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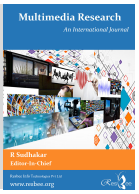

Developing Deep Neural Network for Learner Performance Prediction in EKhool Online Learning Platform

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Abstract: In this technical world, mobile applications and web applications plays an important role in online learning system. Nowadays, learning technology is increasing rapidly with different versions to encourage the learners. Online learning is very useful for every learner and especially, it is very helpful during this covid'19 outbreak, enabling the learners to learn their desired courses in Learning Management System (LMS). However, predicting the attendance of the learner and prediction performance of the learner is challenging in LMS. In this research, the Deep Neural Network (DNN) is used for predicting the learner performance using the log file of the learners in precise manner. The developed model mainly focuses to improve the knowledge of the learners through conducting the online exams to the every learner, and the result of this proposed method yields the prediction of their results using the log file, analysis of the attendance, and mode of technology used. The implementation and analysis of the proposed method revealed that the DNN for learner performance prediction yields a better performance of 90%.

Keywords: Online learning, Deep Neural Network, log files, learner performance prediction, learner percentage prediction.

1. Introduction

Learning Management System (LMS) is an online gateway, which is providing space for classroom property, tools, and actions to be shared the information easily between the instructors and learners [1]. LMS has a different tools and applications that encourage the learners around the world to utilize them for learning [2], and also help to track the activities of learners in further manageable manner, interaction, involvement, and allowing collaboration [3]. It provides various task and communication tools, which is agreed to maintain instructing and learning, such as quizzes, discussion forum, assignments, exams, announcements, chat, and others [4]. These communication tools used either synchronous or asynchronous, and not only develop the instructing and the learning procedure, but also allow the instructors and learners to communicate and collaborate with each other [5] so that the learners can clear their doubts and learn quickly. May be the learning can shifted to learners-centered learning from teachers-centered learning, and the role of instructors must focus on facilitator than knowledge transmitter [1], as emphasized by Makrakis and Kostoulas-Makrakis [10]. The LMS deals with all types of contents, such as video, audio, images, courses, and documents.

Due to COVID-19, many education institutes, schools, and colleges were closed, which facilitated the usage of online LMS to teach their students/learners. Many learning methods are used to support the online learning process, such as e-learning, flipped learning, blended learning, virtual learning, and so on [6]. Many people are interested to learn extra courses in online LMS on their free time. Online learning has a wide range of study materials, strategies, sessions and latest technologies, such as videoconferencing and virtual education and many more [7]. The learners can choose their desired courses from the online LMS to improve their knowledge. If the learners have any doubt about the particular topic, they can ask the instructor. In online LMS, predicting the performance of the learners is one of the most important processes [8]. However, not all learning applications effectively utilized online learning.

The main intention of the research is the predicting the learner's log file and final exam result based on the performance of learners using Deep Neural Network (DNN). Initially, when the user sign in the user account, the user must enter their personal details to verification. Once the sign in process completed, then the user can log in LMS anytime with verified user id and password. After that, the user

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can learn any courses or subjects from the LMS. The system conducts the online exam, and it predicts the user's attendance percentage from log file and exam results based on their performance.

The major contribution of the paper:

Proposed Deep Neural Network for learner's performance prediction: The learners' performance prediction and exam result prediction model is achieved using the proposed DNN for which the features considered is based on the technology such as web or mobile type of learning.

The paper is organized as follows: section 2 elaborates the literature review of the existing online LMS. Section 3 elaborates the proposed method. Section 4 elaborates the results and discussion, and finally, section 5 elaborates the conclusion.

2. Motivation

This section describes the motivation of learner's log file and exam result prediction using DNN method. The negative sides of existing learner's performance prediction techniques are considered to formulate a novel approach for predicting the performance of the students/learners in the online EKhool LMS.

