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Measures of Effectiveness for E learning of University Students During the Covid-19 Pandemic Using the Statistical Model

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***Abstract*—** E-learning considers the best solution for continuing education during the COVID-19 pandemic, especially in tertiary education. The present study aims to analyze and the evaluation efficacy of learning in an e-learning system measures to improve the technical skills among dental and medical undergraduate students during Covid-19 outbreak. One thousand five-hundred students were assigned for this study and the answers for the given questionnaire were collected. The rate of response was 96.86% among respondents who use module and classroom tools, techniques, or platforms. The statistical model was applied to the analysis of the questionnaire. Principle component analysis techniques were used to determine the variables' efficacy on the E-learning model. The reliability of the associated components was measured using (Cronbach's α) test gives 0.801. The findings of this study that medical education skills have been slightly affected by the use of e-learning during the COVID-19 pandemic. Therefore, the idea E-learning entails Familiarity with the technology; Usability, Learned skills, and Competency; Quick Responsiveness; Learning Quality of the learner; Time and Cost; Faster Learning; Information quality; and Knowledge sharing.

***Keywords*—** E-learning, Effectiveness measure, Covid-19, pandemic, principal component analysis

I. INTRODUCTION

The COVID-19 pandemic, as a global health crisis ,is ruthless on education worldwide. Thus, continuing direct learning or not has been an issue as the health of the students and teachers could be in danger. Nevertheless, Iraqi higher education institutions have continued to offer education through various E-learning models. The COVID-19 pandemic forced the of institute of Medical Technology to close their campuses and shift to E-learning. E-learning may provide a flexible environment for the students to get learnt. Learning is a method in which the knowledge and skills can be obtained. In addition, the way in which these knowledge and skills were acquired, can be ubdated overtime [1,2]. Nowaday, almost undergraduate students prefer using new teachnologies like smart mobiles and e-notebooks for acquiring their knowledge. As a result,most of classical ways for learning have been updated. It is apparent that learning process has been quickly developed using these new technologies [3].Recently, Many undergraduate and graduate students have extensively used the tools based on E-learning in academic sectors. In addition, This kind of learning does not need physical classrooms [4,5]

Moreover students can also get an access to the E-learning from elsewhere using different sorts of devices [6,7]. Furthermore, classes based on E- learning can easily be changed or updated from their admins [8]. Previous research has suggested that several parameters can be applied detecting the efficacy of E-learning [9]. In this paper, some of these parameters are used to test the efficacy of E-learning at university level. The outcomes of this work could expand our understanding towards the effectiveness of E-learning for all users.

II. LITERATURE REVIEW

E-learning refers to any activity of learning via internet. This kind of learning can target both students and teachers [10]. Previous research indicated that E-learning is used in online and offline achieved by any an individual or a group using a range of electronic media [11,12]. The measurement of the quality of E-learning should meet the satisfaction of users[13] .To get better results of E-learning process, an active user is required. One effort to improve the quality of E-learning of students can be pursued by the discovery of E-learning methods, which emphasizes the discovery of previously unknown concepts or principles [14]. The teacher must evaluate the effectiveness of students in the learning process for the latter to obtain optimal results [15].[16].

In general speaking, all organizations, groups and even an individual can improve their skills and performance using E-learning via different electronic devices[17.18]. According to increase the number of internet users, E-learning is getting more used among people [19.20].

