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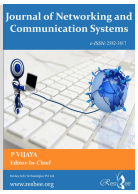

Examining User Experience of eLearning Systems using E-Khool Learners

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Abstract: E-learning platforms are becoming highly demanded between the students and universities as the virtual learning platforms are growing rapidly. The evaluation of the user experience is important as they show the attitude of the user towards the learning platform. This paper examined the user experience of the E-Khool learners in the E-Khool eLearning systems using the RideNN. E-Khool is a learning procedure that boosts the emotional connectivity in the busy class schedules by providing visually striking stock videos, images and audios. Initially, the user experience metrics, such as Nielsen usability heuristics, Didactic effectiveness heuristics, Hedonic heuristics and Website specific criteria are used for the evaluation of the user experience. Then, the evaluation metrics forms a vector and is given as the input to the RideNN classifier. The RideNN classifier predicted the performance of the user experience on the E-Khool platform. The user evaluation method based on RideNN is evaluated based on the metrics, like accuracy and MSE by varying the hidden layers. When compared to the existing user evaluation method, the proposed user evaluation method based on RideNN obtained a maximum accuracy of 0.95 and minimum MSE of 0.00113, respectively.

Keywords: eLearning Platform, e-Khool users, e-Khool user learning experience, Artificial Intelligence, Optimization

1. Introduction

The advancement and the growth of the information and communication technologies (ICT) have influenced the aspect of life and one of such areas that had huge impact is the education sector. The eLearning is abbreviation as electronic learning and the eLearning is designed for learning and teaching. The electronic communication like internet is utilized in eLearning platforms from a distance. For instance, while considering the teaching tasks, the eLearning application is similar to the traditional face-to-face teaching and learning style. In the eLearning application, the classroom-simulated student-teacher interaction takes place thus, the feedback can be provided to the students within the required time by the teacher. The synonyms for the eLearning are web-based learning and Open and Distance Learning (ODL). The school boards, training departments of governments, students, and corporations are the Consumers of eLearning. The major requirements of the consumers of eLearning are high quality and more usable systems. According to the International Standardization Organization (ISO), the usability is defined as the ability of the specified users to achieve the goals with effectiveness, efficiency, and satisfaction by using the product up to certain extent [9] [8].

The most important strategic factors in the development of the software is the evaluation of the user and it is an important topic in the human–computer interaction area [10] [8]. In the eLearning systems, the usage and the acceptance can be ensured by eliminating the user experience and usability problems. Numerous methods are developed for ensuring the usability of the system [11,12]. The pragmatic aspects such as hedonic aspects and traditional usability features along with the emotional responses from the system are considered by the user experience [13]. The system with the good usability and user experience features attracts the user [14]. The user experience plays a vital role in the eLearning systems for the satisfaction and the acceptance of the user [1]. In this paper, an advanced e-learning system E-Khool is considered for evaluating the user experience. The E-Khool is a learning procedure that has Learning friendly, Course friendly, Technology friendly, Enterprise friendly, User-friendly and Customization procedures. The E-Khool provides one step solution to the busy class schedules using various modules like discussion forums, automatic certificate generation tools, online assignment tool,

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course management system, student portal, notification management system, intelligent report generation tool and faculty portal. Nearly 50000 concurrent users are handled in an efficient manner in the E-Khool through the advanced framework.

The major contribution of the research is the evaluation of the user experience of the eLearning systems using E-Khool learners. The Nielsen usability heuristics, Didactic effectiveness heuristics, Hedonic heuristics and Website specific criteria are used as the user experience evaluation metrics. Finally, RideNN is used for predicting the performance of the user experience on the E-Khool platform [18].

The organization of the paper is as follows: section 1 describes the eLearning and the user experience evaluation approaches, section 2 reviews the user learning experience of the eLearning systems, section 3 describes the User experience metrics, section 4 explains the performance prediction based on Ride NN, section 5 discusses the result of the proposed user experience based on RideNN and section 6 concludes the paper.