2.1. Literature Survey

This sub-section elaborates the existing approaches of improving online LMS as follows. Roberto D. Costa et al. [9] developed a teaching and learning model in distance education (DE) by using Artificial Intelligence (AI), and analyzed the association among AI techniques and Learning Styles (LS) concepts. In this method, once the student joined the LMS, AI identified the learning preferences of all students, and also identified the LS of each student from their interactions through the LMS. Results showed the relation of the Students' LS was high or low based on their behavior in LMS. Dewa Gede Hendra Divayana et al. [6] developed an e-learning content by using 4D model. In this method, the 4D model was focused on numerous stages, such as define, design, develop, and disseminate stage. Here, six subjects were involved to test the quality of design using trial tools in the questionnaire form. Test results showed that the design of this method was of very high quality and the percentage of design quality was 92.50%, but the problem of the design was not presented the respondents answer's percentage to each question that had been answered. Fabio Persia et al. [10] introduced multimedia-based education for teaching computer science. Here, the multimedia-based education was integrated to the learning systems, and conduct the experiment through the course of operating system. This method showed that the exploiting multimedia, such as smart text and educational video was able to improve the learning performance of students in terms of knowledge transfer and exam grade. The obstacle of this method was that the design has no interactive systems, real-time communication or virtual reality. Jonathan Yepez et al. [11] developed an application through virtual technology in distance education. In this method, the students experienced the real classroom situation when they attended the distance or online learning course. It generated a virtual learning environment, wherein students cooperate directly with the teacher and other students. The students joined the online classes from the different places via an android mobile through internet access. Hyundo Kim et al. [12] introduced the Visual Reality (VR) Massive open online course (MOOC) LMS. In this method, the VR content of chemistry experiment was run for the students, and the supervisor monitored the student's interaction behaviors and learning performance. This method included both a PC (supervisor) and HDMs (students) through the 5G mobile network. The students and teachers interacted with the VR, and the supervisor intervened whenever necessary. The supervisor monitored and notified about the performance of all students, who participated in online learning.

3. E-Khool LMS Architecture

This section explains the developed E-Khool Learning Management System (EKhool-LMS) to predict the performance of the learner based on the log file of the learner. The proposed approach includes log activities and report generation. Initially, when the learner tries to log-in the EKhool-LMS, the admin panel verifies the log-in request to check for the authorized person. The authorized person is provided access to the Ekhool-LMS, and the virtual classroom starts automatically. In the virtual classroom, the lecturer provides the study materials, like contents, video, audio, PDF, and so on to the learners in such a way that there is an interaction between the learners and the lecturers. The admin panel monitors the performance of the learner, log-in and log-out time, collected materials, total duration of utilizing the virtual classroom, and satisfaction of the students regarding the study materials. Finally, the online exam is organized by the admin panel and generates the report based on the performance of the learners. Finally, the performance of the learners is notified. Fig. 1 shows the architecture of the EKhool-LMS.

