, given a restricted eye to eye time educators can have with each understudy during the class. The accompanying Subsections provide a comprehensive record of the significant highlights and segments of the created mobile AR pedagogical tool. Representational State Transfer (REST) protocol is highly supportable for client and server communication through the internet. This produces a web-based application to construct suitable communication between end systems. This uses HTTP (HyperText Transfer Protocol), which is required for web standards, where the MeL application of the end-user is added to the ODBC database drivers. The generic data provider connected to the app provides the instructor's data sources to the learner. Fig. 3 demonstrates the screen captures of the investigations directed for utilizing this tool.

### 4.1. The proposed MeL framework

Fig. 4 shows that every learner first uses the in-built camera of the member's web-empowered handheld gadget to check a printed 2D image, known as Quick Response Code (QRC). QRC is vital to locate the best possible setting. For example, each QRC can express a remarkable coursebook. By checking this code, the AR application identifies the coursebook and gives access to the comparing storehouse of virtual substance. When the QRC is recognized, learners can turn pages and glance at various pictures in the coursebook through the mobile camera's perspective indicated in Fig. 5. These pictures from this point forward are alluded to as cracking images. When the AR application identifies each following image, learners will most likely view

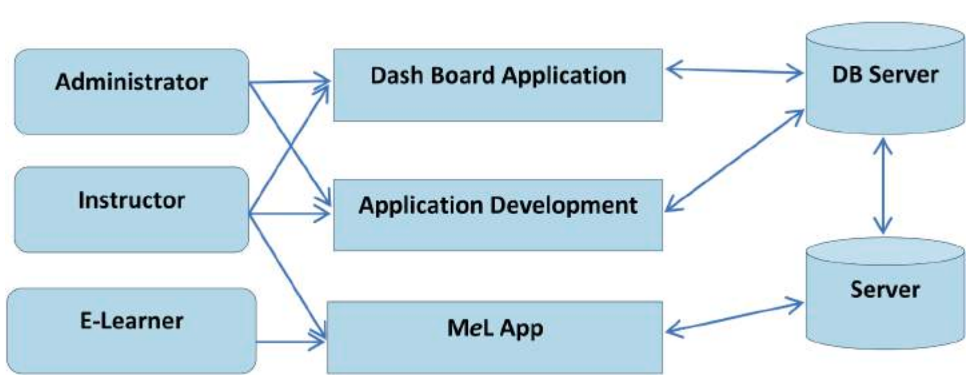


**Fig. 1.** The Proposed Mobile-*e*-Learning Framework.

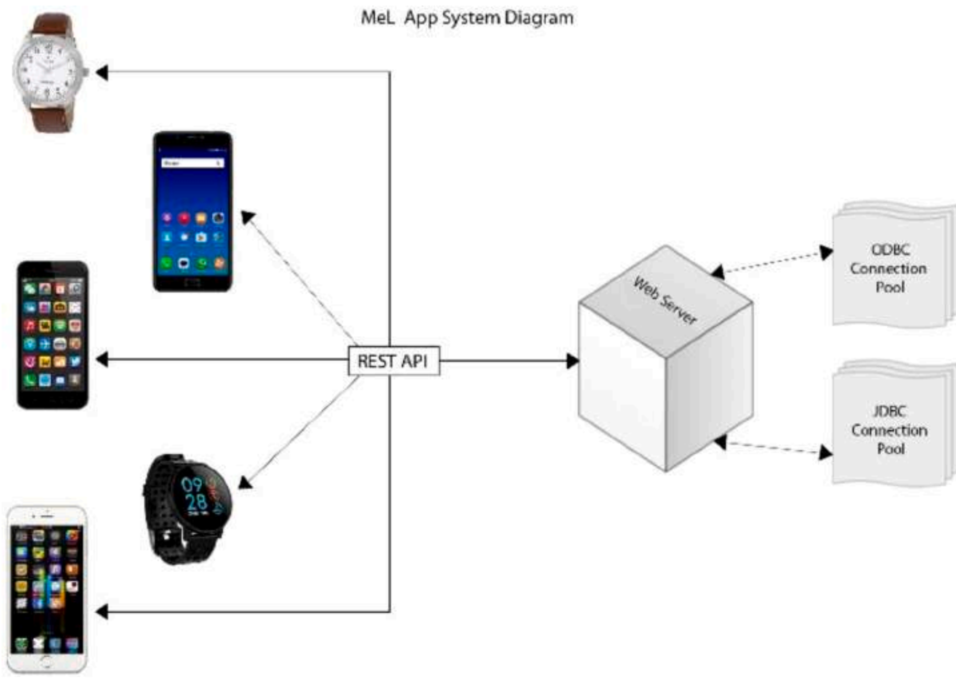


**Fig. 2.** MeL App System Diagram.

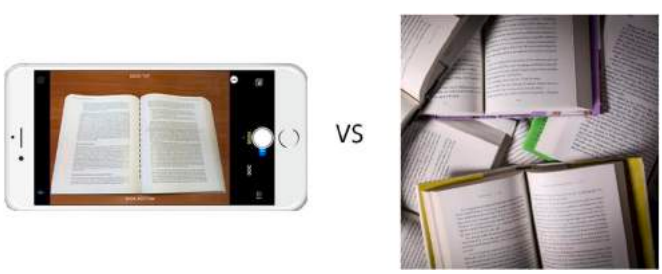


**Fig. 3.** Screen Captures for Digital Virtual Objects.

**Fig. 4.** MD to Scan a QR code.

advantageous visual substances and connect with the virtual objects to get data, notwithstanding what is given in the book.

### *4.2. Implementation of the MeL framework*

This proposed MeL framework, as depicted in the system segment, comprises the customers, web application, work area application, database, and the server. The framework's versatility, productivity, and practicality develop different software technology and guarantee for utilizing subsystems. These subsystems were later associated with a dynamic connection library. In building up the application, we ran it a few times on the test system and useful gadgets to affirm the various unit's usefulness. At that point, the MeL framework has introduced the application on a particular SD for troubleshooting. The testing on the SD has been done. Member's prerequisite details executed the framework. Thorough adjusting and iterative highlights of Agile utilized. The main version of the application is produced for mobile OS clients. MeL application (MeL app) is discharged on the mobile Operating System (OS) App Store. Acquiring mobile OS MeL is free and requires enrolment by clients.

