

Development of Learning Software for Deaf: A Sample of Language Learning Material

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Abstract— Hearing capacity is given bestowed to humans. The significance is underappreciated in its presence. However, children with hearing loss feel challenges to be faced in learning and moving socially. According to a survey three children out of 1000 are born deaf but generally diagnosed between 2-5 years. Deaf education has come a long way since its inception in 15th century. Most common educational approaches available for deaf children include bilingual-bicultural, auditory/oral, and total communication. First approach uses a sign language, second approach without it, while the third approach combines visual communication and auditory. In this information age, this paper focuses on the use of ICT and web technologies bestowed by Web 2.0 for developing software which can leverage e-Learning process for deaf children. A hybrid approach is incorporated to children with sign language and traditional teaching methods through the use of software. A web based interface is built with functionalities for teacher and student roles. Materials are uploaded and managed by users of teacher role while the users in student role (deaf children) can have good learning experience of English language basics. The results revealed that the proposed sample e-Learning mechanism is the good proof of the concept which can be improved to have full-fledged e-Learning portal for deaf children.

Keywords— Education, E-Learning, Deaf children, Teaching for deaf, Language learning material

I. INTRODUCTION

Children are born with abilities for language development. It is understood in 1960's that children have Language Acquisition Device (LAD). Children use it to understand language with ease. They make experiments in speaking language in terms of application of grammar. This happens by the time child reaches five years age. However, LAD works well when people sign or talk to children constantly and with visual aids if needed. LAD closes down as children grow in age. That is the reason language learning is easier in the early years of childhood. This chapter provides information that helps to understand the need for the research and development of e-Learning portal for educating deaf children to acquire language skills.

Deaf children have no hearing capacity or hard of hearing. When there is one-to-one conversation with deaf child, there is possibility to convey something through speech or sign as they cannot overhear conversations. They miss many opportunities pertaining to incidental learning by listening to radio, watching TV and listening to a group of people involved in conversations. Thus they lack background knowledge of different topics and thus they do not have good imagination on different topics as well. When compared with children without hearing problem, deaf children receive very

less information in school and home. With respect of learning language there are many factors that affect deaf child include age at which hearing loss occurred (by birth or later age), degree of hearing loss, the quality of language input, parents' hearing status, the quantity of language input, early intervention and age of diagnosis.

By the time a deaf child enters school, it is essential to have good vocabulary of language and good exposure to basic language skills. Otherwise it will be very to cope with studies in school. With technology innovations and the emergence of computing or communication trends, it is believed that a web portal that can work in all devices can help deaf children to acquire basic language skills. The web portal with edutainment which has language learning material can support e-learning for deaf children. With simple training of usage of web portal children can operate and self-learn language skills. Of course deaf children are to be helped to make use of the software initially. Therefore the aim of this project is to build a web based application that can be used in all devices. The proposed software has learning material for deaf children which has impact on them in learning language basics. The skill will go a long way in their life in the context of school and afterwards. This is the motivation behind taking up this research.

Our contributions in this paper include designing and implementation of learning software for deaf children to support English language basics. It is the proof of concept for the sample of language learning material for deaf children. It incorporates various learning materials like alphabets, numbers, fruits, vegetables and so on. The remainder of the paper is structured into various sections. Section II reviews literature on deaf education and tools used to help them in learning. Section III presents the problem definition that is used to do research in this paper. Section IV shows the proposed methodology. Section V shows implementation of the web portal and its results. Section VI provides conclusions and future recommendations.

II. RELATED WORKS

Hoffmeister and Caldwell (2014) [1] studied on the deaf children acquiring language skills in English via print. In absence of natural hearing ability, deaf children cannot properly learn language in childhood. Language acquisition needs social interaction tool which is not possible by deaf children. The researchers [1] focused on describing a model in which deaf children can acquire language by reading and writing. Their model allows children to learn language in different stages. In stage 1 translation equivalents are mapped. In stage 2, translation is broken down into words

and sentences. American Sign Language (ASL) is employed to learn English language via print. Autism Swanwick and Marschark (2006) [2] focused on educational research for deaf. They made a review of deaf education research available. They found research gap between practice and research.