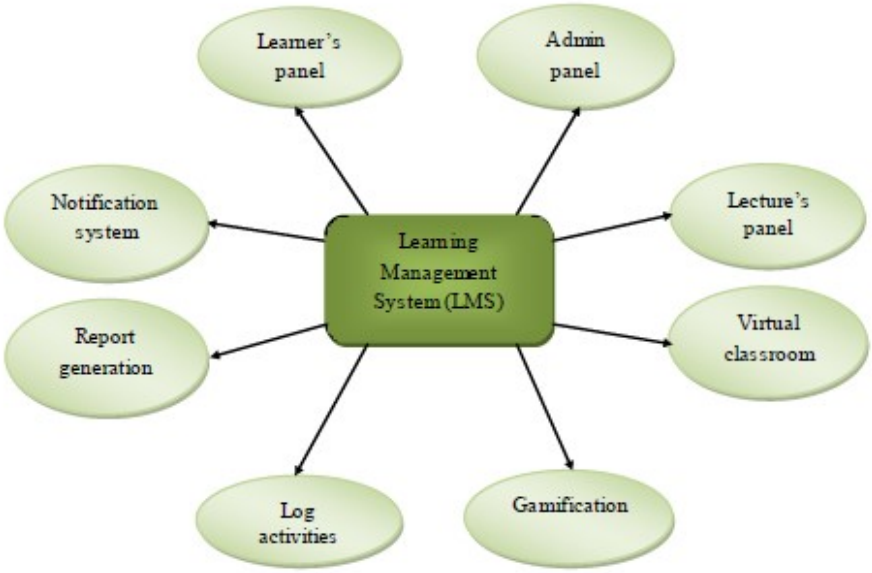


Fig. 1. *E-Khool LMS Architecture*

3.1 Admin Panel

Typically, the online learning system has an admin panel for controlling the processes, such as learner's panel, lecture's panel, virtual classroom, student's log file, exam result, report generation, and gives notification. Admin panel is also called as control panel or dashboard. The main process of admin panel is to create the content and manage the Ekhool-LMS and in turn, takes care of an operational performance of the online learning and establishes a connection among the software and technical support. Ekhool Admin verifies the authorized learners, collects their personal details and stores in the database. For securing the authorized learners account, the admin verifies the face of the learner. The admin has the ability to block or unblock the account of the learners and IP addresses. In this architecture, the admin panel relays the information between learners and lecturers.

3.2. Learner's Panel

With the use of the learners' panel, the learners can able to enter into the LMS. Usually, admin panel tracks the data of the learners through the learner's panel. The learners can change their system settings, user ID or password and can choose their desired courses, study time, and so on in learner's panel. Admin panel stores all the updates from the learners in the LMS and in addition, the learners can answer to the questions asked by the lecturer. At the same way, the Learners can communicate their doubts with their lecturer and shall receive the suggestions from the lecturers.

3.3. Lecture's Panel

Generally, lecture panel is used to update the study materials and clear the doubts of learners. This panel teaches the learners on any subjects, courses, programs, and so on. The lecture panel conducts the quizzes, discussions, assignments, projects, exams, and other processes associated with learning. If learners are not satisfied with the study materials provided by the lecturer then, the lecturer modifies the materials and updates the materials.

3.4. Virtual Classroom

Virtual classroom is an online learning environment, which allows the learners and instructors/lecturers to connect in LMS real-time. It utilizes online whiteboards, screen sharing, and video conferencing to permit educators to hold, discuss, fix virtual office hours, and provide live lectures to the learners in an interactive setting. Virtual classroom replaces the traditional classroom through the added benefits of interaction, files sharing, feedback, and is perfect in distance learning situation.

3.5. Gamification

Gamification in online learning is about changing the virtual classroom environment and usual activities into games, such as puzzle, quiz, crosswords, spell bee, and so on. Gamification involves play games, collaboration, and creativity. The main purpose of Gamification relies in motivating the students and training them in the precious manner.

3.6. Log Activities

In this architecture, the log activities are very useful to monitor the learners' activities. By monitoring the log activities of the LMS, the admin shall predict the learners attended the online course and learners dropped-out of the online course. Moreover, the time spent by the learners on the online course, their task completion, and so on is analyzed. The activity history and feedback on the status in LMS is useful to learners, instructors, program managers, and administrators.

3.7. Report Generation

Here, reports are generated based on the performance of the students. Initially, the admin checks the learners' log files to predict the performance and checks the exam result conducted in the LMS, and finally, generates the report about attendance and exam result of the learner.

3.8. Notification System

LMS notification system enables all the students to view any updates directly in their web/mobile technology without interference of third party media, such as text message or email. The notifications directly come-into sight with a pop-up on learner's own smartphone display so the learners can easily know about the new updates.

4. Proposed Method of Learner Performance Prediction Using the Deep Neural Network Based on the Learner Log Files

The main objective of the proposed method is to predict the learners' performance based on their log activities in the EKhool-LMS. For enable the effective prediction, the log file of the learner is processed to extract the attribute features. Based on the attributes, such as technology, university and results, the performance of the learner is predicted using DNN, which is a deep learning-based classifier. Fig. 2 shows the block diagram of the learning model.

