

A Proposed Model for E-learning Adaptability Measurement During COVID-19 Pandemic Using Data Mining Techniques

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Abstract—E-learning became the main medium of education in the world for the past two years. COVID-19 virus has pushed all the universities and academic institutions to utilize and activate E-learning platforms and systems. The sudden and urgent transformation from the regular traditional learning system to E-learning system has involved many challenges and limitations. Therefore, the need to evaluate and enhance the current E-learning mechanism in Iraq became very urgent and critical need. The target level was students at higher education institutes which include university students in Basra city. The data collected based on students' evaluation and opinions about E-learning based on their interaction and usage during two years under COVID-19 spread era. This research involved applying data mining techniques to sample dataset and utilizing the obtained results as feedback for a proposed model suggested by the authors to measure adaptability. The proposed model is derived from the idea of the Technology Acceptance Model (TAM) with focus on the positivity as the main factor to measure adaptability. The results of the research showed approximate adaptation level of 52% which is very close compared to the actual situation in real life which involve limitations and challenges faced by Iraqi students.

Keywords—e-learning, computer aided learning, data mining, e-learning adaptation model, web based learning

1 Introduction

E-learning is a term used to define a method of teaching and learning based on technology [1]. E-learning is a digital form of delivering knowledge and lectures to students. It is a distance based learning environment where students can get their knowledge anywhere and anytime. Furthermore, it employs the internet services as transmission medium to publish lectures and materials electronically [1]. It can take different modes and shapes as it could be synchronous or asynchronous learning environment [2]. Asynchronies E-learning mode doesn't require students/teachers be available at the same time to get/deliver knowledge [3]. While, synchronize E-learning mode

requires both students and teachers be available at specific time according to specific schedule to get and deliver the knowledge and lectures [3].

E-learning is a term used to define a method of teaching and learning based on technology [1]. E-learning is a digital form of delivering knowledge and lectures to students. It is a distance based learning environment where students can get their knowledge anywhere and anytime. Furthermore, it employs the internet services as transmission medium to publish lectures and materials electronically [1]. It can take different modes and shapes as it could be synchronous or asynchronous learning environment [2]. Asynchronies E-learning mode doesn't require students/teachers be available at the same time to get/deliver knowledge [3]. While, synchronize E-learning mode requires both students and teachers be available at specific time according to specific schedule to get and deliver the knowledge and lectures [3]. The advantages of E-learning include cost savings, flexibility of time and venue, and joyful learning experience [4]. On the other hand, the disadvantages of E-learning could involve interrupted internet services, poor of IT skills and background, low quality of electrical power, and isolated learning environment [5].

In Iraq, E-learning was recently applied and become the main mode of learning in higher education due to the crisis of COVID-19 pandemic. The same situation applies to other countries worldwide such as India [6]. Before COVID-19 pandemic occurs, E-learning was developing gradually in slow rate worldwide [7]. A significant change to online education has occurred during COVID-19 pandemic globally [8]. Higher education in Iraq follows the regular classroom learning mode as the main education method. E-learning approach in Iraq was first applied on 2020 when COVID-19 pandemic took place and forced all the education institutes as well as most of the facilities to close and operate remotely. Therefore, it is considered as new experience for Iraqi student and teachers to go through and to experience during their lifetime.

Applying E-learning in Iraq faced many challenges and limitations due to the poor of Information Technology (IT) infrastructure in Iraq. The poor IT infrastructure includes and not limited to low quality internet services, poor computer networks infrastructure for high education institutes, low quality power services, and poor IT culture for both staff and students. The IT infrastructure for most of the universities is not established. Providing the needed ICT infrastructure is the key point in the success of E-learning [9]. The internet and power services are not stable and go through many cut off periods. In addition, most of the student and faculty doesn't know how to use E-learning applications.

In Iraq, E-learning was recently applied and become the main mode of learning in higher education due to the crisis of COVID-19 pandemic. Higher education in Iraq follows the regular classroom learning mode as the main education method. E-learning approach in Iraq was first applied on 2020 when COVID-19 pandemic took place and forced all the education institutes as well as most of the facilities to close and operate remotely. Therefore, it is considered as new experience for Iraqi student and teachers to go through and to experience during their lifetime.