**Fig. 5.** Virtual Contents Demonstrated Fore-Learners.

### *4.3. Mathematical model of mann-whitney 'U' test*

Members of $n_b$ perceptions $\{B_1, B_2 \ldots B_n\}$ are in one group and Participants of $n_g$ perceptions $\{G_1, G_2 \ldots G_n\}$ are in another group. The M-WU Test depends on comparing each perception $B_i$ in the first example with each perception $Gj$ in the other model. The complete number of pairwise correlations is $B_x$ and $G_y$. If the models have the same median, at that point, every $B_i$ has an equal chance (i.e., probability 1, 2) of being higher or smaller than each $G_j$. In this way, it is under the null hypothesis $H_0$: $P (B_i > G_j) = 1,2$ and under the elective hypothesis $H_1$: $P (B_i > G_j) 6 = 1,2$. It

**Table 2**
Key activities performed on SD.

| e-Gadgets Actions | SD Outcomes (*Int*) |
|---|---|
| Messaging | 4.26 |
| Photos | 3.96 |
| Mailing | 1.64 |
| Voice Calls | 3.96 |
| Facebook | 1.32 |
| Online Trial | 1.99 |

tallies the count $B_i$ from test 1, which is more significant than $G_j$ from test 2. $U_b$ represents this number. The count Bi from test 1 is also smaller than $G_j$ from test 2, indicated by $U_g$. Under the null hypothesis, it would expect $U_b$ and $U_g$ to be nearly equivalent. The method for doing the test is shown in equation 1.

Step 1: Set findings in order of size
Step 2: Form B / G
Step 3: $B \rightarrow B_i$
Step 4: $G \rightarrow G_i$
Step 5: Sum = $B_i > G_j$ — Symbolized by $U_b$.
Step 6: Sum = $G_j > B_i$ —Symbolized by $U_g$.
Step 7: Form that $U_b + U_g = n_b n_g$.
Step 8: Compute $U$ = minimum ($U_b$, $U_g$)
Step 9: Routine geometric tables = *M*-W U Test

$$\mu_U = \frac{n_b n_g}{2} \qquad \sigma_U = \sqrt{\frac{n_b n_g (N+1)}{12}} \tag{1}$$

*where*, $S = n_b + n_g$

*4.3.1. Dealing with relations*

It is conceivable that at least two perceptions should be equivalent. If so, in any case, ascertain U by assigning a large portion of tie to the **B** value and a large portion of association to the **G** value. If so, then the typical guess must be utilized with expected standard deviation estimation. The following EQU2 is as follows:

$$\sigma_U = \sqrt{\frac{n_b n_g}{N(N-1)}} X \sqrt{\left[\frac{N^3 - N}{12} - \sum_{i=1}^{P} \frac{TR_i^3 - TR_i}{12}\right]} \tag{2}$$