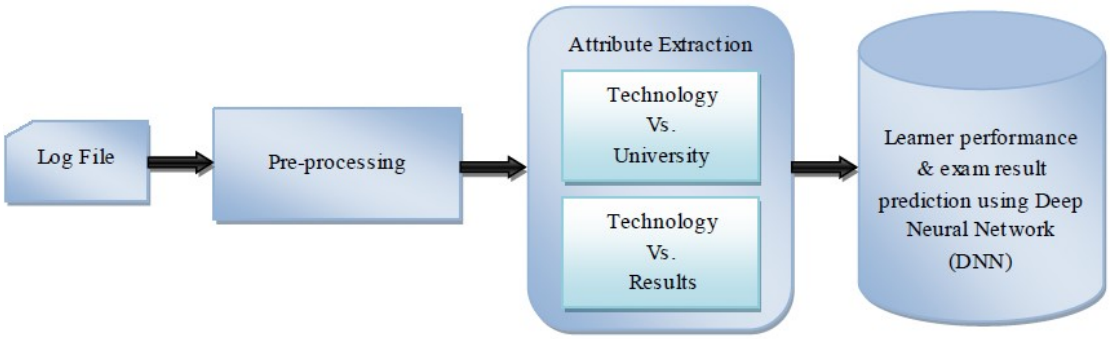


Fig.2. *Block diagram of learner performance prediction*

4.1. Log Files

Table1. *Log files of the learner*

No	Date & Time	Student I'D	Lecture's note	Technology used (Web/Mobile)	University	Exam result
1	12/11/2020 01:50:00	1301	PDF	Web		89.3%
2	12/11/2020 01:20:00	1302	Audio	Mobile	-	63%
3	12/11/2020 00:40:00	1303	Audio	Mobile	-	33.9%
4	12/11/2020 01:35:00	1304	Video	Web	-	79.6%
5	12/11/2020 00:55:00	1305	PDF	Mobile	-	49%
6	12/11/2020 01:40:00	1306	Video	Web	-	81%

Table 1 shows the log file of the students. In this technical world, learners utilize the LMS to improve their knowledge in their area of specialization or upcoming technologies. In this research, the DNN classifier is employed for the prediction of the learner performance based on their online learning experience and other associated activities. Accordingly, the data, such as the log-in time of the learner, student/learner ID, lecture note, technology-used (web/mobile), and university is recorded from the learners for predicting the exam performance of the learner. In online LMS, the actions of the learner are stored in log files that give detailed information to the lecturer or administrator about the learner's behavior. The administrator records the log-in or log-out time, duration of course, time of attending the course, duration of exam, and so on, which are revealed clearly in the log file that will be utilized for predicting the performance of the learner.

4.2. Pre-Processing

The data pre-processing is an important step that changes log data into a readable and understandable format. In other words, pre-processing cleanses and organizes the data for assuring a balanced data for learning performance prediction so that the prediction accuracy is boosted. The pre-processed data is further used for the prediction of the learner performance in such a way that the useful attributes are selected from the log file.

4.3. Attribute Extraction

The second step is the attribute selection in which the significant details of the learner is filtered in order to minimize the computational complexity of learner performance prediction. The features of the learner with respect to the attributes, like technology versus university and technology versus results are extracted such that the learner performance is predicted without any computational complexities.

4.4 Deep Neural Network for Learner Performance Prediction

Machine learning is a subset of Artificial Intelligence that plays a major role in its functionality. An Artificial Neural Network (ANN) is a Deep Neural Network (DNN) with multiple hidden layers between the input layers and output layers. DNN not only works according to the algorithm but predicts a solution for the task and immediately makes conclusions using the prior experience so that the user does not need to use coding or programming to get the refined output. DNN can recognize the voice commands, recognize graphics and sound, review, and execute a lot of other activities, such as creative thinking, analytics, and on other hand, DNN is applicable for the prediction problems. Hence, DNN is used in this research for learner performance prediction.

The extracted attributes are fed to DNN for predicting the learner performance. The input vector to the input layer is the attributes selected from the log data, which is processed further in the hidden layers for enhancing the prediction performance. Fig. 3 shows the architecture of the DNN. The classifier, DNN predicts the results/performance of the learner based on the information related with technology, university, and results. It is revealed that in addition to the prediction of the learner performance, the attendance of the learner is also revealed based on the learners' presence in the online class. Moreover, the researchers reveal that the most attentive learner is promoted and acquire good results.