Previous literature have highlighted the importance of some parameters like Stability, security, reliability, responsiveness, ease of use, and user-friendliness for being used to test the efficacy of , E-learning [20]. [21] analyzed the students' perceptions regarding the effectiveness and focus on learner satisfaction while going through Covid-19 on the bases of data gathered through a survey (N = 784). [22] demonstrated that the Covid-19 outbreak makes the E-learning process to be more usable from both instructors and students. In a study done by [23] suggested that the parameters for testing the efficacy of E-learning could be sorted out in 5 orders as: interactivity, collaboration, motivation, network of opportunities, and pedagogy.While, other study indicated that both efficacy and an attractiveness of a leaner could be considered important parameters in measuring of E-learning effects[24]. Furthermore, the fast response of instructors to the student's questions could be another parameter for testing the efficacy of E-learning e. The study conducted by Salter and his colleagues tested to the efficacy of [25] on the pharmaceutical education indicated that the acquired knowledge among staff and students in short term were significantly improved by E-learning [26]. The outcomes of other study done by[27] showed that E-learning was less time consuming comparing to the traditional learning and easily to be updated to fulfill learning needs. Furthermore, E-learning provides all users with an entertaining and interaction environment. Another findings also added more evidences towards the importance of E-learning [28]. In addition, E-learning was seen to be easier in learning with high quality of gained knowledge in both education and training prospective [29.30]. E-learning facilitates the acquisition of skills through varieties of tools including images, videos, and texts, among others [31] A survey done by Unwin in Africa (2008) indicated that most of responses had shed the light towards the importance of E-learning. E-learning enables the users to make a control on the contents using different facilitates [32]

However, E-learning can incur some disadvantages for all users . From the students point of view, most of them have become more isolated with no social physical life (Santos, 2020). While from the instructors point of view, intellectual property rights using online courses could be compromised. [33]

The purpose of the current study aims to analyze and the evaluation efficacy of learning in an e-learning system measures to improve the technical skills among dental and medical undergraduate students during Covid-19 outbreak using Statistical model.

III. RESEARCH METHODOLOGY

Data in the current study were collected from a structured questionnaire collected from the students of University of Babylon, College of Dentistry and Middle Technical University, Institute of Medical Technology/Al-Mansour, Iraq. One thousand five-hundred questionnaires were sent out to the students, of which 1453 were returned and thus gained a response rate of approximately 96.86%. The questionnaire involved 60 items divided into four subgroups. The questionnaire is based on the beliefs toward E-learning, quality and usefulness of E-learning, and the urbanization level. The first section of the questionnaire includes 6-points of personal data and the second section covers the questions related to the sort of devices being used in E-learning. The third section presents the time spent on E-learning, the standard of living, relationship between the students, relationship between the students and the teachers, evaluation of classroom activity, and satisfaction with online teaching.

This study applies the Principal component analysis (PCA) as Statistical model based on the analysis of the variance differences between variables, thereby rendering the analysis processing extremely sensitive. These differences might lead to the wrong conclusions [34]

The model includes three main steps as shown in Figure 1. The first covers the data preparation, while the second step consists of several processes and algorithms to determine the components. The third step is considered the more sensitive and important, because it gives evidence of the model's reliability. The model extracts nine used variables measuring the effectiveness of E-learning, namely, familiarity with technology, usability, faster learning, quick responsiveness, learning quality, time and cost, usability outside of the class, appropriate for independent work, and knowledge sharing.

A. Preparing the data

This step is deemed very important because it includes preparing a numeric data file, standardizing the data set for missing value computation, and properly analyzing outlier data. Where, the second step focuses on the correlation that exists among each one of the variables. The construct covariance matrix of data shows the correlation matrix. It displays that few variables are slightly correlated, few are highly correlated, and few are not. Afterwards, the numbers of factors can be extracted on the bases of the two methods; Kaiser Normalization rule and Elbow method [35].

Factors' numbers must be identified on the basis of computing Eigenvalue, where the Eigenvectors are a list of coefficients which show how much each input variable contributes to each new derived. The sum of all Eigenvalues equals the sum of the variances of all input variables as variance summarization[36,37,38]. The number of factors is clearly seen on the Scree Plot and Elbow method. The Elbow method determines the number of clusters in a dataset. Finally, the number of clustering summarizes the number of components. Different techniques have been used to evaluate the result data analysis using the (PCA) model. To test the reliability of the data, Cronbach's Alpha test is used. To analyze the respondents, Frequency distribution and the percentage have been used, and the PCA was applied measuring the component loading.