Hendrix, Eick and Shannon (2012) [3] studied the difficulties in teaching complex science topics to students. The process of conceptual learning and the effect of student attitude were studied. They found that creative drama has good impact on the enrichment of students in terms of knowledge and skills. Luckner, Slike and Johnson (2012) [4] focused on helping students with hearing problems to succeed in life and education. There are many challenges for educators to deal with deaf students. They include issues pertaining to vocabulary, language, and literacy delays, gaps in domain knowhow, inadequate use of strategies to learn, deficits in social skills and dependence on assistive technology. They considered different types of hearing loss such as chronic middle ear infections, severe deafness, hard of hearing, and hearing loss in one year. They said that interesting reading materials can improve the vocabulary of deaf students. Mann and Marshal (2012) [5] investigated British Sign Language (BSL) for improving vocabulary of deaf children. The tasks involved in the process include meaning recognition, form recognition, form recall and meaning recall. Target and distracter pictures are used to promote learning. Target picture, phonological distracter, semantic distracter, and visual distracter are used in the learning process. In [36], studies for special interest groups are discussed.

Easterbrooks and Stephenson (2012) [6] focused on instructional strategies that led to improvements in the learning process of deaf and hard of hearing. They identified six key factors in teaching deaf. Healy and Powell (2013) [7] focused on understanding the reasons in difficulties in learning of mathematics and how to overcome the problems. Humphries et al. (2014) [8] focused on the actions needed by linguists in order to teach deaf children. They opined that home and school environments should be different for deaf children to ensure that they feel better in language acquisition. Morford, Rathmann, and Villvock (2014) [9] focused on German sign language (GSL) for word recognition in deaf readers. Smith (2012) [10] focused on deaf adolescent females and their health information details.

Fichten et al. (2000) [11] made a review of research on learning and digital technology of post-secondary students with disabilities. Whyte et al. (2011) [12] focused on learning methods of children with autism. They focused on methods that can help such children to understand idioms. In [13] an online course by name Massive Open Online Course (MOOC) was explored. MOOC supports learning of materials in different subjects. It serves people who wanted to learn subject. MOOC has no restrictions to class, gender, race or country. In [14], the authors explored it well. There are many products in the real world that make use of AI. For instance, Watson system of IBM, AlphaGo from Google, Google Assistant from Google, Alexa from Amazon are systems to help people in learning to mention few.

It is explored in [15] for game-based learning approaches. Natural interfaces and NUI devices can easily capture gestures of both and sounds in order to have interaction between computer and user. In [16] a device known as Raspberry-Pi based Assistive Device is explored. Such device is used to support blind people, deaf people and dumb people. It is said that 82% of impaired people are suffering from poverty. It is understood that 9.1 million of world population are deaf and mute. Educational games for disabled children are explored in [17]. It is explored in [18] that there is need for prototyping in order to have better results in educating deaf people. In [19] CAPTCHA is explored to enable applications to have security from malicious bots. It is important to have good user experience when education is given to people with disabilities.

In [20] virtual environments are explored for promoting learning experience of students. It is important for students to have game based learning. The rationale behind this is that it provides business rules or game rules besides the educational content for learning. Similar kind of work was done in [23], [24]. In the field of natural science and technology, the usage of such virtual environments is crucial for better results. The usage of the method provides some sort of Virtual Reality (VR) which is one of the promising tools for having powerful interface in learning. It is a tool used in education in order to improve the performance of students.

In [21] the role of the age is explored with respect to auditory and executive functions. In [22] different kinds of instructions for teaching and different kinds of courses are explored in education systems. They explored different means of finding the importance of classroom learning and the other learning approaches. In [25] it is found how to teach a foreign language to deaf children while the evaluation of the education is studied in [26]. In this paper we investigated, designed and implemented a learning portal which provides sample learning material for deaf children to support learning English language basics. A web based interface is built to demonstrate proof of the concept.

III. PROBLEM DEFINITION

Deaf children have no natural hearing equipment. They have difficulties in learning subjects taught in school. Therefore they need to learn basic language skills before they enter school. Deaf children have many common language difficulties. They include that limited vocabulary, grammar and syntax of language, difficulty in understanding common expressions and idioms, difficulty in asking questions and giving answers, and inability to catch complete conversation. These problems encountered by deaf children are challenges to be addressed. By developing software which can address these issues can help children to have good language basics before joining school.

