

# Predicting the Saudi Student Perception of Benefits of Online Classes during the Covid-19 Pandemic using Artificial Neural Network Modelling

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## Abstract-

One of the impacts of Covid-19 on education systems has been the shift to online education. This shift has changed the way education is consumed and perceived by students. However, the exact nature of student perception about online education is not known. The aim of this study was to understand the perceptions of Saudi higher education students (e.g., post-school students) about online education during the Covid-19 pandemic. Various aspects of online education including benefits, features and cybersecurity were explored. The data collected were analysed using statistical techniques, especially artificial neural networks, to address the research aims. The key findings were that benefits of online education was perceived by students with positive experience or when ensured of safe use of online platforms without the fear cyber security breaches for which recruitment of a cyber security officer was an important predictor. The issue of whether perception of online education as a necessity only for Covid situation or a lasting option beyond the pandemic is a topic for future research.

**Keywords-** *Online learning, Saudi Arabia, benefits, artificial neural network modelling*

## I. INTRODUCTION

Online education has become a popular method to increase access and affordability of education for socio-economically backward population. Especially, the popularity of mobile enabled online education is rapidly increasing even in educational institutions facilitating learning of regular students. There had been a lot of research works on this topic worldwide, as some recent reviews show. In the review of [1], the topic has been dealt with in an exhaustive manner covering almost all research and practical aspects. Both pros and cons of online education were discussed in another review by [2]. Predictive factors for students' success in learning and satisfaction were reviewed by [3]. These reviews deal with online education in a more general context across many research conducted in different countries.

However, the onset and spread of Covid-19 pandemic has made online education a necessity. In this context, perceptions of its advantages and disadvantages may be different. Various challenges and opportunities offered by the pandemic were outlined by [4] in the context of higher education in Philippines. Adjustments required to continue education using online mode in the pandemic context were explained by [5]. According to [6], there is need to study on the benefits and challenges of the Covid-19 pandemic necessitate specific strategies to ensure the continuation of education by students.

It is clear from the above research reviews that online education is here to stay, pandemic or not. In this period of the pandemic, however, the benefits and challenges of online education is observed more conspicuously. It will be very useful to investigate on how university students perceive these new requirements related to online education. This study aims to undertake such an investigation in the context of Saudi Arabia.

Covid-19 had its peak of 50,000-60,000 active cases during June-August 2020, but it has come down drastically to about 11,000 as on 31 July 2021. Daily cases are around 1,200 according to the World Health Organization (WHO). Hence, the country still continues with a mixture of restrictions and relaxations on daily life needs. It also means, online mode of education needs to continue as the sole method for some more time.

The research questions for this study was framed as-

- a) What are the perceptions of Saudi higher education students (e.g., post-school students) about online education during the Covid-19 pandemic?
- b) How artificial neural networks can be used for predicting students' perceptions about online education during Covid-19 pandemic?

Accordingly, the aims of this research were-

- a) To understand the perceptions of Saudi higher education students about online education during the Covid-19 pandemic?
- b) To predict students' perceptions on the benefits of online education during the current Covid-19 pandemic,

## II. LITERATURE REVIEW

Teachers' and learners' perspectives of benefits, challenges and strategies during and after the Covid-19 pandemic were assessed by [6] through a survey of teachers and students in Nepal. Beneficial effects especially for online research, sharing information with others through networking and consultation with experts on the subjects, were reported by the participants. However, challenges of time management, lack of freedom for teachers and students and internet connectivity problems were also expressed. Suitable changes in ICT policies and blended learning instead of online only, were suggested as strategy improvements to tackle the situation[7].

Using data and textual information from secondary sources and mini-interviews over phone with private university students, [8] noted that even in the middle of challenges due to the pandemic, students have realised this as the only available method of learning and view this positively for devising appropriate learning strategies.

