Journal of Engineering Education Transformations ,
Volume 38, No. 4 , April 2025 , ISSN 2349-2473, eISSN 2394-1707

10.16920/jeet/2024/v38i4/25093

Interactive Low-Cost Virtual Learning Device NOODLE to get rid of Digital Divide in Outcome Based Education

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Abstract— Change is the nature of the world and so also the teaching Learning process. Perhaps it was never so challenging as it is today. Post pandemic, online learning under across the Globe has gained wide academic and commercial recognition. Hand held and ubiquitous devices viz. mobile phone, tab, iPod have major role to play. The purposeless / bad use of these devices sometime is a concern. Sometimes, students join their online classes but they do other activities in the background of the device without concentrating on their own class. Sometimes unexpected voice or video calls terminate the online classes. Also, students of rural /village area, can't afford good quality devices for online learning. This creates a Digital divide. Researches on virtual learning are extensively distributed. Now the proposed device "New-normal Object-Oriented Dynamic Learning Environment (NOODLE)" is a newer kind of global and diffusive device to ameliorate consecutive devices for learning and collecting resources is yet to be extensively publicized in the educational world. Proposed work is expected to provide a solution to the students in virtual learning. This device facilitates automatic recording on online classes and there is provision for the audience control by the Admin so as to make the sessions more participatory and interactive. This automatic recording, audio and camera activation is supervisory password protected. The network cost can be minimized through control on social applications and parallel activities. This resolution may be adjuvant for worldwide students along impoverished and is capable of effectively contribute to e-learning.

Keywords—Digital Divide; Interactive; NOODLE; OBE; Virtual Learning.

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1. Introduction

Advanced wireless virtual learning and mobile technology have improved the interactive virtual learning and communication process. Mobile Learning or M-learning is an accession in education interface that provides the user located anywhere and anytime through mobile devices. Virtual technology helps to practise digital learning and resources which is one of the greatest technologies that has changed the education horizon. The digital learning scenario is entirely new. During the Covid situation, digital learning substantially contributed in sustaining the teaching-learning activities and across the globe, stakeholders viz. students, faculty, staff, guardian, alumni are immensely benefited This even has made the life and activities of the educators or managers easy.

Cloud computing is an important support in this regard and emerges as effective domain of research in terms of Big Data Analytics and Data Science due to availability of huge virtual resources. Cloud computing is a model for on-demand network access to a shared pool of configurable computing resources and is released with minimal management effort or service provider interaction. Cloud computing provided a new style of dynamic computing often virtual resources service over the network system. People use various devices like PCs, laptops, smartphones, etc. in the cloud computing world. In Mobile Cloud Computing public cloud suppliers provide extensible and large calculation and memory resources which could be operated every time throughout the world. Also, they provide high Quality of Service. Mobile Cloud Learning is an innovative composition of cloud computing and mobile learning. Students can access their content like audio, video files, and text-based documents via their mobile devices connected to the Internet. Mobile learning in Flipped mode, the classroom, and residential proceedings are corresponded or inverted.

A. The objective of the study

- To develop Virtual learning enable Teaching-Learning device.
- It is an Outcome-Based Educational digital device.
- While using this application, the other common applications (viz. Twitter, WhatsApp, Facebook, Phone calls, etc.) will be by default inaccessible i.e. selectively accessible.
- Device will be facilitating with automatic recording facility of online teaching and learning session.
- Student cannot stop their audio and camera throughout the session.
- This automatic recording, audio, and camera activation will be supervisory password protected.
- Tn post-pandemic situations online teaching using low-cost devices is high in demand.
- To find financial capabilities of people to provide new device NOODLE (New-normal Object-Oriented Dynamic Learning Environment).

The above device with some of the features are devised and applied for intellectual property claim. The detailed advantages and impact on teaching learning has been presented under Section 4 Result Analysis.