*where* $N = n_b + n_g$

TR=Total no. of Tie Group
$t_i$=Total no. of Tie Group *i*

## 5. Result and discussions

The gathered information was handled for the Open-Source software's recurrence examination strategy and evaluated by the research. The exploration led in the example is gathering of 500 M*e*-L of the Faculty of Information Technology, Private University of Tamil Nadu-B. E. program of Informatics has enrolled (63%) and Information Management for M.E. study program (37%); male learners having 60%; having 54% full-time learners and 46% part-time; being in the age group of 18–20 years (72%), 21– 33 years (13%), 24–28 years (11%) and 41% in the age group of 28–32. M-W U tested the main activitie*s* of the participants on their mobile device concerning whether their SD.

*Int* represents integers of survey findings. Members *{B, G}* were asked to rate their level of happiness with their main device. Those who used an SP as their MD were significantly happier than ordinary mobile phone users *(Int*=$-5.436$*,* $p<0.001$*)*. Members *{B, G}* used their SP as primary MD has significantly more for the following test activities: Text Messaging *(Int*=$-1.129$*,* $p<0.0101$*)*, Images *(Int*=$-23.567$*,* $p<0.01090$*)*, Mailing *(Int*=$-09.432$*,* $p<0.00110$*)*, Voice Call *(Int*=$-12.105$*,* $p<0.101$*)*, Facebook *(Int*=$-6.987$*,* $p<0.001$*)*, Online Trial *(Int*=$-8.123$*,* $p<0.0011$*)*. Table 2 illustrates events participant's levels and learner's SD.

Members *{B, G}* were approached to give data on the advantages of MeL utilizing an open-finished inquiry in which 500 members responded. The two critical benefits distinguished were availability and adaptability to learn inside hours that fit. A few members felt that material, which is electronically accessible, would mean that they often need not go to the educational institution. Others felt that electronic material being accessible through an SP would guarantee whether they could take it if they kept going to classes because of sickness/climate conditions. Just a couple of members'*{B, G}* shows that the utilization of various learning may be an advantage of MeL. 500 learners gave their