In a Chinese study, [9] did different types of analysis on the user experience data collected from online sources and observed the existence of different concerns and requirements, access, speed and reliability of online educational platforms. Users focused on course management, communication and interaction, learning and technical support services of the platform. The authors suggested some improvements in support systems, facilitation of interactions, optimisation of ease of use and enrichment of user platforms. In another Chinese study, [10] evaluated the effectiveness of the 'Schools out, Classes on' large scale campaign implemented by Chinese government to address the problems of education during the pandemic. The campaign had a very large impact on the majority of educational institutions and students, accelerated integration of technology with teaching and home and school education. It also helped to develop new models of teaching and learning.

Thus, many countries adopted various strategies to ensure that students do not lose their education due to the pandemic, for which strengthening online education system in various ways was required. In Saudi Arabia also, similar efforts were made as some reports show.

Positive perceptions of synchronized online education by medical students in Saudi Arabia were observed by [11] through a qualitative study. There was saving of time and improvement of performance due to enhanced utility of time. However, some methodological, content perception, technical, and behavioral challenges were also reported both

during sessions and online exams. They preferred continuance of online education in future too. Using a survey, [12] showed that no gender differences existed in preparedness, attitude or barriers for online education among Saudi pharmacy students. A good majority perceived that the college of pharmacy was well-prepared and had completely transitioned to be ready for the online education by the time COVID-19 started as pandemic in the country. Need for training in online learning was pointed out by some students. In another study by [13], English language bachelor degree students were in favor of asynchronous learning on Blackboard due to its flexibility. However, virtual education was not preferred by many students.

Thus, a few studies already done in other countries and a limited number of studies in Saudi Arabia, have shown that students generally perceived online education positively as a solution to the problem of continuing education while Covid-19 related restrictions are in vogue. However, some problems were also highlighted. Prediction of students' perceptions on the benefits and challenges of online education during the current covid pandemic in presence of both positive and negative variables become important in this respect. This justifies the search for predictive ANN model using survey data. Some works in this direction are reviewed below.

ANN was used by [14] to predict students' academic performance using secondary data on different test scores in various subjects. ANN consisted of 11 input variables, two layers of hidden neurons, and one output layer and Levenberg-Marquardt algorithm as backpropagation training rule. Error performance, regression, error histogram, confusion matrix and area under the receiver operating characteristics curve were used as evaluation models of ANN performance. A prediction accuracy of 84.8% was achieved with some limitations. In a Chinese study, [9] used back propagation ANN to evaluate and predict user experience of online education platforms by Chinese students during the Covid-19 pandemic. A survey and a web crawler were used for collection of data. Results showed no relationship for user factors with user satisfaction of online educational platforms. Platform availability influenced user satisfaction highly. Two Chinese online educational platforms were high quality service over MOOC platform. Prediction accuracy of ANN was 77.5%. Suggestions to improve platform technology and two-way interactions in teaching were made. In a Spanish study by [15], ANN was used in the second phase (after SEM in the first), to rank the relative influence of significant predictors obtained by SEM. Perceived satisfaction with MOOC was influenced by quality of the course, its entertainment value and usefulness, although ANN had a different order of these predictors. Both methods together predicted high intention to use MOOC and high levels of satisfaction. Machine learning algorithms including ANN were compared by [16] in a study of acceptance of online education by UAE university students. Extended technology acceptance and theory of planned behavior models were used to collect data on

relevant variables through a survey of seven universities in UAE. Accordingly, data were collected on attitude, intention to use mobile learning platform in the Covid context, subjective norms, perceived behavioral control, perceived ease of use, perceived usefulness and perceived fear. Perceived usefulness was best predicted by J48 classifier with 83.76% accuracy, 80.3% precision and 83.8% recall value. Mobile learning platform was considered to be safe by students for use during the Covid pandemic in the country. Multilayer perceptron ANN using backpropagation algorithm was very useful with high predictability for learning strategies on students' academic performance of Spanish private university students, as was observed by [17].