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Therefore, this paper discusses and measures the adaptability level of students towards E-learning after 2 years of applying it at the higher education institutes. It is the first paper to study the adaptability level towards E-learning in Iraq as new real education experience. One of the most joy factors to determine the efficiency of learning system is to study and analyze students' contentment [10]. The research done in this paper is based on data collected from students representing their opinions in E-learning. Data mining techniques are utilized to analyze this data in order to drive patterns and hidden knowledge that can help to measure students' adaptability level. Furthermore, a proposed model called PUNM is suggested to measure students' adaptability for E-learning experience.

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2 Methodology

2.1 Literature review

The learning system in Iraq was forced to switch to E-learning form totally on the academic year of 2019-2020 due to the wide spread of Covid-19 virus. Most of the world facilities was shifted to electronic and online form of business due to the pandemic. Some universities switched back to remote learning and education system after short period of covid-19 infections [11].

E-learning was totally new experience for both academic staff and students in Iraq. The spread of Covid-19 continued during the following academic year of 2020-2021. Therefore, E-learning became the main out look of the higher education system in Iraq. There were many limitations, complications, and complains by both students and staff towards the utilization of E-learning system. Therefore, measuring the adaptability of students towards E-learning became an urgent need to understand their needs and to improve the current E-learning approach in Iraq.

The acceptance of E-learning was examined by Almajali [12]. The study focused on the relationship among different factors including Infrastructure for knowledge management, benefits of E-learning, and system usage complexity level. Almajali [12] focused on the Jordanian users at university level as scope of work and study. In addition, Almajali [12] utilized the technology acceptance model (TAM) to study E-learning acceptance in Jordan. They used 300 survey respondents from Jordan to analyze the data and was categorized according to gender and major. The study of Almajali [12] concluded that cultural knowledge infrastructure factor didn't affect the relationship between E-learning acceptance and usefulness factor. However, it found that the cultural knowledge infrastructure significantly affected the relationship between E-learning acceptance and ease of use factor [12].

According to Habes [13], the acceptance of E-learning was studied using sample of 314 college students in Sahiwal, Pakistan [13]. Habes [13] categorized the data according to gender, study year, and residence area. The study applied different types of analysis techniques including intercoder reliability analysis and univariate Pearson correlation, Analysis of variance, and linear regression analysis. The study of Habes [13] found that there is a strong positive relationship between E-learning acceptance and students [13]. In addition, it concluded that E-learning has positive impact on students' academic performance.

On the other hand, Shazhad [14] studied the quality of E-learning systems by making comparison between respondents based on gender. Shazhad [14] study was applied to Malaysian University student's both in undergraduate and postgraduate levels. The data collected was classified according to gender, age, experience level with E-learning, and graduate level. According to Shazhad [14], the majority of data collected was submitted by female students due to high enrollments of females in Malaysian universities. After, analyzing the collected data and performing the needed assessments based on gender groups, Shazhad [14] study resulted in positive relationships between E-learning portals and system quality and user satisfaction for female model. And found that information quality and system quality has positive impact on user satisfaction in male model [14].

A recent research on E-learning acceptance in Indonesia carried out by Tussardi [15] which tested students' acceptance towards CeLOE LMS in Telkom University. CeLOE LMS is the E-learning platform utilized by Telkom University staff and students. Tussardi [15] has applied the Unified Theory of Acceptance and Use of Technology Model (UTAUT). The UTAUT model used to assess the level of acceptance of new technology. Tussardi [15] collected the data through a survey designed used google forms. Furthermore, Tussardi [15] categorized the collected data according to age, gender, experience, and voluntariness of use. The results reached by Tussardi [15] is that the average students accepted the CeLOM LMS at Telkom University [15].

In this research, the data collected from Iraqi university students located in Basra city. Feedback received from 928 students represents the dataset. Students' response towards E-learning was collected in terms of positivity, negativity, enjoyment of the system, evaluation of the whole new experience, and some other factors related to E-learning platforms and digital devices.