IV. PROPOSED SOLUTION AND METHODOLOGY

The proposed system is a web portal which serves deaf children to learn language basics. In fact it is an e-Learning platform that helps deaf children to equip with language basics. It helps them to learn in their own pace as it is done online. The scope of the project is limited to developing web portal software that can work in various devices to support education to deaf children in terms of acquiring language

skills. The proposed software provides language materials that can help deaf children to grasp basics of language with ease. The web portal incorporates both traditional and sign language approaches in order to help deaf children acquire language basics. This paves way for them in life to overcome learning issues in education.

Advantages of the proposed system are described here. It helps deaf students to have self-learning without much training as the software provides edutainment that attracts students to learn subject without strain, Helps parents across the globe to have a good platform for teaching their children early in their life to acquire basics language skills. This will get rid of problems in school as the child will have good vocabulary and imagination, Helps schools to have a reference material and teaching aid to help students to complete prerequisites to cope with subjects in school. Helps researchers to take the work to next level by understanding the present work and improve it further to the level of satisfaction. The software can have impact on the society as the deaf children have mechanisms and platforms to learn basic language skills. The impact of the software on deaf children is significant as the children can feel good with learning and build in confidence much needed by them to face the world of children without hearing loss. The proposed software can trigger a series of patches or improvements to reach satisfactory level in such a way that it can be reused by all stakeholders across the globe. More importantly the software can help children to have their own pace in learning and acquiring language skills without any pressure. The software can have its impact on the learning speed of deaf children as it is based on edutainment which makes acquiring basic language skills fun.

A. Methodology

This section provides methodology to complete the research and implementation of e-Learning web portal for help helping deaf children language basics in English. It shows both language acquisition activities and non-functional requirements that can provide rich user experience. The end result of the project is to have an efficient e-Learning portal for deaf children which demonstrate proof of the concept.

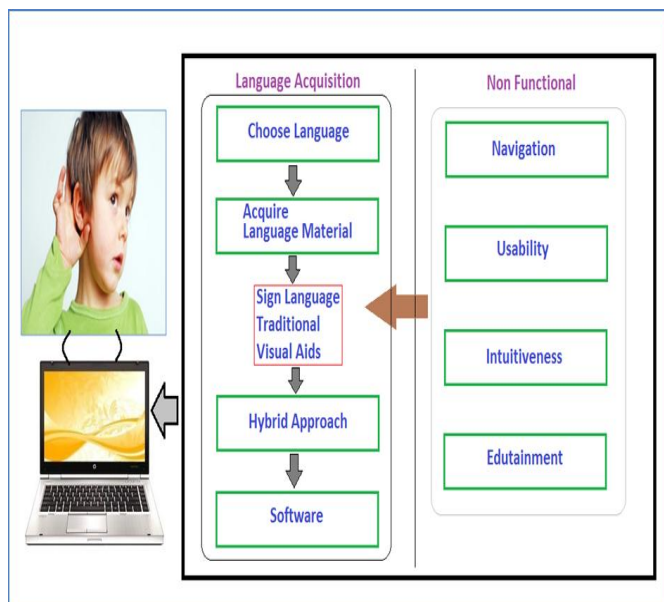


Fig. 1. Methodology.

As shown in Fig. 1, it is evident that the language acquisition process includes a series of easy steps. It involves user registration, user authentication, and other activities. After successful authentication, deaf children (teachers or administrators help in registration and login) can have their dashboard with all the possible actions they can make to acquire language skills in English. Default language is English. Language selection option can help to choose different language in future. Language material can be obtained and understood with visual aids. Language material includes alphabets, numbers, vegetables, animals, and so on. On choosing the kind of language material, the user gets visual aids in the form of image and video to understand the specific material. For instance the letter A in English is understood by deaf children by using the visualization of image and video. The video emphasizes lip movement so as to enable the learner to grasp the subject faster. A hybrid approach is followed which combines textual, graphical, audio and video features for making the learning experience good with the proposed e-Learning framework.

B. Non Functional Requirements

Different non-functional requirements fulfilled in the eLearning portal are described here.

1) Usability

It refers to learnability and ease of use of the portal created for e-Learning. Usability is given high importance while designing the web application. The application is made user friendly and that is realized by the users. It is actually used by teachers (administrator role) and deaf children (student role). The degree with which users feel it easier is the actually usability attributes of the web portal. The portal is built with usability attributes in mind and the navigation, appearance and other options are made simple. The complexity of the web portal is not shown to users. Users feel it easier and very useful.