The above review demonstrates the essentiality of online education in the Covid pandemic context and usefulness of ANN to evaluate and predict variables associated with different aspects of online education. In this research, the perception of Saudi university students on the benefits of online education was the dependent variable tested with ANN for its predictability of some factors. The required data were collected using a quantitative questionnaire survey.

Students are likely to be satisfied if online education offers them significant benefits including academic performance as shown in the above review. The effect of different variables on their benefits perception can be predicted using ANN for a survey data as shown by a few papers reviewed above.

In the next section, the methodology used for this research has been described.

### III. METHODOLOGY

- Research design

A quantitative survey was done to answer the first research question: what are the perceptions of Saudi higher education students (e.g., post-school students) about online education during the Covid-19 pandemic? Questions like 'what' demanding list of factors and relationships among them are best answered through surveys, as has been explained by [18] and [19]. The survey data were used for ANN predictive modelling to answer the second research question.

- Population and sample

A total of three million university students in Saudi Arabia has been estimated for 2018 [20]. It is possible that this number may be higher now, as there is rapid expansion of higher education in the country as part of its Vision 2030 strategies [21]. Of this total population, Umm Al-Qura University has about 110,000 students in its rolls. Of these, 2000 male students were randomly selected for the survey.

- Development of survey instrument and distribution

The survey instrument was developed by the researcher based on literature and consultation with experts. The questionnaire contained 4 items of demographic variables and 11 items related to online education and cyber security.

The questionnaire was uploaded onto the online surveying tool SurveyMonkey and circulated to the 2000 male participants using their email Id. A total of 238 responses were obtained, giving a response rate of 11.9%. As over 200 responses were obtained, 238 was considered an adequate sample for valid statistical analysis.

The Cronbach's alpha value for the 11 items on online education and cyber security was 0.77, which is more than the minimum value of 0.7 required for satisfactory reliability.

### IV. DATA ANALYSIS

The data were analyzed using SPSS software. The analysis consisted of descriptive statistics and artificial neural network [22]. The results of the analysis are described in the following section.

### V. RESULTS

- Demographics

The age of the survey participants is given in Table 1.

Table 1. Age of survey participants.

	<i>N</i>	<i>Minimum</i>	<i>Maximum</i>	<i>Mean</i>	<i>Std. Deviation</i>
What is your age (years)?	238	19.0	35.0	24.17	4.26
Valid N (listwise)	238				

The age of the 238 participants varied between 19 years and 35 years, with a mean of 24.17 and standard deviation of 4.26.

All 100% of the 238 participants were male students. So, there was no gender differences.

The courses being pursued by the participants are presented in Table 2.

Table 2. Courses being pursued by the survey participants.

		<i>Frequency</i>	<i>Percent</i>	<i>Valid Percent</i>	<i>Cumulative Percent</i>
Valid	Bachelor's	151	63.4	63.4	63.4
	Diploma	16	6.7	6.7	70.2
	Master's	71	29.8	29.8	100.0
	Total	238	100.0	100.0	

Highest number of participants (151, 63.4%) were pursuing bachelor's degree, followed by those pursuing master's with a frequency of 71 (28%), totally accounting

for about 93% of total participants. Less than 7% of the students were pursuing diploma courses.

The frequency responses of 238 student participants on their experience in online education have been presented in Table 3.

Table 3. Frequency responses of survey participants on online education experience.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	148	62.2	62.2	62.2
	Yes	90	37.8	37.8	100.0
	Total	238	100.0	100.0	

Out of 238 participants, 148 (62.2%) had no online education experience and the remaining 90 (37.8%) had this experience. Thus, about two-thirds of the students had some online education experience already.

- Benefits of online classes and importance of cybersecurity

The survey participants were asked about the benefits of online classes and importance of cyber security. The descriptive statistics of their responses are given in Table 4.