The method followed in this paper is based on new adaptability model suggested by the authors. The proposed model is derived from the Technology Acceptance Model

(TAM). TAM is a generic model to measure acceptance according to actual system usage [16]. It utilizes perceived usefulness and perceived ease of use as main factors to measure acceptance [16]. The proposed model in this paper consider positive, negativity, and perceived ease of use. The suggested model is specific to measure adaptability towards E-learning. The authors decided to call it PUNM model. This paper used the results of applying data processing techniques as input variables to the proposed model in order to measure the adaptability level of Iraqi students towards E-learning during covid-19 pandemic.

2.2 Data mining techniques

Data processing is one of the most valuable and useful tools used in computer science applications [17]. It utilizes large volumes of data in order to extract useful knowledge and hidden patterns [18]. It uses large amount of data that stored in databases, datacenters, and other data storage techniques [18].

Data processing can be employed in various fields such as machine learning, artificial intelligence, database technology, image and signal processing, high-performance computing, and data visualization [18]. Data processing phase is applied to clean and organize the dataset by correcting syntax errors, manipulation of missing values, and removal of outliers [17]. Finally, the clean and structured dataset can be analyzed and explored to identify relationships between target variables.

The data analysis and exploration phase was applied to the collected data in order to get deep insight about the knowledge hidden in the dataset. Furthermore, it helps to discover patterns that can help to understand student's orientation towards E-learning as first time experience. In addition, the results of this phase is used to measure the adaptability level of Iraqi students towards the new learning environment and the new experience of E-learning in Iraq.

Data collection and pre-processing. The data processing approach in this research is based on data which collected from university students who attend universities in Basra city. The target was undergraduate students because they represent the large sample of students who exposed to the new technology of E-learning. The data collected using Google form populated with some questions that represents the data needed to be collected.

The collected data includes student's preferred learning style (LS) whether it is E-learning, traditional, or blended style. It also includes the desired learning platform (LP), the preferred interactive learning platform(IP), the advantages of E-learning, the disadvantage of E-learning, the desired lectures style (Lec.S) which could be interactive lecture, recorded lecture with PPT slides, or PPT slides only. In addition, the collected attributes included the evaluation level of E-learning experience from student's point of view (EE), the digital device used by students for E-learning (DD), and the enjoyment level. The total response received was 928 records.

Table 1 represents sample of data collected for this study. It shows the main factors used in this study besides other attributes collected as additional attributes which can be used in further studies about the evolving of E-learning in Iraq. The values of the data in Table 1 are abbreviated and they are explained in details in the results section.

For instance, LC refers to low cost, PI indicates poor interaction, and IL represents interactive lecture.

Table 1. Sample of the collected data

Positivity	Negativity	Lectures	Evaluation	Device	Enjoyment
LC	UGD	PPT + RVL	Average	Smart Phone	Yes
OPE	PI	IL	Poor	Smart Phone	No
OPE	UGD	IL	Average	Smart Phone	Yes
ALR	PI	IL	Average	Smart Phone	No
ALR	RISE	PPT + RVL	Poor	Smart Phone	No
TVF	LCW	PPT + RVL	Average	Desktop	Yes

Data preprocessing and cleaning phase has been applied and considered during the design and implementation of the response collection form. The questions in the survey form were all designed as MC questions in order to avoid any noisy data such as missing values, syntax errors, and empty values. Therefore, time and efforts for data cleaning was saved proactively and embedded efficiently in data collecting phase. Figure 1 shows a proof of the cleanness of the data. It represents student’s preference in terms of lecture style. The lecture style has three modes which include MS Power Point slides only, interactive lecture style, and MS Power Point slides plus previously recorded video lecture. The majority of Iraqi students desire the lectures to be posted on E-learning platform as recorded video lecture supported by MS Power Point slides as study material.