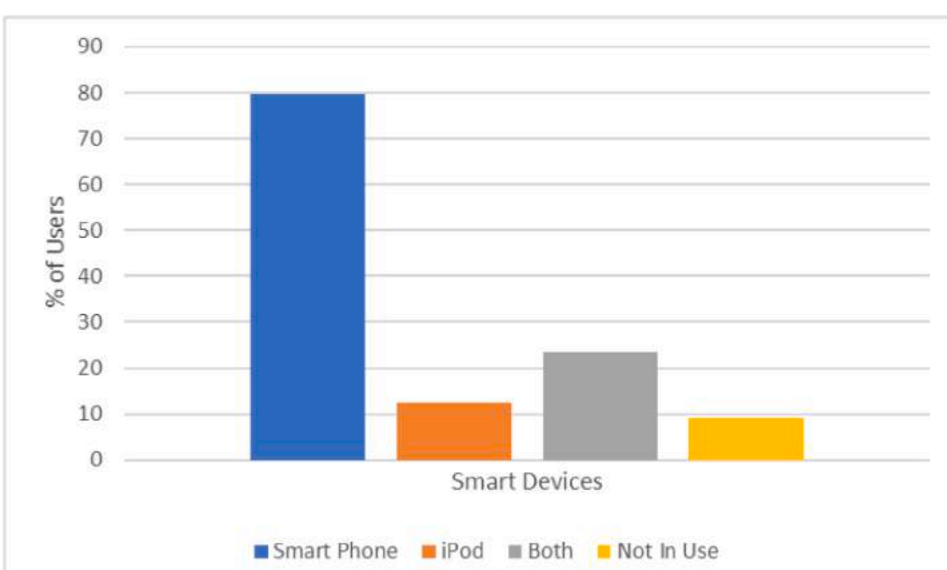


**Fig. 6.** Learners Used Devices.

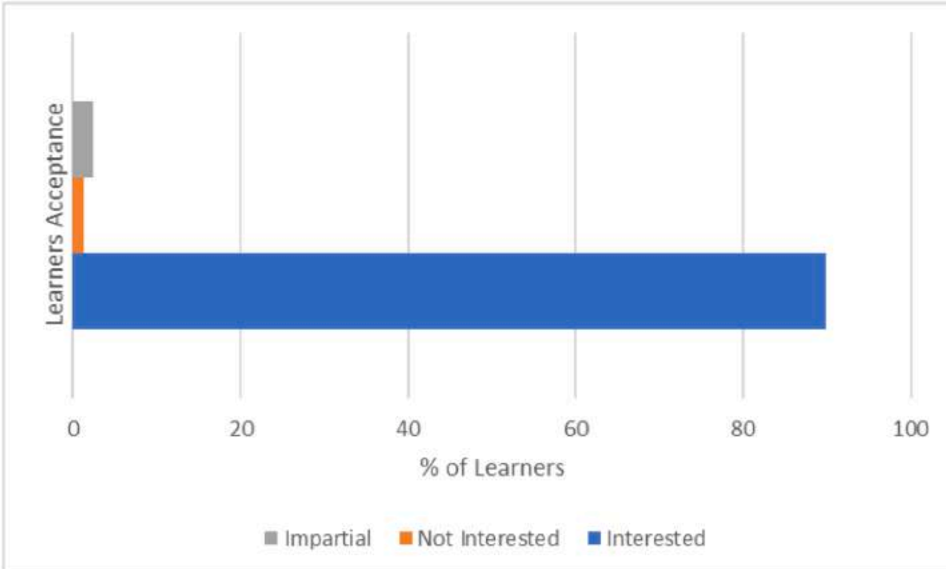


**Fig. 7.** Usage of Visual Learners.

perspectives on the obstructions to M*e*L. The main problems distinguished were cost, device restrictions, absence of recognition with advancements on a device, and lack of encouragement.

### *5.1. Research questioners explanation*

The survey was performed at THE in late 2020. The feedback was made accessible through an online Survey. Members {B, G} were educated regarding the study through study hall utilizing Virtual *e*-Learning Portal.

### *5.2. Preliminary outcomes of investigation*

The proposed framework relied upon enabling understudies to speak with one another and with their teachers makes it simple to get to the learning materials, help the *e*-learners to take an interest in the test improvement and the instructive procedure, adjust to the students' knowledge by changing the trouble of inquiries in the tests and team up in taking care of questions and issues through the exchange module. As expressed in the beginning part, this investigation manages three inquiries, mainly concentrating on the MD controlled by specialized and building *e*-learners from MD's misuse in instructing/*e*-learning specialized/designing *e*-learners and engineering *e*-learners response after SD-assisted M*e*L.

### *5.3. The outcomes of the SD*

The test outcomes demonstrated that an enormous level of learners had excellent prior knowledge about terms; for example, Virtual Reality (VR) is sufficiently capable of installing and utilizing a mobile application on their *e*-gadgets. Five hundred members finished the M*e*L and SD Questionnaire. As appeared in Fig. 6, 96% of members reacted that they claimed e-devices, which without anyone else, was a good sign that the latest technology has turned into a pervasive portion of learner's day by day plans and that learners have simple access to MD. The learning mechanism is concerned to the extent that there are two significant segments relating to learners' consciousness of subjective handling and their control over it, an idea that is indicated as "metacognition" [22] [26]:

Accordingly, the review additionally included inquiries concerning understudies' attention to their learning procedure and their proposals about utilizing innovation and visual data, notwithstanding

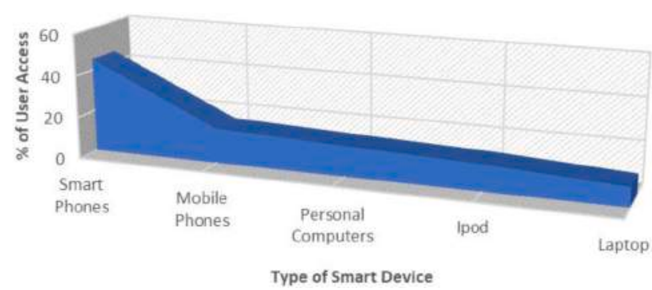


**Fig. 8.** Learner's Activity by SD.

conventional learning techniques.

(1) Attentiveness to acknowledge learning of an individual, and
(2) To acknowledge how to screen and control one's learning.

In this way, the overview included inquiries concerning learners' consciousness of their learning procedure and their recommendations about utilizing innovation and visual information added to customary learning strategies. Fig. 7 shows the more significant part of learners using a mobile phone, tablet gadgets, or both. Fig. 6 shows the audit results that 94% of the learners considered themselves visual students and concurred that they would better understand when teaching utilized 2D/3D perception or media to show conceptual building and relevant subjects. Likewise, over half of respondents proposed adapting better when working in a shared setting and assuming a job gathering during the learning procedure.

#### *5.3.1. Respondents possess mobile devices*

The devices of checked lists contained both the mobile (*e*-gadgets). The gathered information is shown in Fig. 8 describes that textbooks are presently most claimed MD (78% of respondents have them), Smartphones (41%), Mobile Phones (22%), PCs (18%), iPods (13%), and Laptop (6%) were reasonably once in a while possessed. Logically, learners don't have just one SD, yet concurrent ownership of *e*-devices has been verified.