B. Literature Survey

The appearance of digital technologies has unboxed momentous new scope and challenges for educators. Virtual technology helps us to introduce our digital classroom opportunities and resources otherwise we are unable to access. This is one of the greatest technologies that has changed the education process. The digital learning is still an emerging technology. It will give more information about what activities should be done by students or kids and what should not. In the present days Parents, Caregivers, Teachers and School leaders etc. are better prepared to assist their child for social, emotional and academical p during the Covid situation. (Christine Elgersma, July 30,2020)

1) Mobile Technology

Is now adapted as M-learning in various fields. Users get a flexible learning environment in regardless of geographical location by M-learning. In our flexible dynamic environment cloud computing is an important issue. M -learning using cloud is also known as Mobile Cloud Computing (MCC) and it is an important research area for a researcher. (Areej Omar Balghoson, M. Rizwan Jameel Qureshi. Department of Information Technology, Faculty Computing and information Technology, King Adulaziz University, Saudi Arabia, December 2014)

2) Cloud Computing

Is “a model for enabling ubiquitous, convenient on-demand network access to a shared pool of configurable computing resources (i.e. networks, servers, storage applications and released with minimal management effort or service provider interaction. (Mell and Grance 2009), (Wang et al. 2014). Cloud computing obey two implicit properties, that are resource scaling up and resource pooling. Resource scaling and Resource pooling are slow known as elasticity and running various independent service. (Hirsch and Ng. 2011), (Wang et al. 2014). Cloud computing provided a new style dynamic computing often virtual resources service over the network system. Users use various device like PC’s,

laptops, smartphones etc. in cloud computing world. (Mr. Ramkumar Lakshmi Narayanan, Dr. Binod Kumar, Mr. M. Raju. – Higher College of Technology, Muscat, Oman.) Fig.1 is the service model of cloud computing environment. There are three different service layers. One of the first Software as a Service (SaaS) provide to access the apps like Gmail, Facebook etc. for the end users. Platform as a Service (PaaS) is the Second layer of cloud computing model offers API and programming circumstances for application builders. Infrastructure as a Service (IaaS) is the last layer offers virtual technology with calculation and memory resources.

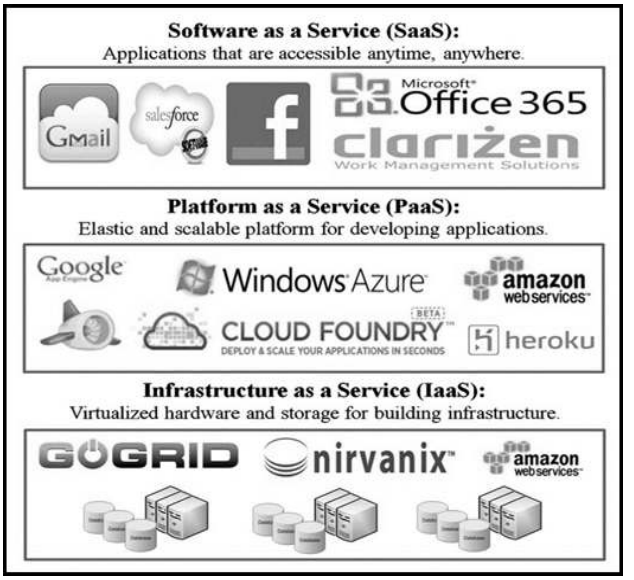

Fig. 1. Cloud Computing service model.

3) Mobile cloud computing (MCC)

In MCC public cloud suppliers provide extensible and large calculation and memory resources which could be operated every time throughout the world. Amazon, Google App Engine etc. are the circulated data centers in the world. MCC could be simply viewed as using cloud services to possess mobile applications in (Rajan 2016). Figure 2. shows the general ecosystem of MCC and some of its important constituents, (Susanta Mitra & Dr. Somsubhra Gupta - Springer,2020).