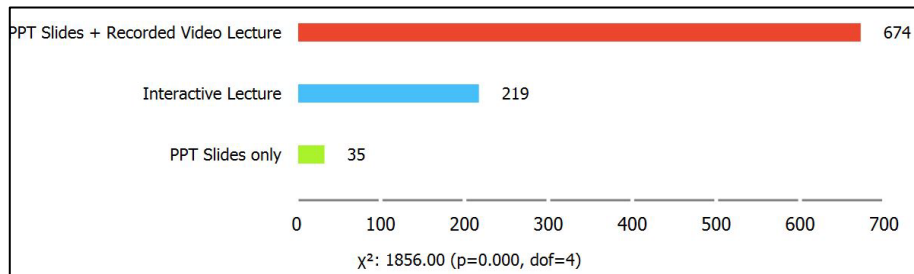


Fig. 1. Proof of clean data – lecture style data

The preference of Iraqi students regarding the learning system settings is displayed in Figure 2. The learning system factor involved three modes of the education system. The first mode is the regular learning which refer to the traditional learning system based on attending lectures in the regular classroom at university. The second mode is E-learning mode which is the new mode that was applied and implemented during COVID-19 spread period. The E-learning mode represents the remote learning system which is utilize distance communications based on the internet and Information Technology applications. Blended learning is the third facotor which represents a mixture between E-learning and regular learning systems. Some of the courses in

blended learning are taught in the regular classroom while other ones are taught using E-learning applications and platforms.

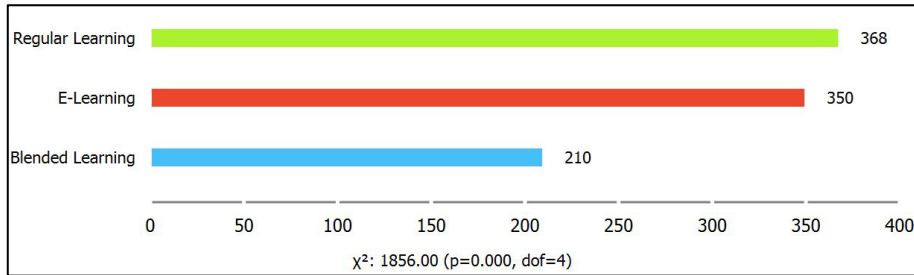


Fig. 2. Data of learning system preferences

In addition, the digital device used by Iraqi students as main communication tool for E-learning is represented in Figure 3. It is important to understand and record which device is used by students in order to determine the capabilities and tools available for students to perform E-learning tasks and activities. Knowing the digital device utilized by students also useful to understand the limitations and challenges faced during E-learning experience. The majority of students used their own smart phones to attend online lectures, submitting assignments, and sitting online quizzes and exams.

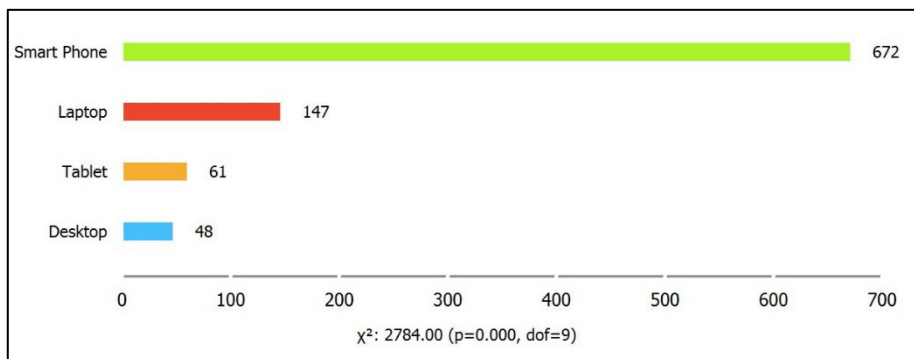


Fig. 3. Data of digital devices

Data analysis and exploration. In terms of learning environment and based on the first phase of data exploration and visualization, we found about 39% of students prefer the traditional (regular classroom) learning style, about 37% of students prefer the E-learning style, and about 22% prefer the blended learning style which is a mix of regular and E-learning learning environment. In terms of learning platform, around 99% of students' favor is Google Classroom. In addition, about 88% of students selected Google Meet, about 5% of students selected Zoom, about 5% of students picked FCC, and around 1% choose Microsoft team as their desired interactive lecture presenting platform.