Table 4. Descriptive statistics of responses of survey participants on benefits of online classes and importance of cyber security.

Items	N	Minimum	Maximum	Mean	Std. Deviation
Benefit of Online Education (1-level and 5 - High level) - how did you rate the benefits of online education compared with face to face learning	238	1.0	5.0	3.25	1.29
Positive Features of Online Education (1-Low level and 5 - High level) - rate the level of interaction between students and teacher in online education	238	1.0	5.0	2.61	1.23
Positive Features of Online Education (1-Low level and 5 - High level) - how comfortable were you in appearing for exams and tests during online education	238	1.0	5.0	3.62	1.08
Positive Features of Online Education (1-Low level and 5 - High level) - how difficult is it to manage time with online education	238	1.0	5.0	3.73	1.05
Importance of Cybersecurity (1-level and 5 - High level) - how did you think about cybersecurity concerns during online education	238	1.0	5.0	2.07	1.06

Importance of Cybersecurity (1-level and 5 - High level) - rate interest in learning about cybersecurity concerns in online education	238	1.0	5.0	2.56	1.22
Importance of Cybersecurity (1-level and 5 - High level) - how important do you think are cybersecurity concerns in online education portals	238	1.0	5.0	3.86	1.05
Importance of Cybersecurity (1-level and 5 - High level) - how important do you think is it for the university to teach students about cyber safety for online education	238	1.0	5.0	3.84	1.08
Importance of Cybersecurity (1-level and 5 - High level) - rate knowledge of cyber safety practices for online education	238	1.0	5.0	2.49	1.18
Importance of Cybersecurity (1-level and 5 - High level) - how important do you think it is to have an information security officer for online education	238	1.0	5.0	2.84	1.26
Importance of Cybersecurity (1-level and 5 - High level) - how important do you think it is to be aware of data privacy with the increase in online education	238	1.0	5.0	3.71	1.16
Valid N (listwise)	238				

The rating scale indicates: 1-Low, 2-Slightly low, 3-Neutral, 4-Slightly high, and 5-high. As 3 is the mid value between the rating extremes of 1 and 5, the mean values of the following items were above this mid value, ranging from 3.25 to 3.86, indicates neutral to slightly high as the value increases from 3 to 4-

- 1) How would you rate the benefits of online education compared with face-to-face learning?
- 2) How comfortable were you in appearing for exams and tests during online education?
- 3) How difficult is it to manage your time with online education?
- 4) How important do you think are cybersecurity concerns in online education portals?
- 5) How important do you think is it for the university to teach students about cyber safety for online education?
- 6) How important do you think it is to be aware of data privacy with the increase in online education?

Thus, there were good benefits and comfort in appearing for tests and exams with online education, but it was difficult to manage. Cyber security is important, and the University needs to teach the students cyber safety for online education as it is important to be aware of data privacy with increasing use of online education. On the other hand, the items for which the mean scores were below 3, indicate poor interactions between students and teachers,

not very concerned about cyber security while attending online classes, low interest in learning about cyber security, low level of knowledge about cyber security practices in online education and not attaching importance to having a cyber security officer for online education.

- Predicting benefits of online education

An artificial neural network model was fit to the survey data with benefits of online education as the dependent variable, and the factors and covariates mentioned in the table below as the independent variables. The network information is presented in Table 5.

Table 5. Network information details.