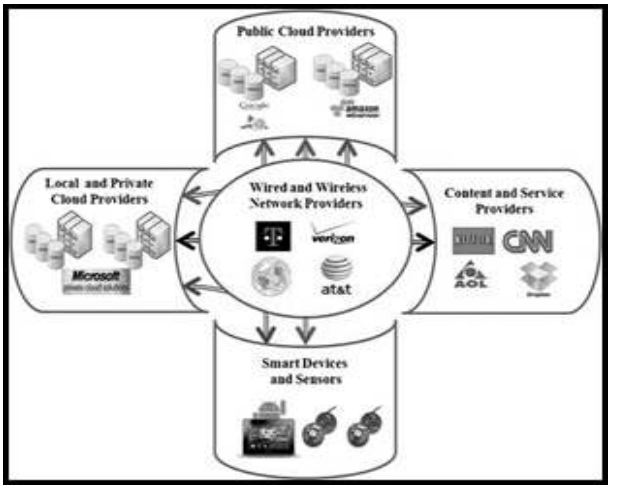

Fig. 2 : Mobile Cloud Computing Eco systems

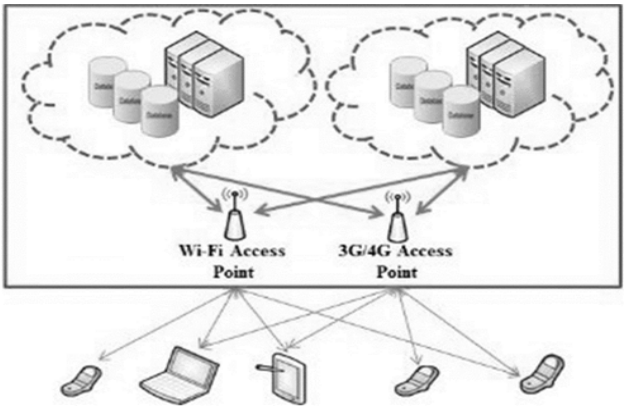

Fig. 3: Two-tier Mobile Cloud Computing Architecture

As shown, both cloud providers i.e. private and public are not scalable and elastic but they provide high Quality of Service (QoS) like, security and privacy, real time services like games and video streaming, etc. The end mobile device users (news, videos, email, games etc.) are getting usable data contents and services which are provided by Service and Content providers. All MCC component could communicate with each other using wired and wireless of the network infrastructures which are provided by Network providers.

In Fig. 3, 2-Tier Architecture of MCC provide rich functionality and ubiquitous, resource limitations of mobile devices are regardless in (Reza 2014). Ultimately, the last members are smart mobile devices and sensors like Tablets, Smart phones, Traffic cameras and sensor wearable. So there have many services on mobile teaching and learning applications and service providers. But I want to provide some special features for learning.

4) Mobile Cloud Learning (MCL)

Is an innovative composition of cloud computing and mobile learning. Students can access their content like audio, video files and text-based documents via their mobile devices connected with the Internet like Wi-Fi, WiMAX, UMTS, HSPA, GPRS, or LTE in mobile cloud learning (Hirsch and Ng 2011; Wang et

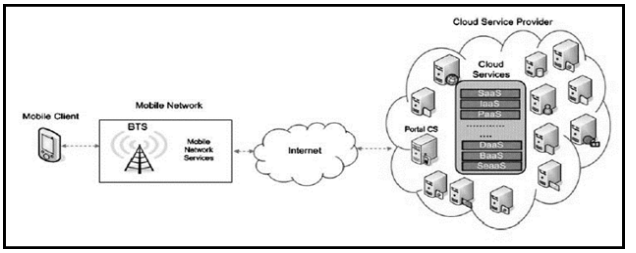

Fig. 4 : Mobile Cloud Learning Architecture.

al. 2014). The structure of mobile cloud learning is also described in Fig.4.

While Mobile learning in Flipped mode, shows in Fig.5 and Fig.6 has (Bergmann and Sams 2012). In this case the class room and residential proceedings are corresponded or inverted. So, teacher distributed study materials before to the beginning of the class. We assume that the learners have gone through all content and attend the class in an informed way. In the class, instructor circulates the matter to the pupils and also in the class, pupils produce their personal substance and present to the instructor. After the class, teacher checks and integrates each content of students provide ultimate substance on the subject and distribute. So, teacher act as a mentor.