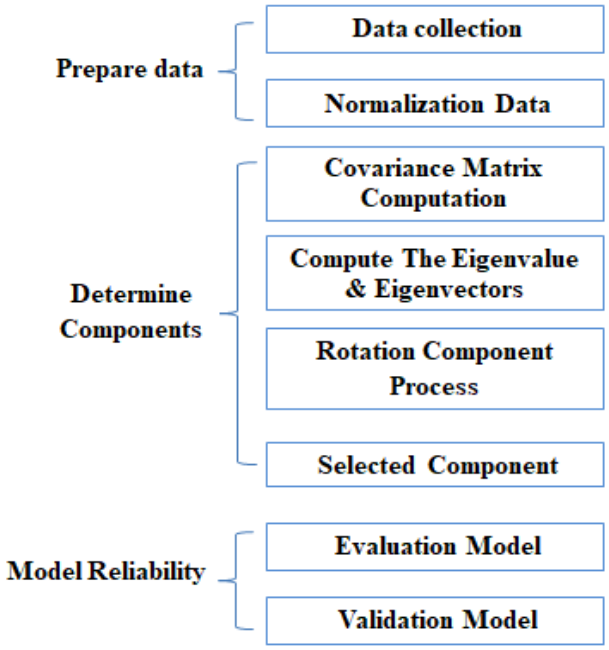


Figure 1. The PCA model process

B. The Statistical Model Assessment

This paper used a PCA technique as statistical model. It was applied to explore the potential relationships among the variables that being used in measuring the effectiveness of E-learning involved among students from the Middle Technical University, Institute of Medical Technology/Al-Mansour, Iraq. Different techniques were used to apply the statistical model, first measuring the suitable data with the model.

Kaiser Meyer-Olkin (KMO) and Bartlett's test were performed, and the KMO test was used to indicate the suitability of the data for structure detection. Meanwhile, Bartlett's test was applied to check out the homogeneity of variances. It was performed to test whether variances are similar for all samples. In this paper, the calculated KMO was 0.891, which indicates that the data being used in this research were suitable for the model.

Afterwards, the model fitting degree index was tested. The relationship theoretical model and the sample data was tested using model fitting degree index. However, no certain standard was existed as the value of chi-square could be affected by sample size and complexity of the model. So, the value of chi-square used here was $\chi 2$ = (2,892.520) and the degree of freedom was , (df = 281).

To get the sum of the variances of the squared loadings maximized, the squared correlations are shown between variables and factors using the Varimax rotation process. Varimax rotation is a statistical technique based on orthogonal rotation in which the assumption is that no inter correlations exist between components [39,40]. It is nominated as Kaiser-Varimax rotation maximizing the sum of the variance of the squared loadings, where "loadings" suggest the correlations between variables and fixed factors. Table 1 shows the number of variables in each component with the weight of the variance and cumulative variance.

This paper applies 10 Varimax rotation times in the analysis to obtain the best loading variable in the components. The degree of rotation is measured by the average diameter for the component transformation matrix. Using the latter, the correlations among the components prior to and after rotation were displayed. Table 2 shows the comparative load and maximizing the sum of the variance of the squared loadings of variables value in components before and after 10 Varimax rotation times. The component loadings were above 0.852 for measured components. Thus, it indicates that there will be a significant association between the items and the component groupings.

Table 1. Summarizes The Components Values

Components No.	No. of variable	Variance	Cumulative variance
1	14	31.38	31.38
2	11	22.12	53.5
3	8	11.51	65.01
4	7	7.087	72.097
5	6	5.54	77.637
6	5	3.25	80.887
7	4	3.02	83.907
8	3	2.187	86.094
9	2	1.89	87.984

Table 2. The comparative variance load before and after varimax rotation

Components No.	Before	After
1	0.713	0.912
2	0.641	0.892
3	0.802	0.904
4	0.771	0.903
5	0.798	0.901
6	0.736	0.882
7	0.694	0.852
8	0.727	0.902
9	0.781	0.883

C. Discriminant Validity

Based on what was mentioned in [41,42]. The extracted square root of the average variance (AVE) of construct was an indicator for its discriminant if (AVE) was exceeded over the correlation coefficient between other constructs, the discriminant validity of a component was accepted as shown in Table 3.