#### *5.3.2. SD purpose for e-Learning students*

Entertainment and Communication have dual primary purposes,

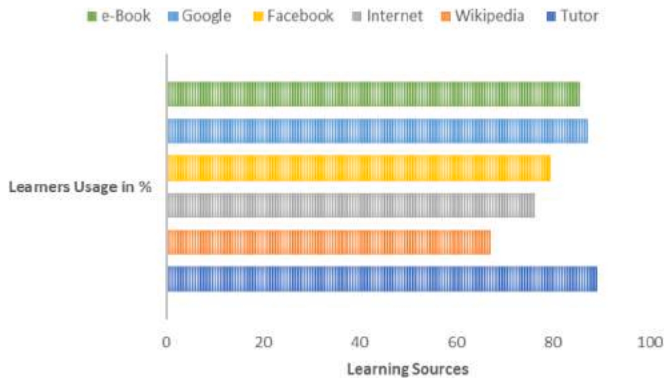


**Fig. 9.** Information Sources for e-Learning.

which respondents utilized MD for the messages organized into two fields: (a) Private Statement, for example with personal and companions on related subjects, (b) Professional Statement covering school-and business-related themes.

Most importantly, the respondents consider the following causes of data: individual participation in Lectures, Wikipedia, Internet, Facebook, Google, etc. As exposed in Fig. 9, the data source is utilized for the respondent. It demonstrates the following conveyance: e-subjects are compulsorily used by all learners (98.19%), just as the individual participation of lectures (91.46%) and work with textbooks. That is why learners acquire reading material from libraries, least of them purchase books; however, most of them contemplate materials from the Internet for free (78.91%). They are interested in gathering learning techniques (88.46%) and from Facebook (80.81%); the materials are accessible on the page.

A large portion of data is of conventional origin and are connected with e-learning for years. As referenced above, what mirrors the MeL approach is, the e-subjects keep running on SD, and fundamentally, Facebook is utilized through SD for sharing knowledge, study materials, and talking about studies.

### 5.4. Validation and outcomes

The structured AR-based learning device was verified in a technical education course at the Private University of Tamil Nadu during the 2018 academic semester. Specifically, the creators chose a senior-level college class (COP-Computer Programming) with a complete enlistment of 500 learners to test this exploration theory.

An example section from a development strategy and the board coursebook [24] covered analysis and soil inspecting chosen and improved utilizing PC generated visual data. The created device enabled learners to examine various pictures and charts inside the book part and obtain specific virtual data [23] (for example, 2D/3D models, video, and sound) as they took a glance at various pages. Previously, during, and after this examination, information was gathered regarding how learners depicted and grasped the points of interest or disadvantages of taking part in an AR simulation-based learning condition [25]. For the investigation learning, learners were coordinated in a few gatherings to cooperate and talk about their thoughts, and it's exhibited in Fig. 10.

All members finished the analysis effectively. After that, they rounded out an anonymous survey about their experience working with the MeL stage, just as considering their contemplations about utilizing this or a comparable framework in the future. The replies based on the post-experiment survey detailed that the technology-mediated account and the intuitive, arranged, community-oriented affordances of the MeL were exceptionally captivating, particularly among the less early individuals learning about the chosen course point.

An exhaustive investigation of student answers to the open inquiries in this survey demonstrated that a large portion of the *e*-learners found the MeL application exciting and agreed that it helped them better to get familiar with the material by giving more top to bottom visual data about the course material. They additionally felt that the MeL application made the lecture progressively intelligent.

On the other hand, a couple of respondents felt that the device was diverting and testing to work with, mostly when the handheld gadget was not held when scanning images. They liked to get the equivalent visual data utilizing computer slides relatively. The *e*-learner's character towards the MeL application was encouraging, and most of them thought it was too somewhat helpful.

The feedback on research investigations from this outline and the outcomes of determining each reaction arrangement are presented in Table 2.

The Research Questions as follows:

RQ1: What is the rating of *e*-learner's experience in this app?
RQ2: In what way the *e*-learners tool is used for THE?

As Table describes, the mean value (μ) of RQ1 was 3.88, with the standard deviation std (X) of 0.68, which means that the fulfillment rate among *e*-learners was high with the new learning technique. Moreover, concerning RQ2, the mean value ($\mu$) was 2.98. The standard deviation σ(X) was 0.89, which infers that most *e*-learners were eager to utilize this new MeL application in different classes and points.