<b>Input Layer</b>	<b>Factors</b>	1	What degree are you pursuing?
		2	Did you have any experience of online education before Covid-19?
	<b>Covariates</b>	1	What is your age (years)?
		2	Question 2 - Positive Features of Online Education (1-Low level and 5 - High level) - rate the level of interaction between students and teacher in online education
		3	Question 3 - Positive Features of Online Education (1-Low level and 5 - High level) - how comfortable were you in appearing for exams and tests during online education
		4	Question 4 - Positive Features of Online Education (1-Low level and 5 - High level) - how difficult is it to manage your time with online education
		5	Question 5 - Importance of Cybersecurity (1-Low level and 5 - High level) - how often did you think about cybersecurity concerns during online education
		6	Question 6 - Importance of Cybersecurity (1-Low level and 5 - High level) - rate your interest in learning about cybersecurity concerns in online education
		7	Question 7 - Importance of Cybersecurity (1-Low level and 5 - High level) - how important do you think are cybersecurity concerns in online education portals
		8	Question 8 - Importance of Cybersecurity (1-Low level and 5 - High level) - how important do you think is it for the university to teach students about cyber safety for online education
9	Question 9 - Importance of Cybersecurity (1-Low level and 5 - High level) - rate your knowledge of cyber safety practices for online education		
10	Question 10 - Importance of Cybersecurity (1-Low level and 5 - High level) - how important do you think it is to have an information security officer for online education		

		11	Question 11 - Importance of Cybersecurity (1-Low level and 5 - High level) - how important do you think it is to be aware of data privacy with the increase in online education
	<b>Number of Units<sup>a</sup></b>	16	
	<b>Rescaling Method for Covariates</b>	Standardized	
<b>Hidden Layer(s)</b>	<b>Number of Hidden Layers</b>	1	
	<b>Number of Units in Hidden Layer 1<sup>a</sup></b>	1	
	<b>Activation Function</b>	Hyperbolic tangent	
<b>Output Layer</b>	<b>Dependent Variables</b>	1	Benefit of Online Education (1-Low level and 5 - High level) - how would you rate the benefits of online education compared with face to face learning
	<b>Number of Units</b>	5	
	<b>Activation Function</b>	Softmax	
	<b>Error Function</b>	Cross-entropy	
a. Excluding the bias unit			

About 75% of the data was used as the training set for the model and the balance as testing set, as given in the case processing summary in Table 6.

Table 6. Case Processing Summary.

		<i>N</i>	<i>Percent</i>
<b>Sample</b>	Training	177	74.4%
	Testing	61	25.6%
<b>Valid</b>		238	100.0%
<b>Excluded</b>		0	
<b>Total</b>		238	

The network diagram is shown in Fig 1 below.

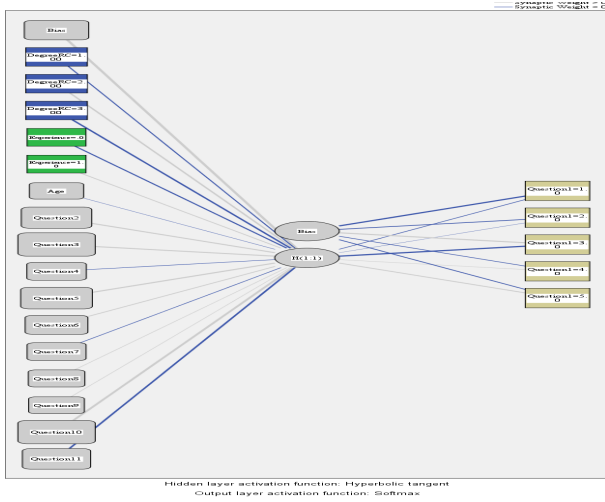


Figure 1 Network diagram

The accuracy of the model as measured from the testing set was 37.7%. This means that the model was able to predict the benefits of online education correctly for students based on the independent variables included in the study 37.7% of the times. The classification data are given in Table 7.

Table 7. Classification of table of the artificial neural network.