AVE=0.88+0.93+0.82+0.76+0.83+0.91+0.97+0.86+0.70/9

AVE= 7.66/9

AVE = 0.85

Table 3. Discriminant Validity

Component	1	2	3	4	5	6	7	8	9
1	**0.886**								
2	0.789	**0.935**							
3	0.678	0.761	**0.82**						
4	0.646	0.713	0.701	**0.755**					
5	0.623	0.604	0.681	0.701	**0.836**				
6	0.706	0.677	0.614	0.702	0.765	**0.911**			
7	0.560	0.512	0.645	0.623	0.628	0.506	**0.799**		
8	0.621	0.655	0.536	0.425	0.611	0.631	0.518	**0.869**	
9	0.476	0.461	0.517	0.510	0.518	0.611	0.497	0.61	**0.701**

Table 3 shows results of the AVE analysis. The AVE values are above 0.85, moreover, are above the correlation coefficients for each component.

D. Reliability Model

SPSS software was used to analyze the data (IBM, Armonk, NY, USA). The Reliability Test was detected using the Cronbach's α value; the value scores of the reliability of the scales was above 0.7, thus confirming the reliability of the questionnaire' components[40,41]. The outcomes of the test were illustrated in Table 4, in which the coefficients were ranged from 0.691 to 0.834, suggesting that the measured components were internally consistent. The values of measured components were greater than 0.50, and the average measure of Cronbach's Alpha is 0.801, indicating high independence between components used in the study

The effectiveness of E-learning among undergraduate students was found using descriptive statistics and hypotheses testing The significant level was 5% for one sample T-test with confidence level 95%. The P value was considered significant with less than 0.05 for Two-tailed test, in which it supports the hypothesis that the base of E-learning education smoothly uses information technology. The p-value for usability component is 0.012, indicating that E-learning was usable for learning in active way. Learned skills and competency component have also been proven because the p-value of skills and competency is below 0.001, indicating that E-learning was very crucial for quicker learning. For components related to the quick responsiveness, p-value was 0.003, indicating that E-learning was very effective to get a quick response in classwork. For components regarding to the E-learning quality, P- value was 0.021, indicating that E-learning quality was positive. For components regarding to the knowledge sharing, P –value was less than 0.001, suggesting the idea that E-learning was applicable outside the classroom. Testing the effect of E- learning on time and cost indicated that E-learning was appropriate for independent work (P –value of the component was less than 0.001; time effect, p-value was 0.021; cost effect, respectively).Measuring the Information quality showed that E-learning was no different from the traditional classroom (p-value of the component was above 0.05) .

Table 4. Reliability statistics

Factor's No.	Factor's Name	Cronbach's Alpha	Sig
1	Familiarity with the technology	0.855	0.00
2	Usability	0.812	0.000
3	Learned skills and competency	0.761	0.001
4	Quick Responsiveness	0.771	0.003
5	Learning Quality learner	0.705	0.007
6	Time and Cost	0.814	0.00
7	Faster Learning	0.701	0.004
8	Information quality	0.691	0.021
9	Knowledge sharing	0.809	0.00

IV. FINDINGS AND DISCUSSION

Out of 1476 students assigned for the current study 98.4% were relying on different E-learning tools, techniques, or platforms for academic learning. Students were asked about how frequent in a weekly period they like to use E-learning as a learning approached during the COVID-19 pandemic. The outcome of this statement revealed that 58.8% of the students preferred to use E-learning two hours a day, 26.7% from the students used E-learning two hours a week, 9.2% used E-learning when they had an exam , and only 5.3% who used E-learning every day in a week as shown in Figure 2.

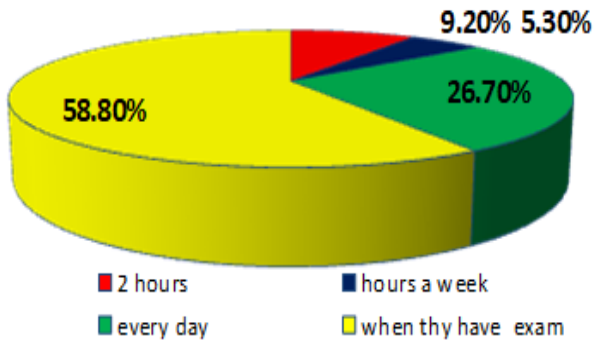
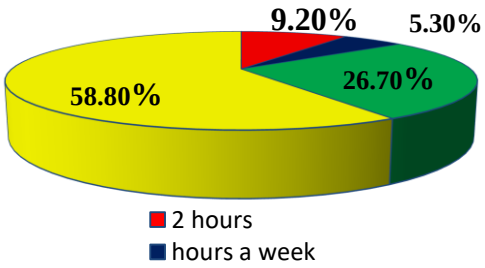