### 5.5. MeL application visual view

When the e-learner first opens the *e*-learning, an application named *"MeL App"* (Fig. 11), a record has to be created by the *e*-learners. To brand a record, the e-learner should enter the student's qualifications (login credentials) and click on create an account, and the *e*-learner has the option to get to the MeL App.


**Fig. 10.** Students Understanding of the Topic using the AR.


**Fig. 11.** *e*-Learner Login Credential.

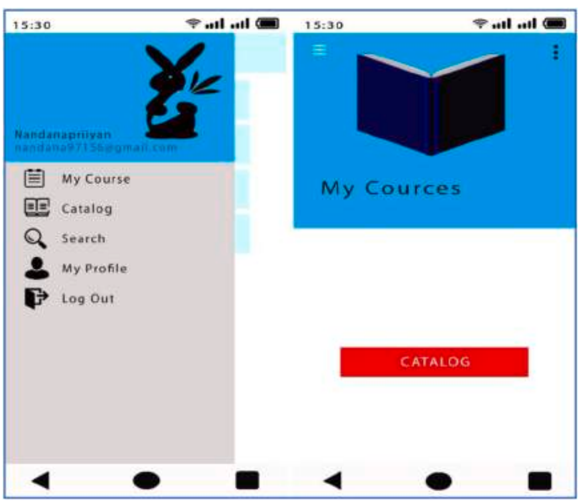


**Fig. 12.** App Access Page.

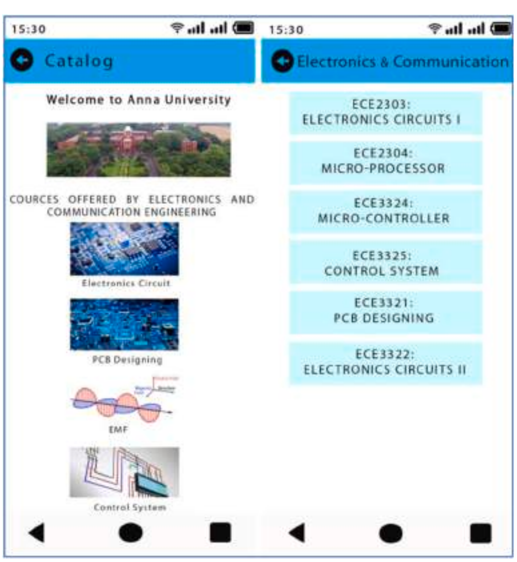


**Fig. 13.** Choices of Course.

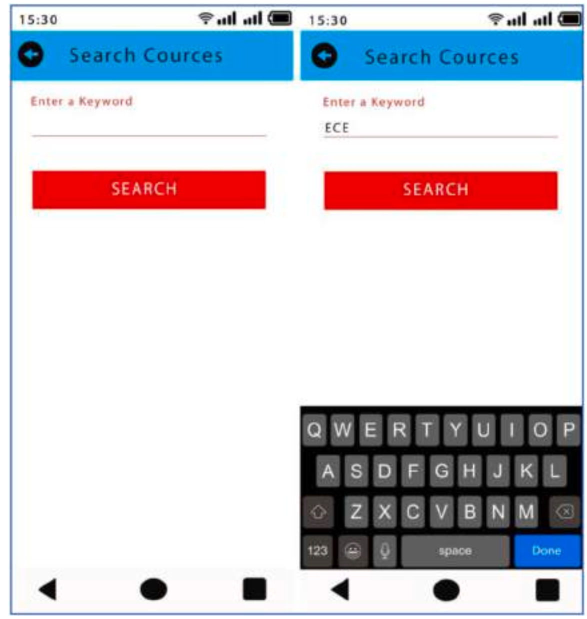


**Fig. 14.** Looking for Course.

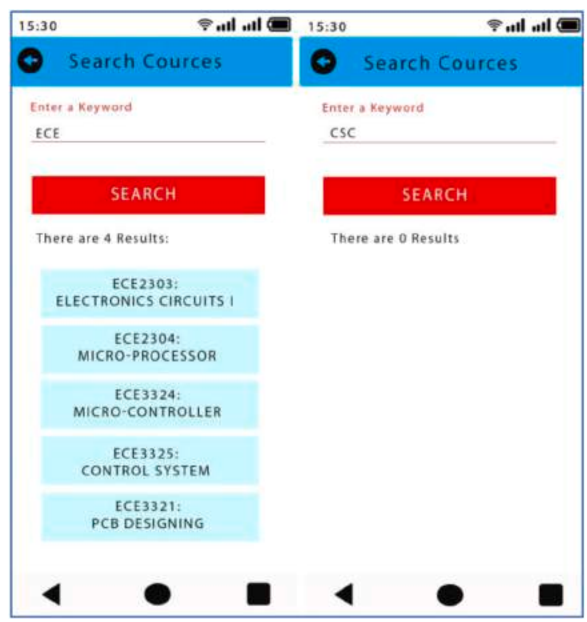


**Fig. 15.** Search Result of Course.

At that point, if the *e*-learner did not join up with any course, they should click on the catalog button (Fig. 12) to see the university catalog. The courses' fields of study are composed and relied upon the mobile learning application catalog. Computer Science incorporates practices, programming in advanced applications, computer design, and software engineering (Fig. 13).