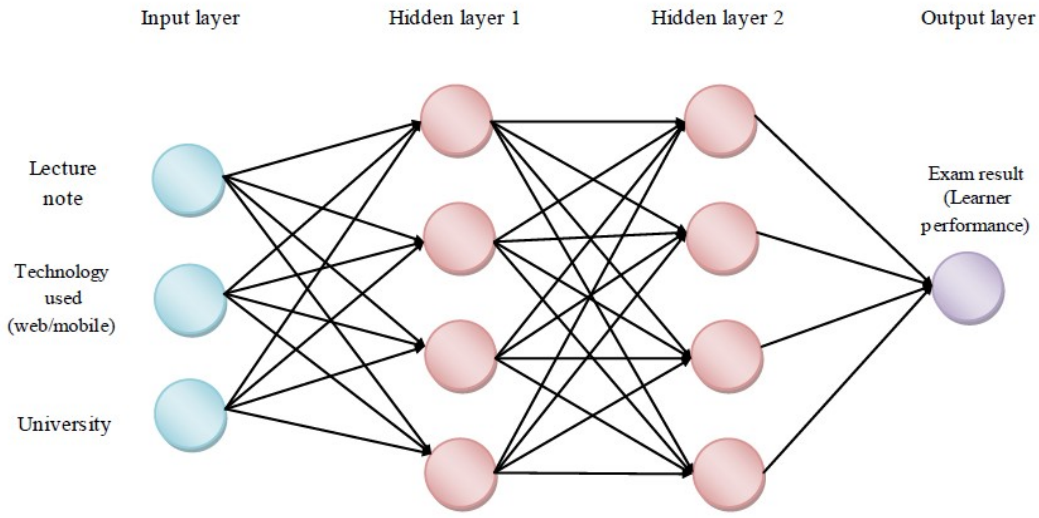


Fig.3. *Architecture of Deep Neural Network*

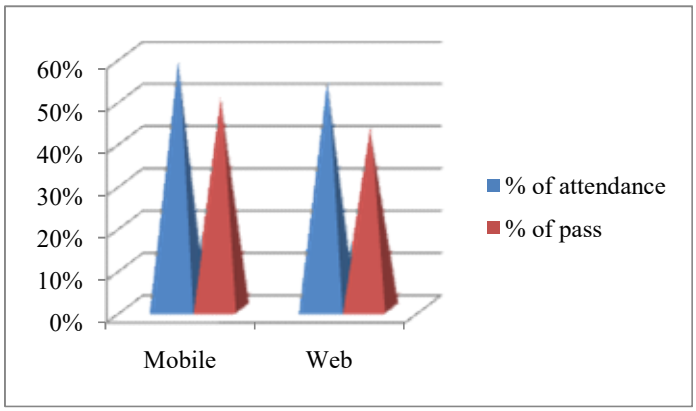
5. Result and Discussion

This section reveals the analysis of the performance prediction method based on the learners' online visits and attendance. For the analysis of the DNN-based learner performance prediction, the EKhool data from the Online LMS platform is considered, which carries the log file of the learners using the EKhool learning platform. The EKhool learners' performance is predicted through analyzing the attendance or classroom participation of the learner and the technology the learner used for the learning experience, which may be either web or mobile technology.

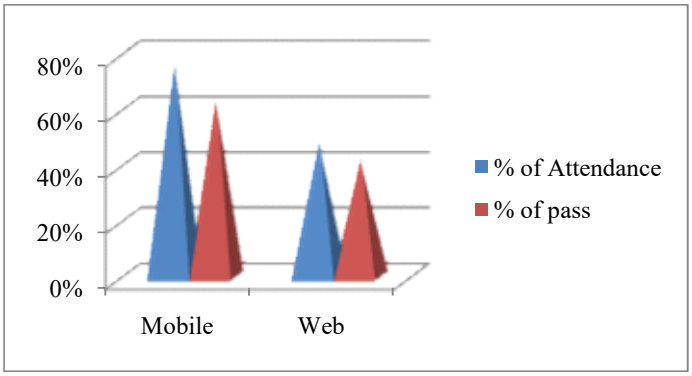
Table 2. *Percentage of attendance and pass*

Technology used	First year		Second year		Third year		Final year	
	Attendance	Pass	Attendance	Pass	Attendance	Pass	Attendance	Pass
Mobile	59%	50%	76%	63%	91%	70%	98%	82%
Web	54%	43%	48%	41.9%	35%	28.7%	26%	23%