Figure 2. student for using e- learning

Students were also asked about how the COVID-19 pandemic has affected teaching and learning. Most of them answered that the classroom E-learning platform is replacing the traditional class. Thus, that it has not affected the learning level, where 18% of students rely on teaching and learning for self-study. However, 7% of students answered that the E-learning has cancelled teaching, and 3% of the students answered that teaching and learning are not affected during the COVID-19 as shown in Figure 3.



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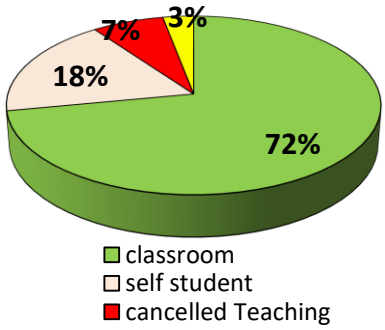

Figure 4. COVID-19 affected teaching and learning

The other important question asked to students was their satisfaction with E-learning during the COVID-19 pandemic. The response of students on the first 5 points was ranged from strongly disagree to strongly agree. Figure 5 shows the evaluation of satisfaction level E-learning.

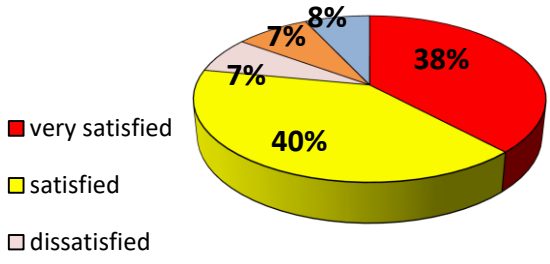

Figure 5. evaluation Satisfaction students for e-learning

The usability of electronic devices is a basic parameter for the evaluation of the E-learning technologies model. Students were asked about their favorite electronic devices in E-learning. Figure 6 below shows the answer. The answer supported the following assumption: the advantage of E-learning is that the learner enjoys continuous learning anytime and anywhere. Moreover, the student prefers the classroom platform than the module by 95.7% as show in Figure 7.

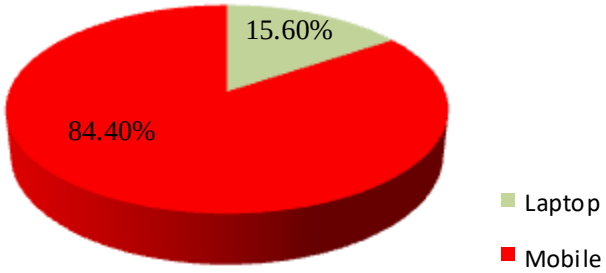

Figure 6. .The favorite electronic devices in e-learning

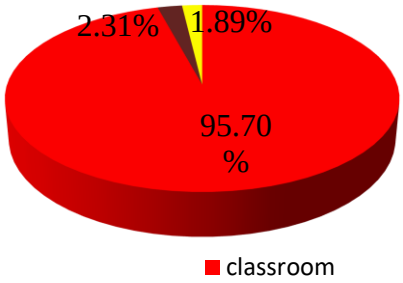

Figure 7. Students prefer to use Module and classroom as tools in e-learning

V. CONCLUSION

The study results have shown that medical education skills have been slightly affected by the use of e-learning during the COVID-19 pandemic, and college students' continuing education during the COVID-19 pandemic, especially in tertiary education, has a significant positive effectiveness. The analyses above suggest that the study supports the assumption that E-learning entails familiarity with the technology. In addition, it entails usability for using electronic devices to all levels of students. E-learning improves the learned skills and competency. Through E-learning, the students develop quick responsiveness. Learning quality of learners is indicated significantly, and the factors of time and cost are reduced. Faster learning is the result of using different types of multiple media. The information quality and knowledge sharing are the best results of E-learning.

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