2) Intuitiveness

The web portal is intuitive in nature. In other words, it is user friendly. Users need not to memorize commands to operate the web portal. Instead, users can get all needed options after successful authentication. The rationale behind this intuitiveness kept as part of the framework is that it helps users feel it easier. Deaf children look at the user interface as natural as possible. The intuitiveness in the user interface can help them to like it and come to the web portal form time to time for learning subject with interest.

3) Edutainment

The target audience or the target users play important role in the design decisions of any web portal. In the e-Learning framework, this is considered and the portal is determined to be built to support edutainment. Edutainment refers to the education through entertainment. As the deaf children start learning English basics, the web portal has different media to support learning and provide entertainment as well. The audio and video presentations can help them to learn the subject interestingly and they learn through entertainment.

V. IMPLEMENTATION AND RESULTS

Since it is a web based application, three-tier architecture is used to implement the proposed system. It has three tiers. The first tier is known as web tier. User agent or browser acts as web tier. It has built in functionality that allows users to have interaction with the e-Learning system. Browser helps users to connect to remote server. The middle tier is known as web tier. It is used to have business logic implementation. It is in the web server. The data tier is with the database management system. It is used to have persistence.

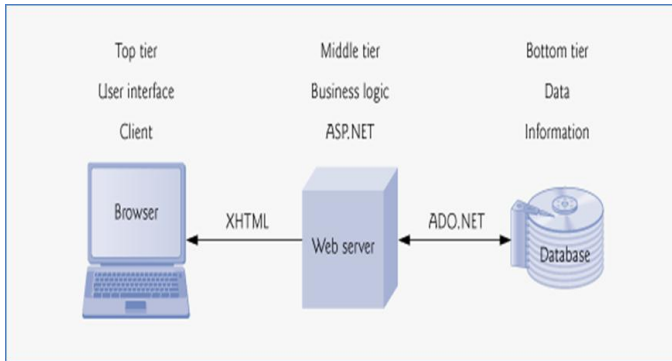


Fig. 2. Three-tier architecture used in the implementation.

As shown in Fig. 2, it is evident that there are three tiers. The middle tier contains business logic which is implemented using ASP.NET. The business logic is written actually using C# programming language. ADO.NET is used to have interactions with database. The ASP.NET application runs in web server which provides user interface in the browser. The roles involved in the system are teacher (administrator) and student (deaf children). Both the users can have registration and login. However, deaf children's registration is made by the administrator. After registration and authentication, they can make use of database connectivity for performing various activities.

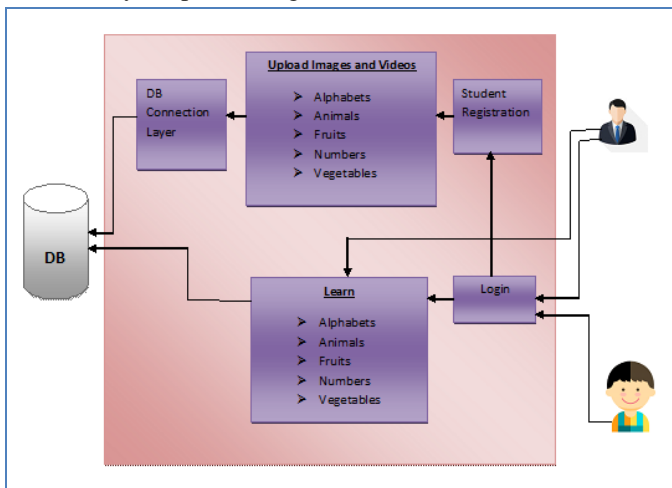


Fig. 3. Architecture Diagram.

As shown in Fig. 3, student role is meant for learning English language basics while the teacher role is to add learning material for deaf children. The administration activities after successful login include adding or manipulating materials like alphabet, animals, numbers, and vegetables. User can view all these material added by administrator. However, the users do not have permission to

manipulate training material. However, the administrator can do this as and when needed. The functional requirements are logically divided into two major modules. The modules are known as teacher and student. Actually these two encapsulate the roles such as teacher and student respectively. The teacher module is also known as administrator while the student role represents deaf children for which e-Learning portal is built in order to facilitate them to learn language basics. The web portal has incorporation of training material in the form of audio, video, images and text. With these media, deaf children can have their right to education in terms of learning language basics. This knowhow paves way for them to grow faster in learning other subjects as they grow. For helping users online, the web portal is deployed over Internet. Its URL is www.elearningfordeaf.com. The functionalities of the e-Learning portal are thoroughly tested and the screens of systematic usage of the portal are kept in the ensuing section.