2. Literature Review

The literature review of the existing eLearning systems are as follows: Mtebe, J.S. [1] developed the factors for evaluating the user experience of the eLearning systems. In this research, the questionnaire was developed based on the hedonic metrics and pragmatic metrics. After evaluating the questionnaire, the group discussions were conducted with the students. However, this method evaluated the system with the learners. Shi, D. et al. [2] designed a recommendation model for learning path using multidimensional knowledge graph framework. The learning objects were organized into different classes and stored separately. In the knowledge graph, six main semantic relationships were developed between the learning objects. Depending upon the target learning objects of the e-learners, the learning path was evaluated based on the multidimensional knowledge graph. Although this method recommended qualified learning paths for improving the user learning experience, the success rate required further improvement.

Sanchis-Font, R.et al. [3] modelled a Cross-domain models for the eLearning systems based on the deep neural networks. In this method, the human annotators were used for labeling the opinions collected with the polarity information. This method designed the virtual learning environments that were valued by the user for the quality and usability. However, this method failed to determine the aspects that had influence on the students. Jeong, H.-Y.[4] developed Adaptive E-Learning Hypermedia System (AEHS) for determining the user experience on the eLearning systems. This method provided customized learning experience to the learners. Although this method provided high overall mean score, it failed to use the learner characteristics for applying in the learning systems having wider field areas.

2.1. Challenges

The challenges faced during the examination of the user experience of the eLearning systems are as follows:

- The challenge in the Cross-domain models was the development of the virtual learning environments that determined the aspects that are relevant and had influence on the students. The questionnaire should also contain large amount of data for training the model [3].
- The AEHS method had high overall mean score but the challenge lies in expanding the area reflecting the method. The area can be expanded by fragmenting the learner characteristics using the learning systems in wider field areas [4].
- In [1], learners are used as the evaluators which made it difficult for identifying the didactic violations in the learning system. Hence, the challenges lies in determining the user experience based on the expert evaluators rather than the learners as evaluators as the learners does not have experience in the learning domain.
- The challenge in the multidimensional knowledge graph framework was improving the success rate which in turn helps in the improvement of the quality of the recommended learning path. The success rate can be improved by the generation of the learning paths with complex relationship constraints [2].

3. User Experience Metrics for User Experience Evaluation

This section consists of the metrics used in the research for evaluating the experience of the user in the E-Khool system. The qualities, such as hedonic quality and pragmatic quality are used for evaluating the user experience in the E-Khool system. The pragmatic quality is determined based on the Nielsen

heuristics [15]. The didactic and traditional usability are considered in the Nielsen heuristics for determining the user experience. The didactic quality such as Collaborative learning, Instructional materials, Assessment and Feedback, Learner control, Accessibility, Motivation and Aesthetics are also considered for the evaluation of the user experience [16]. In the hedonic quality, three criteria's, such as identification, stimulation and evocation are considered [17]. The Website-specific criteria are also used as the metrics for the evaluation of the user experience [6]. The user experience metrics are given as the input to the RideNN for predicting the user experience. Table 1.shows the Heuristics usability of E-Khool eLearning system, Table 2 describes the Didactic effectiveness heuristics, Table 3 explains the Hedonic heuristics and Table 4 shows the Website specific criteria for E-Khool website.

Table 1. *Heuristics Usability Of E-Khool Elearning System*

S.No	Measures	Explanation
1	Visibility	The system should ensure that whether appropriate feedback is provided to the E-Khool learners within the reasonable time such that the E-Khool learners can view their actions.
2	Freedom and User control	The E-Khool learners should be provided the facility to logout anytime with the undo operation, exit signs and redo operations in the system.
3	Compatibility between the real world and the system	The phrases and the words in the system should be familiar to the E-Khool learners instead of the terms that are system-oriented
4	Standards and Consistency	The user interface should be consistent in terms of color, menus, dialogue design and typography for ensuring the experience of the E-Khool learners in the system.
5	Prevention of error	The common errors should be prevented in the system and hence, the system should be designed in such a way that there are no errors but if the E-Khool learners make such errors then the system should have procedures for correcting the error.
6	Recognition	The system should reduce the memory load of the E-Khool learner. The memory load can be reduced by making the actions, objects, and options visible. The system should be developed in such a way that information from one to another part of the dialogue need not be remembered by the E-Khool learner.
7	Efficiency and Flexibility of use	The system different E-Khool users from beginner to the experts. The experts should be provided with shortcuts and other advanced tools.
8	Minimalism and Authenticity in design	The information that are rarely needed or the irrelevant should not be included in the system dialogues as these information may distract the E-Khool learners from learning.
9	Recognition, diagnosis, and recovery from Errors	The error message in the system should not be in the programmer code. The error message should be in the simple language such that the problems in the system can be indicated in a friendly manner for suggesting the solution to the E-Khool users.
10	Documentation and Help	The online documentation and help should be provided by the system for making the search and accessing easier to the E-Khool users.