Sample	Observed	Predicted					Percent Correct
		Low levels	2.0	3.0	4.0	High levels	
Training	Low levels	0	0	16	0	7	0
	2.0	0	0	17	0	15	0
	3.0	0	0	35	0	18	66.0
	4.0	0	0	18	0	17	0
	High levels	0	0	19	0	15	44.1
	Overall Percent	0	0	59.3	0	40	28.2
Testing	Low levels	0	0	1	0	4	0
	2.0	0	0	5	0	1	0
	3.0	0	0	15	0	4	78.9
	4.0	0	0	7	0	5	0
	High levels	0	0	11	0	8	42.1
	Overall Percent	0	0	63.9	0	36.1	37.7

Dependent Variable: Benefit of Online Education (1-Low level and 5 - High level) - how would you rate the benefits of online education compared with face to face learning

The importance of the independent variables as predictors is shown in the table and figure below. The top three predictors of benefits of online education were:

1. Question 3 - Positive Features of Online Education (1-Low level and 5 - High level) - how comfortable were you in appearing for exams and tests during online education-100%
2. Question 10 - Importance of Cybersecurity (1-Low level and 5 - High level) - how important do you think it is to have an information security officer for online education-100%
3. Question 5 - Importance of Cybersecurity (1-Low level and 5 - High level) - how often did you think about cybersecurity concerns during online education- 78.1%

The data on the importance of independent variables to predict the dependent variable, as estimated from the ANN model, have been presented in Table 8 and diagrammatically in Fig 2.

	Importance	Normalized Importance
What degree are you pursuing?	.061	38.8%
Did you have any experience of online education before Covid-19?	.045	28.5%
What is your age (years)?	.017	10.6%
Question 2 - Positive Features of Online Education (1-Low level and 5 - High level) - rate the level of interaction between students and teacher in online education	.116	73.2%
Question 3 - Positive Features of Online Education (1-Low level and 5 - High level) - how comfortable were you in appearing for exams and tests during online education	.158	100.0%
Question 4 - Positive Features of Online Education (1-Low level and 5 - High level) - how difficult is it to manage your time with online education	.048	30.6%
Question 5 - Importance of Cybersecurity (1-Low level and 5 - High level) - how often did you think about cybersecurity concerns during online education	.124	78.1%
Question 6 - Importance of Cybersecurity (1-Low level and 5 - High level) - rate your interest in learning about cybersecurity concerns in online education	.069	43.6%
Question 7 - Importance of Cybersecurity (1-Low level and 5 - High level) - how important do you think are cybersecurity concerns in online education portals	.045	28.7%

Question 8 - Importance of Cybersecurity (1-Low level and 5 - High level) - how important do you think is it for the university to teach students about cyber safety for online education	.031	19.5%
Question 9 - Importance of Cybersecurity (1-Low level and 5 - High level) - rate your knowledge of cyber safety practices for online education	.025	15.8%
Question 10 - Importance of Cybersecurity (1-Low level and 5 - High level) - how important do you think it is to have an information security officer for online education	.158	100.0%
Question 11 - Importance of Cybersecurity (1-Low level and 5 - High level) - how important do you think it is to be aware of data privacy with the increase in online education	.102	64.7%

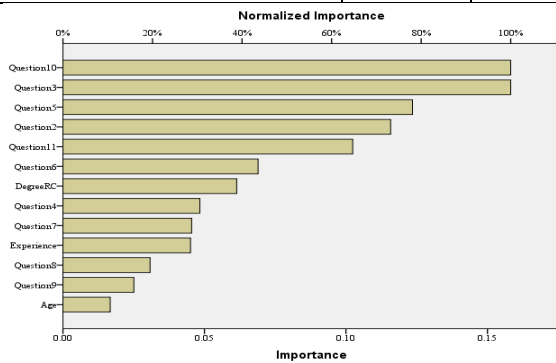


Figure 2 Variable importance

The importance was 100% for questions how important you think it is to have an information security officer for online education (Q10) and how comfortable were you in appearing for exams and tests during online education (Q3), meaning these two dependent variables fully predict benefit of online education to Saudi university students. On the other hand, questions on age and rating knowledge about cyber security practices in online education had least importance of 10.6% and 15.8% respectively. The importance of other items ranged between these two extremes. Between 100% and 78%, there was no value.