C. Observable Characteristics

In the earlier subparagraph (1.1), the publications research submitted, the state-of-knowledge of the Mobile cloud learning in the modern time is speculated from the observation viz. cloud enabled hybrid architecture for mobile learning in (Faud and Deb, 2017), contextualized cloud application for mobile learning in (Sotsenko et al. 2016). There are many remarkable inspiring facts in Mobile learning are as follows:

- In teaching learning process there is a lot of alternatives in this new millennium.
- Activity based learning is gradually come out instated of traditional chalk-and-talk based learning.
- Interactive teaching from monologue to dialogue pattern of teaching is not simply enclosed.
- The new generation learners are very much affected in hands on learning.
- New age of trainees is autonomous on their curriculum provided by teacher.
- Learners are depended on Web contents (like Wikipedia, You Tube, and Google etc.) because those contents are vaster than the individual content.
- Very important aspect, Blendspace, Screencasting, Mysimpleshow etc. are Big corporate driven portals, which provide customized learning aid for Students.
- Moreover, the social networking participation and contribution of learners or students increase their social awareness and knowledge.
- The guidance of a teacher is still important for students because all web contents are not authentic. Now, teachers gradually become Guide for a student.
- All the above-mentioned facts take cognizance for the Outcome Based Education (OBE) frame work.

The last few years of discussions, various studies and researches it has come out that mobile cloud learning has more important role in academic and commercial recognition and also in gradually improving e-learning market in (Lin et al. 2016), (Wang et al. 2014), (Wei and Joan 2014), (Somsubhra Gupta and Susanta Mitra – Springer, 2020).

2. Gap Analysis

But these digital devices are badly used also. Sometimes, users join their online classes doing parallel activities without concentrating on their own class. Unexpected voice or video calls terminate the online classes sometimes. Another aspect is that, in the students of rural/village area, they do not get good quality devices due to price and they are unable to maintain network cost for their online learning. So, researches on virtual learning are extensively distributed. Now, "New-normal Object-Oriented Dynamic Learning Environment (NOODLE)" is a newer kind of global and diffusive device to ameliorate consecutive devices for learning and collecting resources is yet to be extensively publicized in the education.

3. Methodological Aspects

Proposed Circuit diagram of NOODLE is similar to the other general mobile device, but our proposing research work is expected to do education more

effective for the students conducting private network settings also helpful and it is low cost. That device is expected to facilitate automatic recording facility of online teaching and learning session and student cannot stop their audio and camera throughout the session. This automatic recording, audio and camera activation is supervisory password protected. Also social applications and parallel activities can be restricted for this teaching learning device, then data usage is expected to be low, it can control the network cost. This resolution may be adjuvant for worldwide students along impoverished and unconsidered will be helpful to get rid of e-learning.

In the following figure 5 to 8 actually a pre-pandemic digital learning trend has been presented in extension to proposed prototype design of the device NOODLE. That is bound to increase during pandemic and post pandemic era as the trend towards digital learning has been enhanced during this phase.

Fig. 5:Proposed model of the Mobile Device NOODLE

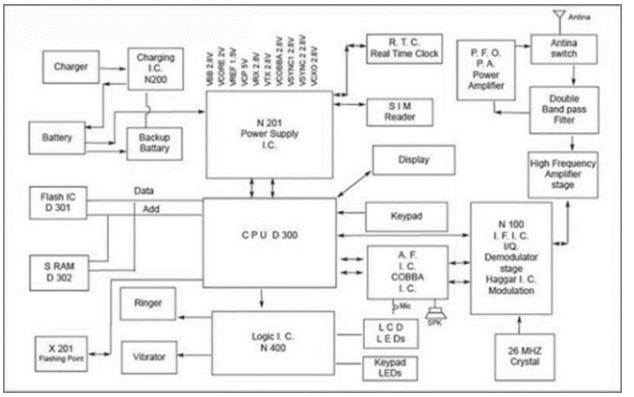

Fig. 6: Proposed circuit diagram of Mobile Device NOODLE.