Table2. *Didactic Effectiveness Heuristics*

S.No	Measures	Explanation
1	Collaborative learning	The intra and inter- group activities like discussions, group projects, teamwork, group debates, presentations and collaborative problem solving should be provided by the systems.
2	Instructional materials	The learning materials of the system should be current and accurate. The E-Khool users should be provided with the overall course objectives for helping the learners to complete the learning process efficiently.
3	Assessment and Feedback	The tools should be provided by the system for allowing the E-Khool learners to access the learning achievements along with the immediate and sufficient feedback. The tools should also let the instructors for recording, assessing and tracking the report of the learners.
4	Learner control	From the learner's point of view, the instructional materials should be broken into logical, clear and meaningful units.
5	Accessibility	The accessibility of the various devices with wide and small screens like laptops and PDA along with different browsers and platforms should be available easily to the E-Khool users.
6	Motivation	The E-Khool learners should be motivated by the mechanisms, such as physical rewards, providing grades, and other incentives by the instructional and system materials.
7	Aesthetics	The information that are needed rarely and irrelevant should be neglected from the system.

Table 3.*Hedonic heuristics*

S.No	Measures	Explanation
1	Identification	The communicating identities provided by the system should be advantageous to others
2	Stimulation	The exciting and the interesting content, functionality, interaction or the presentation style should be provided by the system for stimulating the E-Khool learner.
3	Evocation	The experience on the memories and the background of the E-Khool learners should be provided with the symbolic meanings by the system.

Table 4. *Website specific criteria for E-Khool website*

S.No	Measures	Explanation
1	Simplicity of the site organization, navigation and structure	The options for navigation should be reduced such that the E-Khool user is not overwhelmed. The site should provide the clear details to the E-Khool user regarding the whereabouts and where to go next. The site should follow the basic browser norms. The site should place the related information together.
2	Relevance of the content of the site	The site content should be relevant, engaging and appropriate to the learner and the learning process The site should differentiate the copyrighted materials from the other materials The site should contain the materials that are not dependable on the gender and the racial biases

4. RideNN for Performance Prediction Based on User Experience

This section describes the Questionnaire section for evaluating the performance of the E-Khool system and the RideNN for performance prediction of the user experience. The Questionnaire contains the questions regarding the similarity between the system and the real-world in which the E-Khool users were asked to answer the questions. The RideNN provides the prediction results of the user experience by considering the Nielsen usability heuristics, Didactic effectiveness heuristics, Hedonic heuristics and Website specific criteria.

4.1 Questionnaire

The Questionnaire mainly focused on the hedonic and the pragmatic quality of the E-Khool eLearning system. It also focused on the demographic information. The eLearning system is evaluated based on the statements provided by the user. The Questionnaire section contains the statements regarding the system and the real-world, and the users are expected to answer the questionnaire whether they 'Strongly agree ', 'Agree', 'Neutral', 'Disagree' or 'Strongly Disagree' with the statement. Table 4 shows the Questionnaire section for evaluating the performance of the E-Khool system.

Table4. *Questionnaire Section for Evaluating the Performance of the E-Khool System*

S.no	Similarity between real world and system	Strongly agree	Agree	Neutral	Disagree	Strongly Disagree
1	The system uses the language familiar to the E-Khool learner rather than the terms that are system oriented					
2	The learning graphs, diagrams and images used in the system are understandable and recognized by the E-Khool learner					
3	The information in the system appears in the logical and natural order					
4	The system informs me about what is happening through the feedback					
5	Are you clarified about the searches you make in the system					
6	Note down the problem(s) encountered in the system related to the section					