**VI. DISCUSSION**

The aim of this study was to understand the perceptions of Saudi male university students on online education in the current context of Covid pandemic in the country. The focus was on benefits and features of online education and how cyber security issues affect the full potential of its use as there is a rapid increase in online education platforms in different parts of the world to address the problems to education due to the pandemic.

To achieve this aim, survey results were analyzed. Results showed responses of students towards slightly high level of perceptions on benefits, comfort levels, difficulty of

time management, cyber security concerns, need to teach them on cyber security issues and awareness of data privacy needs in respect of online education. Positive perceptions on the benefits of online education have been reported by [6]. However, the specific effects listed by the students in their study were different from comfort level observed in this study. Perhaps, sharing information, networking and expert consultation listed by [6] indicate high comfort level. Positive views of students on online education during this pandemic was attributed by [8] to absence of any other option during the current restrictions to address Covid problems. Thus, instead of comfort, it is the stress factor that leads to positive perception. Such a possibility is indicated in this study through the concern for cyber security in online education contexts. Benefits could be perceived from good user experience, as the Chinese study by [9] shows. The positive user experience arises from access to the source, internet speed, reliability, content, and facility for interactions. Although these aspects were covered in this study, their importance was not high. Big campaigns like ‘School out, Classes on’ [10] may help students to recognize the benefits of online education despite difficulties, facilitating quick transformation from face to face to online mode as the pandemic spreads fast in different waves. In Saudi Arabia also, a variety of factors contribute to positive perception on online education. These include saving of time and increase in utility time [11]. In this research, difficulty of managing time, instead of saving time or availability of more utilizable time, was reported in a more positive fashion. However, interactions between students and teachers were perceived at slightly low level. This affects sharing of information as a part of beneficial experience observed by [6]. Well-preparedness by switching to online education as soon as Covid starts threatening, rather than wait till it becomes inevitable [12] creates a positive perception on online education leading to recognition of benefits. When one institution has done this, it is certain that many more educational institutions in Saudi Arabia would have adopted this pre-emptive strategy to the benefit of students. This aspect was not examined in the current research.

Three variables were ranked as most important for perception of students on the benefits of online education using ANN modelling. These were comfort level, importance of cyber security as a serious concern and need for a cyber security officer to solve this issue in online education. Comfort level and need for a cyber security officer for online education determined benefit of online education fully with 100% importance for both. Cyber security as a serious concern influenced benefit of online education to the extent of about 78%.

ANN had been used for evaluating and predicting variables related to student satisfaction of online education by many researchers as was shown in the review. Many different algorithms, other than the backpropagation algorithm in this study, have been used in other works. The Chinese study by [23] did not find any relationship of user

factors like education with satisfaction on online education. In this study also user factors like experience and age had very low predictive importance. Quite different variables (quality of course, entertainment value and usefulness) were important predictors of student satisfaction with MOOC platform in the studies of [15] using ANN to measure relative influence of predictors identified from SEM. In a UAE, study of machine learning comparisons including ANN by observed readiness of students to accept online learning under the current Covid situation.

Overall, there is a twin possibility of accepting online education as an inevitable method to continue education under Covid pressure as well as accepting it as a method of significant benefits. In the former case, the students will prefer to return to classroom education as soon as the Covid threat ceases. On the other hand, if benefits attract students to online education, their preference for the method is sustained even after the pandemic ceases to exist. However, this study was focused only on the former aspect.

## VII. CONCLUSION

There was a general perception of benefits of online education among students due to experience and when safe cyber security practices exist, when there is a Covid threat in the country. ANN methodology was able to rank the variables associated with online education according to importance. Their preference to continue use of online education after the pandemic ceases, depends on whether they perceived online education as an inevitable solution to learning problems during the pandemic or due to recognition of significant benefits without the pressure of the pandemic. This aspect may be a topic for future research.

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