Data Source

Mobile Phone* and Smartphone Users in India, 2014-2019**

	2014	2015	2016	2017	2018	2019
Mobile phone users* (millions)	**581.1**	**638.4**	**684.1**	**730.7**	**775.5**	**813.2**
—% of population	47.0%	51.0%	54.0%	57.0%	59.8%	62.0%
—% change	10.7%	9.9%	7.2%	6.8%	6.1%	4.9%
Smartphone users (millions)**	**123.3**	**167.9**	**204.1**	**243.8**	**279.2**	**317.1**
—% of mobile phone users	21.2%	26.3%	29.8%	33.4%	36.0%	39.0%
—% change	62.1%	36.2%	21.5%	19.5%	14.5%	13.6%

*Note: *individuals of any age who own at least one mobile phone and use the phone(s) at least once per month; **individuals of any age who own at least one smartphone and use the smartphone(s) at least once per month*
Source: eMarketer, July 2015
193900 www.eMarketer.com

Fig. 7: Users from 2014 to 2019.

In Fig.7 showing the Mobile phone and smart phone users in India from 2014 to 2019.

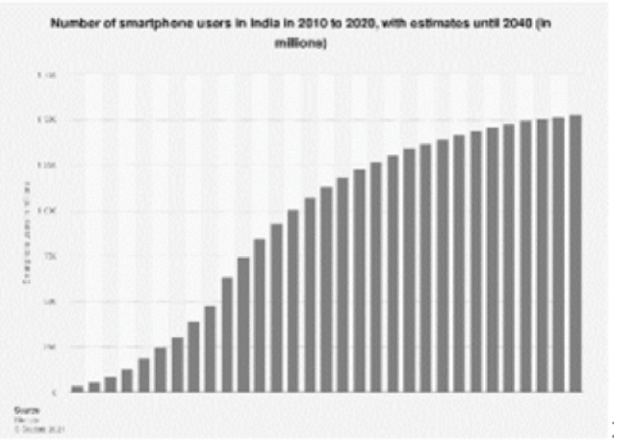

Fig. 8: Users in India 2010-2020 with estimates until 2040 (millions).

In Fig.8, shows in a graph the Number of Smart phone users in India from 2010 to 2020 with estimates until 2040 (in millions)

The result analysis follows this section below

4. Result Analysis

The prototype of the aforementioned device NOODLE has been created and applied for intellectual property claim (A-202331012519 dated 23/02/2023, published: 10/03/2023). Because of this the implementation and testing of the proposed device has been made through emulator the sample case result of which has been provided below.

Its impact on teaching learning can be summarized as follows:

- It's a dedicated digital device for learning purposes only. Its sharable options are optional.
- This enables anytime anywhere learning with dependency on single performance indicator i.e. internet bandwidth
- It also supports Just in time (JIT) learning as Virtual learning tools and Virtual learning platforms are integrated here in this device.
- The full-fledged implementation is expected to bring some more interesting results.

Following is a sample test screen conducted through NOODLE emulator in which the performance of the participants is encouraging indicating a smooth knowledge transfer:

			Internal Assessment Marks						External Assessment Marks	Sem End
Sl No	Registration No.	Roll No.	Internal Exam 1 (30 Marks)	Internal Exam 2 (30 marks)	Home Assignment/ Presentation (10 marks)	Attendance (10 marks)	Total (80 Marks)	Scale down 80 to out of 40	Total (60 Marks)	Total (100 Marks)
1	007-103-2021-001	007-MCS-2021-001	26	29	7	10	72	36	54	90
2	007-103-2021-002	007-MCS-2021-002	20	26	9	10	65	33	52	85
3	007-103-2021-003	007-MCS-2021-003	21	15	5	7	48	24	52	76
4	007-103-2021-004	007-MCS-2021-004	22	15	5	7	49	25	49	74
5	007-103-2021-005	007-MCS-2021-005	20	21	6	8	55	28	45	73
6	007-103-2021-006	007-MCS-2021-006	28	28	6	10	72	36	58	94
7	007-103-2021-007	007-MCS-2021-007	15	abs	6	7	28	14	34	48
8	007-103-2021-008	007-MCS-2021-008	20	10	5	7	42	21	51	72
9	007-103-2021-009	007-MCS-2021-009	24	27	6	10	67	34	52	86
10	007-103-2021-010	007-MCS-2021-010	21	18	5	7	51	26	33	59
11	007-103-2021-012	007-MCS-2021-012	22	22	5	7	56	28	49	77
12	007-103-2021-013	007-MCS-2021-013	25	29	8	10	72	36	57	93
13	007-103-2021-014	007-MCS-2021-014	21	28	5	10	64	32	51	83
14	007-103-2020-009	007-MCS-2020-009	29	29	8	10	76	38	58	96
15	007-103-2021-015	007-MCS-2021-015	abs	13	5	5	21	11	48	59
16	007-103-2021-016	007-MCS-2021-016	abs	abs	5	5	10	5	36	41
17	007-103-2021-017	007-MCS-2021-017	abs	abs	5	5	10	5	44	49

Fig. 9: Emulator test screen.

It has been observed that majority of the students pursuing through the emulator has substantially good outcome, though outcome is not always a reflection of direct knowledge transfer. On the other hand (bottom three entries who preferred to abstain from digital and preferred manual mode) the physical mode knowledge transfer is insignificant.

Its features, as mentioned in the list of objectives under Section 1 Introduction, are reiterated below:

- It is interactive technology-driven virtual learning device NOODLE for equity in outcome-based education is highly needed for mobile education in individual cloud has been presented for apprentices of scholastics and enterprises.
- This ensures financial equity as well to get rid of digital divide for its reasonably low cost
- This cost-effective solution of proposed work extends the dematerialization structure, which not only contributes to the education relocate and distribution but also to Outcome Based Education (OBE).
- Portable, robust and cost effective
- Virtual learning platforms (viz. GMeet, MSTeam, ZOOM) as well as virtual learning apps (Screencasting, Blendspace, TedEx..) can be integrated for purely non -profitable academic works.
- This device architecture is new and yet to be produced early
- This device circuit design is customized according to post pandemic virtual learning need. No such integrated device is reported earlier.
- This restricts use of unauthenticated parallel background activities

Its usefulness can only be provided after a chronological lon- term evaluation and assessment of test cases which is illustrated above. However, considering its unique features, it is definitely effective at start. To the rubric or formula generation for measuring knowledge transfer through NOODLE (like menti-meter) can also be taken into consideration after analysing chronological data. The conclusive remarks have been presented in the next section.

Conclusion

This interactive technology-driven low-cost virtual learning device NOODLE for equity in outcome-based education is highly needed for Virtual Learning. Personal cloud has been presented for apprentices of scholastics and enterprises. This cost-effective solution of proposed work extends the dematerialization structure, which not only provides to the education relocate and distribution but also to Outcome Based Education (OBE).

Using Personal Cloud environment need to research for newer type of appliances, which collect data from the environment and to make more beneficial, practical and interesting. At present, Smartphone, Tablets etc. are used for mobile cloud learning. Those devices have some limitations like small screen, low processing speed, low memory and multiple standards in (Baalghusan and Qureshi 2014). Naturally, it is very essential for learners need-based own design devices to overcome from the limitations of existing devices.

That new device helps to gather information widely to improve their learning. Though this paper a gentle effort has been made to examine encouraging recent and upcoming engineering and introduced innovative unique concepts for educational accomplishment in personal cloud environment that can be cost-efficient, cooperative and adjuvant for worldwide students along impoverished and unconsidered.

Acknowledgment

The authors gratefully acknowledge the research support from the authority of Swami Vivekananda University right from publications to patent.

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