Fig. 4. Home page of the e-Learning portal.

As shown in Fig. 4, it is evident that there are two roles in the e-Learning portal. They are known as teacher and student. Based on the role, the functionality of the corresponding user is shown in Dashboard.

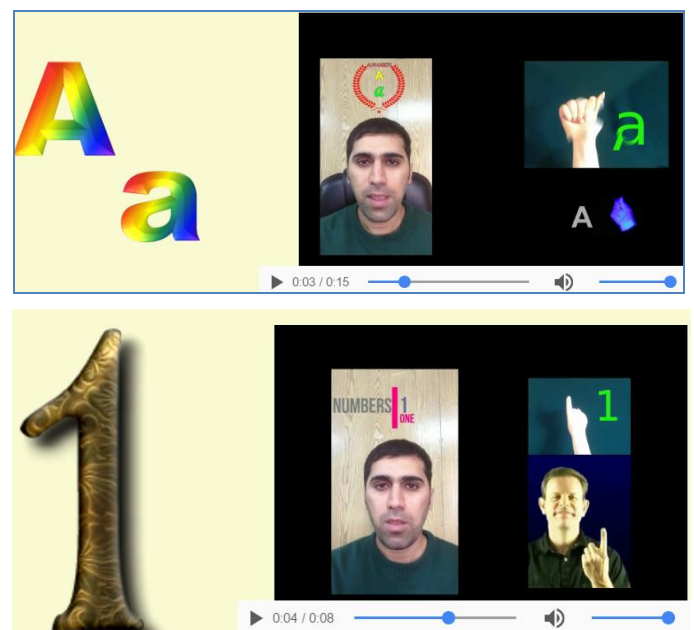


Fig. 5. Learning material with text and video that shows gesture and visual lip movements.

As shown in Fig. 5, it is shown that the letter alphabet and the number 1 are taught to deaf children. The gesture, image and video with lip movements ensure that the deaf children

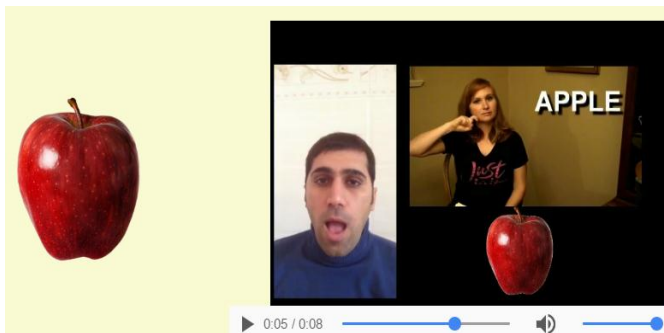
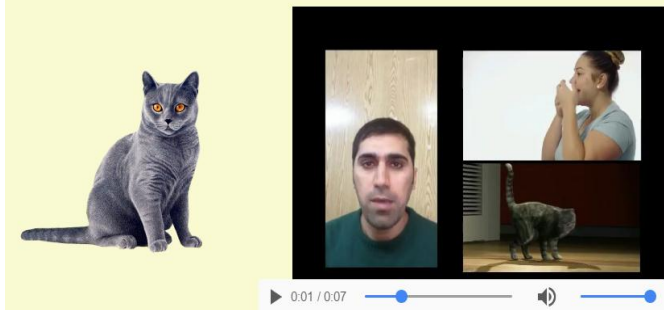


Fig. 6. Learning material with text and video that shows gesture and visual lip movements for animals (cat) and fruits (apple).

As shown in Fig. 6, it is shown that the animal cat and fruit apple are taught to deaf children. The gesture, image and video with lip movements ensure that the deaf children learning English language.