Fig. 4 illustrates the percentage of student's attendance and pass. The analysis of the system is done based on the performance of the learner/student is represented in Fig. 4 a). In mobile technology, 59% students attended and 50% students passed, whereas in web technology, 54% students attended and 43% students passed in their exam. The analysis based on the performance of the second year student is represented in Fig. 4 b). In mobile technology, 76% students attended and 63% students passed in their exam, while in the web technology, 48% students attended and 41.9% students passed. The analysis of the DNN method based on the performance of the third year student is represented in Fig. 4 c). In mobile technology, 91% students attended and 70% students passed in their exam, whereas in web technology, 35% students attended and 28.7% students passed. The analysis of the DNN method based on the performance of the learner is represented in Fig. 4 d). In mobile technology, 98% students attended and 82% students passed in their exam, while in the web technology, 26% students attended and 23% students passed.



a)



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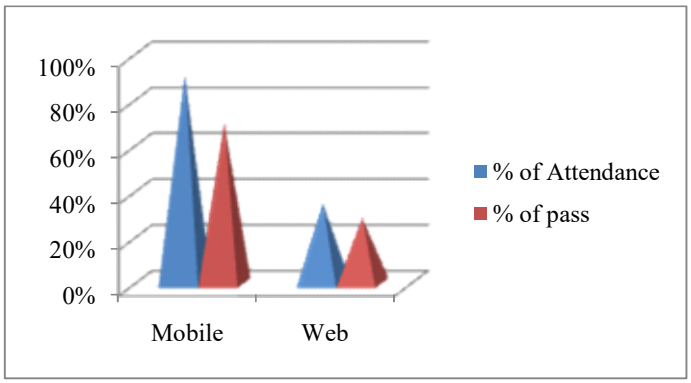

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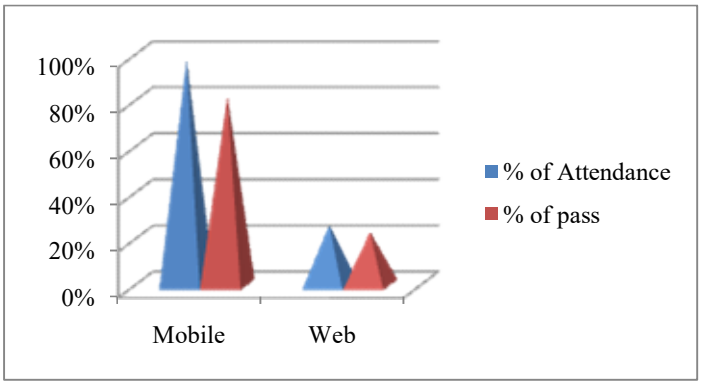

d)

Fig.4. *Performance analysis of the learner based on log files using DNN, a) First year student's report, b) Second year student's report, c) Third year student's report, and d) Final year student's report*

5. Conclusion

The future of students depends upon their academic grades, and their standard, which is duly based on the effective educational system in the educational institutes. Unfortunately, due to the COVID-19, the educational institutions have been stranded unable to provide their learners with proper education and classes. As a result, many countries have changed their educational system to online LMS. Now the challenge is regarding the analysis of the learners' performance through validating the behavior of the learners and predicting their exam percentage. Thus, EKhool-LMS is implemented and stands as an important tool to the learners and lecturers for continuing their course with proper notifications regarding assignments, quizzes, exams, projects, and discussion form. On the other hand, EKhool-LMS assist the lecturers to easily monitor their students/learners, clear their doubts, add or remove the contents, update the previous contents, and so on. In this research, the performance of the students/learners is predicted based on their percentage of attendance using DNN. The DNN classifier predicted the student's performance through the log activities of the students and analyzed the interaction between learners and lecturers. It is revealed that the performance of the attentive learners is recorded to be above 90%. In future, more advanced classifiers will be implemented for analyzing the learner performance.

Compliance with Ethical Standards

Conflicts of interest: Authors declared that they have no conflict of interest.

Human participants: The conducted research follows the ethical standards and the authors ensured that they have not conducted any studies with human participants or animals.

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