Moreover, a particular course can also be selected by users. To do that, they need to enter the first letters of the Course, and all classes beginning with those letters will be exposed (Fig. 14). It would not display any results if the letters didn't match any of the courses. (Fig. 15).

Students can give their data additionally, for example, major and minor. They can likewise alter their data (Fig. 16).

The changes will be automatically saved. In this project, the most significant mobile learning application element is to enable *e*-learners to

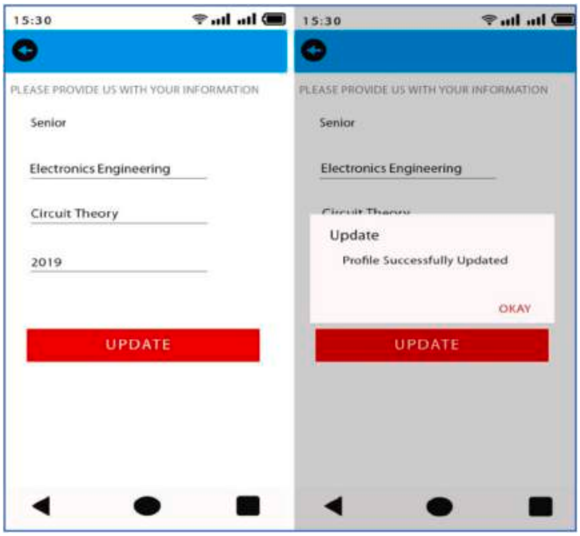


**Fig. 16.** Updating *e*-Learners Summary.

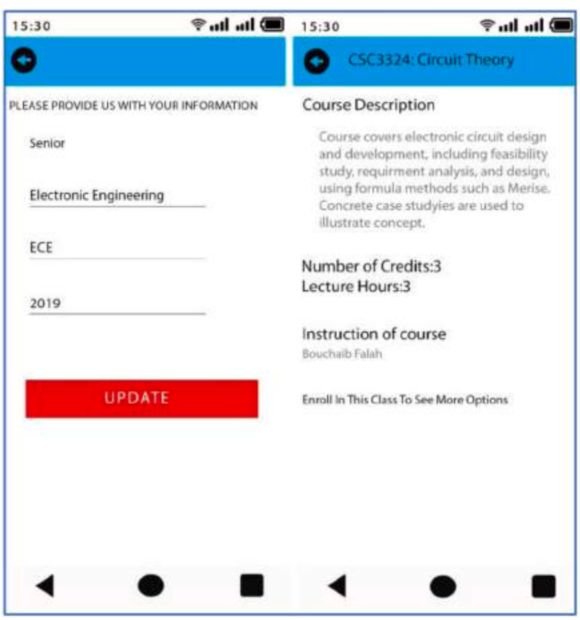


**Fig. 17.** Course Enrolment.

get to any course element. In any case, they are not ready to do that if the Course is not enrolled (Fig. 17).

For accessing the course content, e-learners should first register in the Course they want, and after that, they can get to any of the course content (Fig. 18).*e*-learners can access, for example, the course schedule, the course reports, the course plans or the course assignments (Fig. 19).

By clicking the "Delete" icon, the e-learners can delete any course if they are not interested. The user's records will be automatically deleted (Fig. 20).