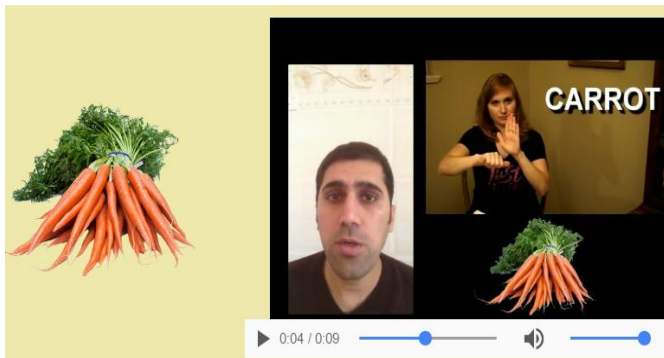


Fig. 7. Learning material with text, and video showing gestures and lip movements for vegetables (carrot).

As shown in Fig. 7, it is shown that the vegetable carrot taught to deaf children. The gesture, image and video with lip movements ensure that the deaf children learning English language. The results of learning language basics are shown in Fig. 5 where it shows a series of lip movements to let deaf child understand pronunciation of letters, numbers and so on.



Fig. 8. Showing lip movements for helping deaf children to understand language materials in the form of alphabets and numbers (A, first row; 1, second row).

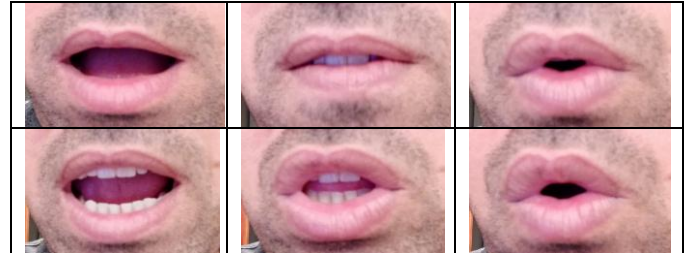


Fig. 9. Pronouncing Avocado animal in the video

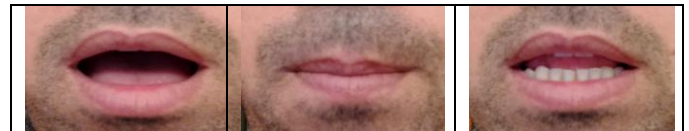


Fig. 10. Pronunciation of the fruit apple



Fig. 11. Pronunciation of animal Alligator animals

As shown in Fig. 8, Fig. 9, Fig. 10 and Fig. 11 it is evident that the pronunciation is provided. This is part of video where virtual pronunciation takes place

VI. CONCLUSIONS AND FUTURE WORK

In this paper, an e-Learning portal is implemented using Microsoft.NET platform. It provides C# programming language for providing functionality to UI. ASP.NET is used to design web pages and support session management. ADO.NET is used to interact with relational databases built using SQL SERVER. The e-Learning portal is built in such way that it promotes usability, user-friendliness and scalability. It incorporated learning materials in the form of alphabet, numbers, vegetables, fruits and animals. However, there is no limit for learning content. Administrator can add new content and manage the existing content as well. The student role is implemented to support good learning experience to deaf children. Deaf children can learn language basics in their own pace. Interestingly, they use the e-Learning portal to have edutainment education through entertainment. In other words, the e-Learning portal has support for visual aids such as text, images, audio and video. The video content provided in the e-Learning portal is unique and it is tailor made to provide rich learning experience to deaf children. The lip movements in the videos, the text appearance, and the images showing the symbol or any learning aid provide good user experience. Deaf children who use this portal can learn language basics with ease and without time and geographical restrictions. The e-Learning

portal has secure access to legitimate users. Users of both the roles can gain access to training materials only after due authentication. This is to avoid unauthorized access and also prevent software robust to misuse the application. Thus the portal is secured from malicious behavior, our e-Learning portal which is made live and available at www.elearningfordeaf.com.

The e-Learning portal as of now supports only English. Though it is very useful to have English language skills for deaf children in order to excel in other subjects, it may be useful to have support for other languages as well. This is our first direction for improving the portal in future. The e-Learning portal can be improved to have responsiveness and give support in all devices. Even smart phones should be able to present the learning content without usability issues. The current e-Learning portal is designed and implemented with this in mind. However, it is yet to be tested with all devices and necessary changes are to be made it to be portal across devices. Then its utility will be improved significantly. When the portal is ported in all devices, it leads to have more users and thus there is need for maintaining concurrent sessions that grow day by day. Thus it is better to move the e-Learning portal to cloud computing environment to make it remain scalable and maintainable with less effort.

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