4.2. RideNN for Prediction of the User Experience of the User

This section explains the prediction of the user experience while using the E-Khool platform and the prediction is done based on RideNN classifier [5]. The RideNN classifier is developed by integrating the Neural Network (NN) classifier with the rider optimization algorithm (ROA). ROA is an optimization algorithm based on the ride group who is riding to win the competition by forwarding towards the common destination and the ROA is a training algorithm used for training the NN classifier. The training problems in the NN are eliminated by training through ROA. The NN classifier is used mostly in the pattern recognition, fault classification and function approximation process. In this research, the NN classifier along with the ROA is used for classifying the user experience of the E-Khool users. The RideNN consists of input, hidden and output layer connected with the neurons. The input to the RideNN classifier is the vectors formed from the Website specific criteria, Heuristics usability criteria, Hedonic heuristics criteria and Didactic effectiveness heuristics criteria. The Bhattacharyya coefficient is used for the selection of the feature vector. The input and the outputs of the different layers in the network are connected with the neurons. The input provided to the RideNN classifier is given as,

$$b^k = \left\{b_1^k, b_2^k, ..., b_\beta^k, ..., b_M^k\right\}, \left(1 \le \beta \le M\right) \tag{1}$$

where, the number of features which is same as the input neurins are represented as, M. In the network, the neurons are assigned with the weights for effective classification. The weight assigned in the hidden layer of the neurons are represented as,

$$J = \left\{J_,, J_2, ..., J_M\right\} \tag{2}$$

A great potential is generated by assuming the hidden layer neuron having bias. The biases of the neurons in the hidden layer are represented as, J_{m+1}. The weight and bias assigned for the neurons in the output layer is represented as, J_{m+2} and J_{m+3}. The transfer function is applied for determining the classifier output which is represented as,

$$P^k = J_{m+2} * \left[\log sig\left(\sum_{\beta=1}^{M} b_\beta^k * J_\beta + J_{M+1}\right)\right] + J_{M+3} \tag{3}$$

where, the log-sigmoid transfer function is given as, $\log sig$. The input and the weight of the β^{th} neuron in the hidden layer is given as, b_β^k and J_β. The output weight is given as, J_{m+2} and the biases are given as, J_{m+1} and J_{m+3}. The output from the net input is determined using the log-sigmoid transfer function. Thus, the user experience of the E-Khool users on the E-Khool platform is predicted with the RideNN method.

5. Results and Discussion

The result of the proposed user evaluation method based on RideNN is determined in this section and the comparative analysis is performed with the existing user evaluation methods using the performance metrics.

5.1. Experimental setup

The proposed user evaluation method based on RideNN considered the data that is collected from the E-Khool platform, which carries the information of the E-Khool users that includes the visiting time, content, usage, experience, and so on.

5.2. Performance Metrics

The performance metrics used for the evaluation of the proposed user evaluation method based on RideNN are accuracy and Mean Square Error (MSE).

5.2.1 Accuracy

The accuracy is defined as the exactness of the result provided by the classifier for predicting the user experience of the E-Khool learners. The accuracy evaluation is done as follows:

$$\text{Accuracy} = \frac{TP + TN}{TP + TN + FP + FN} \tag{4}$$

where, TP, FP, FN and TN are the true positive, False positive, False negative and true negative.

5.2.2. MSE

The MSE is average error between the classifier's actual output and the classifier's estimated output. The MSE is defined as,

$$MSE = \sum_{h=1}^{n} (S_h - R_h)^2 \quad (5)$$

where, S_h is the predicted output and R_h is the targeted output.