## 6. Conclusion and future work

Creating a multi-objective MeL app is an enormous task. This research aims to exhibit the most recent discoveries of a continuous examination for utilizing context-aware mobile condition to increase the feature of coaching and THE preparation. In a preliminary education led by the authors, portions of a typical THE coursebook has improved utilizing 2D/3D and interactive media visual recreations. The *e*-Learners

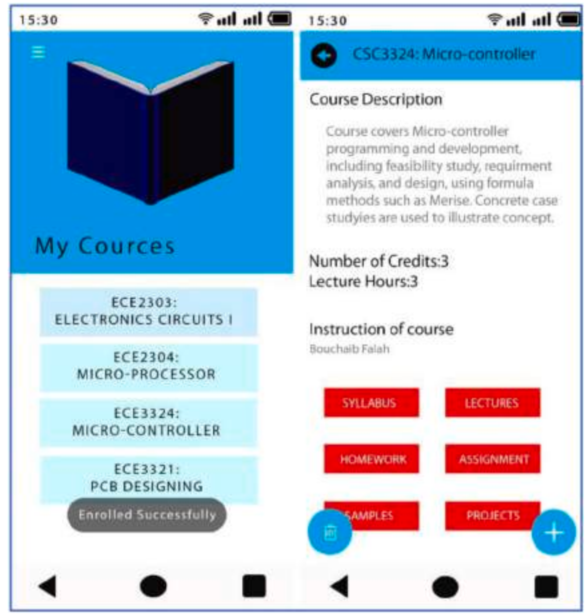


**Fig. 18.** Learners Access Contents.

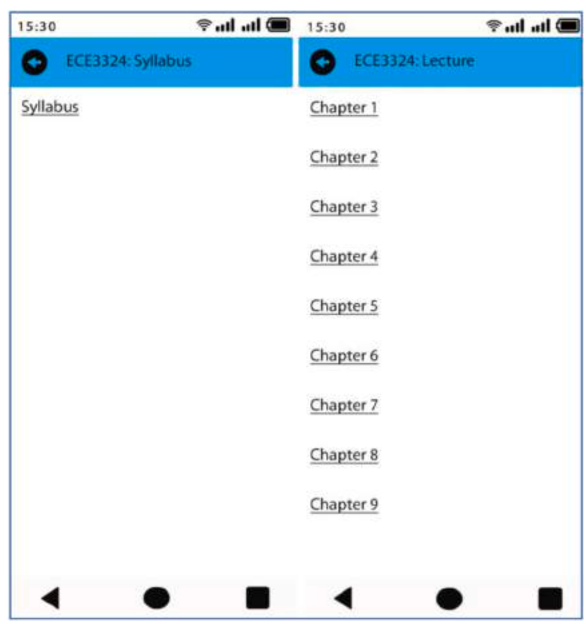


**Fig. 19.** Course Practice.

were then approached to use their SDs to explore through the course reading and get on-request virtual data relating to various figures and charts in the book. This will positively be supportable for THE and creates an automated framework by using the computerized system. It produces innovation-based research towards the e-learning based application. This will be more effective than the existing methods. A more significant part of learners evaluated the MeL as a viable instructive stage and recommended it for all courses. In general, it was discovered that visual reproduction combined with joint effort and collaboration gave numerous affordances in innovation-based and arranged to learn. In this paper, a MeLing application called "MeL application" that would serve in THE has been introduced. The improvement procedure of the MeL framework and Mobile OS form of the MeL application has accounted for MeL supports mixed and cooperative learning with various capacities that benefit the learners to collaborate

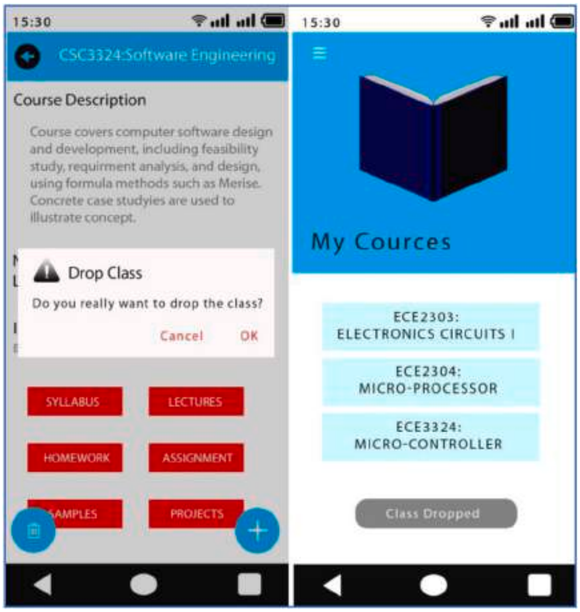


**Fig. 20.** Course Completion Process.

with course resources effectively, adequately, and productively. Software engineering learners assess this proposed framework in technical universities.

Future work in this investigation incorporates new highlights, for example, the capacity to convey area-based data, testing the device in extreme situations, for example, developing job sites to prepare specialists, evaluating the instructive perspectives utilizing more significant and increasingly various understudy and beginner inhabitants, and at last, extending the application space. We are planning to establish an AR-based *e*-learning environment for commercial purposes for an institution or university.

## Declaration of Competing Interest

None.

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