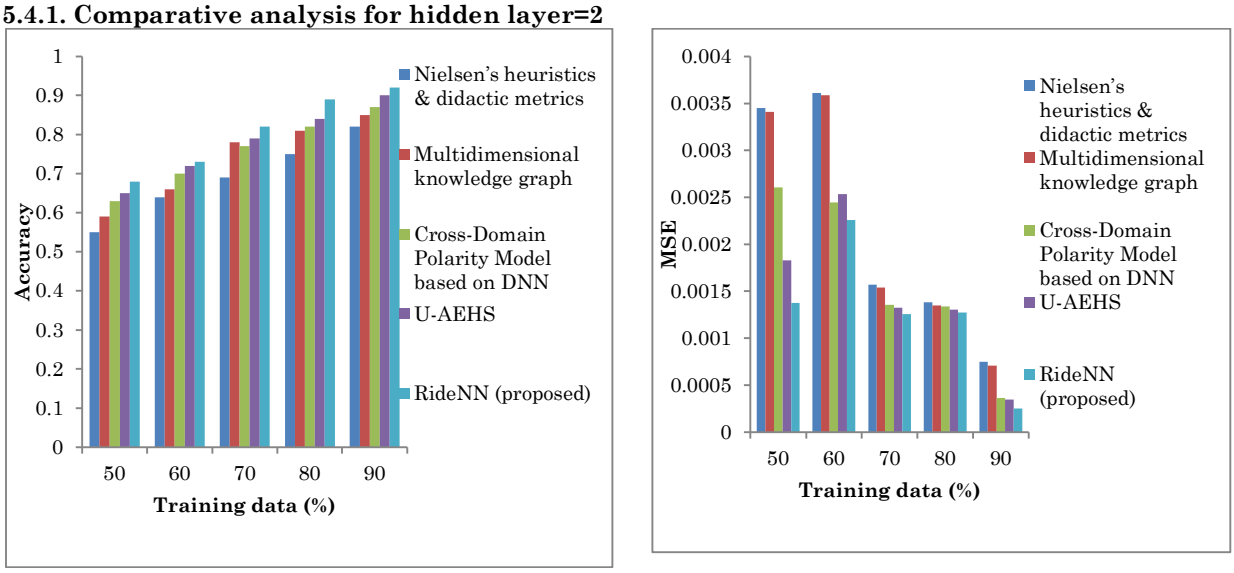
5.3. Comparative Methods

The comparative methods used for the analysis of the proposed user evaluation method based on RideNN are Nielsen's heuristics & didactic metrics [1], multidimensional knowledge graph framework [2], Cross-Domain Polarity Model based on DNN [3], and User experience based Adaptive E-Learning Hypermedia System (U-AEHS) [4].

5.4. Comparative Analysis

The comparative analysis of the proposed user evaluation method based on RideNN is performed with the competing method for the performance metrics by varying the hidden layers.

5.4.1. Comparative analysis for hidden layer=2



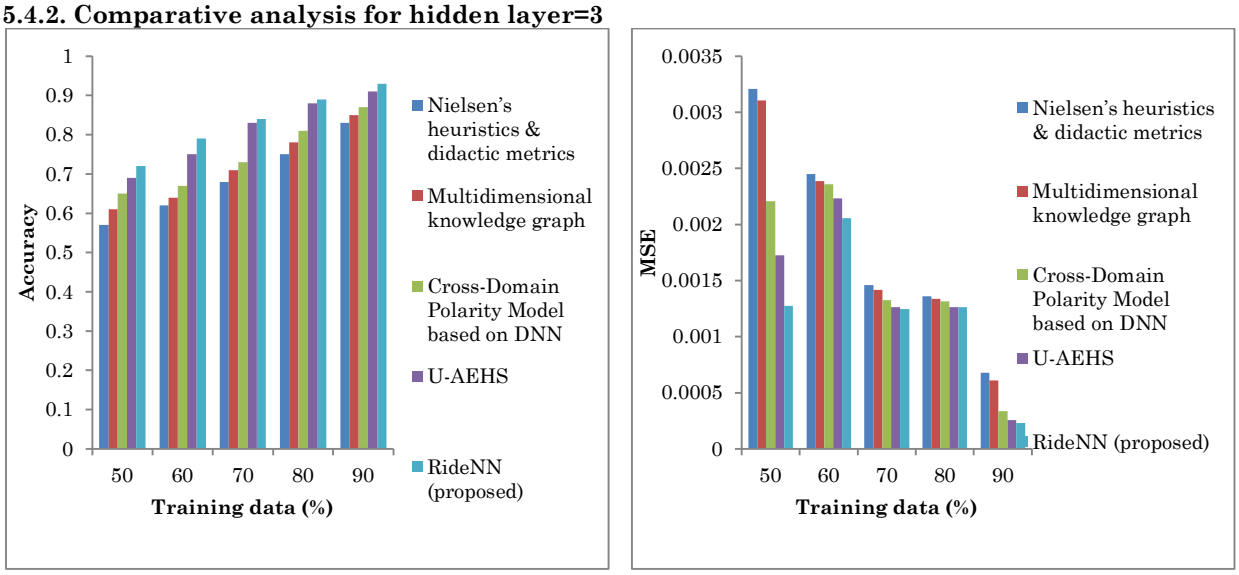
a) **b)**

Fig. 1*.Comparative analysis of the user evaluation methods for hidden layer=2 using a) Accuracy b) MSE*

Fig. 1 shows the comparative analysis of the user evaluation methods for the performance metrics, such as accuracy and MSE for hidden layer =2. Fig. 1 a) shows the comparative analysis of the user evaluation methods using accuracy for hidden layer =2 by varying the training data. When the training data is 50%, the Nielsen's heuristics & didactic metrics, multidimensional knowledge graph framework, Cross-Domain Polarity Model based on DNN, U-AEHS and the proposed user evaluation method based on RideNN obtained an accuracy of 0.55, 0.59, 0.63, 0.65 and 0.68, respectively. The accuracy obtained by the existing Nielsen's heuristics & didactic metrics, multidimensional knowledge graph framework, Cross-Domain Polarity Model based on DNN, U-AEHS and the proposed user evaluation method based on RideNN for the training data of 90% is, 0.82, 0.85, 0.87, 0.9 and 0.92, respectively.

Fig. 1 b) shows the comparative analysis of the user evaluation methods using MSE for hidden layer =2 by varying the training data. The MSE obtained by the existing Nielsen's heuristics & didactic metrics, multidimensional knowledge graph framework, Cross-Domain Polarity Model based on DNN, U-AEHS and the proposed user evaluation method based on RideNN for the training data of 50% is 0.00345, 0.00341, 0.00261, 0.00183 and 0.00137, respectively. When the training data is 90%, the Nielsen's heuristics & didactic metrics, multidimensional knowledge graph framework, Cross-Domain Polarity Model based on DNN, U-AEHS and the proposed user evaluation method based on RideNN obtained a MSE of 0.00075, 0.00071, 0.00036, 0.00035 and 0.00025, respectively.

5.4.2. Comparative analysis for hidden layer=3



a) b)

Fig. 2.*Comparative analysis of the user evaluation methods for hidden layer=3 using a) Accuracy b) MSE*

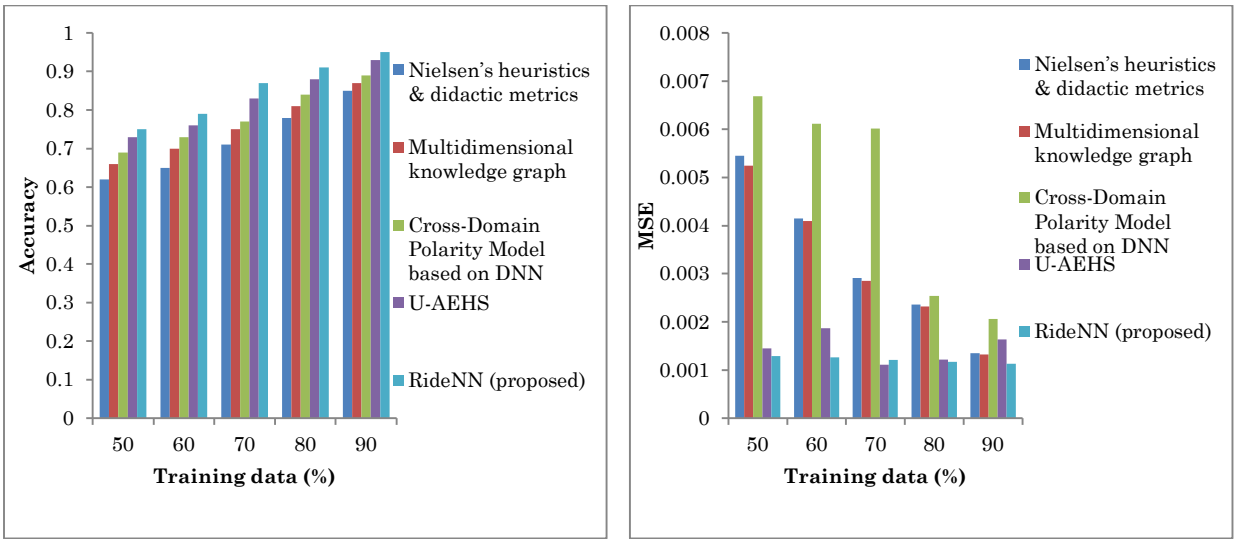
Fig. 2 shows the comparative analysis of the user evaluation methods for the performance metrics, such as accuracy and MSE for hidden layer =3. Fig. 2 a) shows the comparative analysis of the user evaluation methods using accuracy for hidden layer =3 by varying the training data. The accuracy obtained by the existing Nielsen's heuristics & didactic metrics, multidimensional knowledge graph framework, Cross-Domain Polarity Model based on DNN, U-AEHS and the proposed user evaluation method based on RideNN for the training data of 50% is 0.57, 0.61, 0.65, 0.69 and 0.72, respectively. When the training data is 90%, the Nielsen's heuristics & didactic metrics, multidimensional knowledge graph framework, Cross-Domain Polarity Model based on DNN, U-AEHS and the proposed user evaluation method based on RideNN obtained an accuracy of 0.83, 0.85, 0.87, 0.91 and 0.93, respectively.

Fig. 2 b) shows the comparative analysis of the user evaluation methods using MSE for hidden layer =3 by varying the training data. When the training data is 50%, the Nielsen's heuristics & didactic metrics, multidimensional knowledge graph framework, Cross-Domain Polarity Model based on DNN, U-AEHS and the proposed user evaluation method based on RideNN obtained a MSE of 0.00321, 0.00311, 0.00221, 0.00173 and 0.00127, respectively. The MSE obtained by the existing Nielsen's heuristics & didactic metrics, multidimensional knowledge graph framework, Cross-Domain Polarity Model based on DNN, U-AEHS and the proposed user evaluation method based on RideNN for the training data of 90% is 0.00068, 0.00061, 0.00033, 0.00026 and 0.00023, respectively.

5.4.3. Comparative analysis for hidden layer=4

Fig. 3 shows the comparative analysis of the user evaluation methods for the performance metrics, such as accuracy and MSE for hidden layer =4. Fig. 3 a) shows the comparative analysis of the user evaluation methods using accuracy for hidden layer =4 by varying the training data. When the training data is 50%, the Nielsen's heuristics & didactic metrics, multidimensional knowledge graph framework, Cross-Domain Polarity Model based on DNN, U-AEHS and the proposed user evaluation method based on RideNN obtained an accuracy of 0.62, 0.66, 0.69, 0.73 and 0.75, respectively. The accuracy obtained by the existing Nielsen's heuristics & didactic metrics, multidimensional knowledge graph framework, Cross-Domain Polarity Model based on DNN, U-AEHS and the proposed user evaluation method based on RideNN for the training data of 90% is 0.85, 0.87, 0.89, 0.93 and 0.95, respectively.

Fig. 3 b) shows the comparative analysis of the user evaluation methods using MSE for hidden layer =4 by varying the training data. The MSE obtained by the existing Nielsen's heuristics & didactic metrics, multidimensional knowledge graph framework, Cross-Domain Polarity Model based on DNN, U-AEHS and the proposed user evaluation method based on RideNN for the training data of 50% is 0.00545, 0.00524, 0.00669, 0.00145 and 0.00129, respectively. When the training data is 90%, the Nielsen's heuristics & didactic metrics, multidimensional knowledge graph framework, Cross-Domain Polarity Model based on DNN, U-AEHS and the proposed user evaluation method based on RideNN obtained a MSE of 0.00135, 0.00133, 0.00206, 0.00164 and 0.00113, respectively.



a) b)

Fig. 3.*Comparative analysis of the user evaluation methods for hidden layer=4 using a) Accuracy b) MSE*

6. Conclusion

The user experience evaluation shows the attitude of the user towards the learning systems. Thus, user experience evaluation helps in developing the e-learning systems that are user-friendly and technology friendly. In this paper, user experience of the E-Khool learners in the E-Khool eLearning systems is evaluated based on RideNN classifier. At first, the user experience is evaluated by the user experience metrics such as Nielsen usability heuristics, Didactic effectiveness heuristics, Hedonic heuristics and Website specific criteria. Then, the vector is formed from the evaluation metrics and given as the input to the RideNN classifier. The RideNN classifier predicted the performance of the user experience on the E-Khool platform effectively. The proposed user evaluation method based on RideNN is evaluated based on the metrics, like accuracy and MSE by varying the hidden layers. When compared to the existing user evaluation method, the proposed user evaluation method based on RideNN obtained a maximum accuracy of 0.95 and minimum MSE of 0.00113, respectively. The further enhancement in the user experience evaluation methods can be done using more advanced metrics and the classifier for evaluating the user experience of the e-learning systems.

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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