In terms of positivity and negativity of E-learning based on Iraqi student's opinion, about 47% of students were positive about the availability of recorded lecture anywhere and anytime. Moreover, about 23% of students were positive about the low cost of E-learning, around 16% of students were optimistic regarding the flexibility of time and place of lectures provided by E-learning. Positively, around 13% of them desired the open book exams which became available for them as first experience because of applying E-learning.

On the other hand, around 27% of students choose the lengthy computer based work as one of the disadvantages of E-learning, and its health consequences which affect them. Negatively, about 22% of them selected the poor practical experiment as another disadvantage. Moreover, around 22% of students choose the unfair distribution of grades due to online resources based plagiarism, and around 9% of them were negative about the availability of ready solutions for exams over the internet. The poor interaction between students and teachers resulted by E-learning was among the disadvantages of E-learning and was selected by 17% of Iraqi students.

Moreover, the Iraqi students use different types of electronic devices to perform E-learning activities. About 72% of the Iraqi students use smart phones as electronic medium to attend lectures and study E-learning materials. They use smart phones as the main device for all E-learning activities including homework submissions and exam attendance. And 16% of them use laptops which is more flexible and effective. In addition, 7% of them use tablets as their E-learning device, and 5% of them use desktop computers.

Furthermore, students' evaluation of the E-learning experience was distributed at poor, average, and excellent learning environment. Around 46% of them evaluated E-learning as average learning environment, 34% of them thought of E-learning as poor learning approach, and 20% of them ranked it as excellent learning environment. On the other hand, 53% of them enjoyed the new experience of E-learning in Iraq, while the remaining 47% though it is not joy able as the traditional learning environment.

Data exploration is the phase where data is deeply investigated in order to make it more understandable. The structure of data and relationship among various variables become very clear and discoverable during this phase. The organization and distribution of values and characteristics of the data become more noticeable and obvious during data exploration [17].

This paper utilizes Sieve diagram to explore the dataset. Sieve Diagram is graphical representation of frequencies in contiguous table [19]. It utilizes frequencies to outline the links between categorical variables [19]. In addition, it uses color to represent positive and negative deviation from independence. The Red color means negative deviation while the Blue means positive deviation from independence. The results obtained is described in the results section.

Moreover, Mosaic diagram is used to confirm the results obtained using Sieve diagram calculations. Mosaic diagram is a graphical display which is used to display data from two or more variables to help recognize relationships between them [23]. Mosaic plot under Orange visual programming environment was utilized to achieve the required measurements in this study.

2.3 Measurement of adaptability level

In this study, suggested a novel model for estimating E-learning adaptability level. The proposed model is based on the Technology Acceptance Model (TAM) idea with some modifications due to the limitations faced by E-learning in Iraq. The suggested model is specified only to measure student's adaptability towards E-learning. It focuses on four major factors that affect students' behavior towards E-learning.

These factors include student's evaluation of E-learning as new learning environment. The evaluation factor is rated according to poor, average, and excellent. The evaluation factor measures students' interaction and engagement with E-learning under the special circumstance of low quality internet and power services. The second factor is student's enjoyment level which helps to understand student's benefit and comfort level. When students benefit from a system and feel comfortable about it then they must enjoy it.

The third factor of this model is positivity which is derived from four sub-factors that measure the level of confidence and eagerness of students towards E-learning. Positivity reveals people's favorable judgement of reality [20]. In addition, it reflects peoples' satisfaction in regard to experience or an event [20]. The sub factors of positivity include low cost, open books exam, availability of recorded lectures, and time and venue flexibility.

The fourth factor is Negativity which measures students' uncertainty and disapproval of E-learning. Negativity is measured depending on five sub-factors. These sub-factors include poor interaction, unfair grade distribution, lengthy computer work, availability of ready solutions for exams, and poor practical experiment. Negativity is important factor to include in the suggested model because it reflects people's disagreement towards specific experience or system.

The suggested approach to measure adaptability in this paper is based on the total of positivity gain. The reason behind utilizing positivity as the main factor to measure adaptability level of Iraqi students toward E-learning is that positivity has significant impact on student's adaptation to school life [21]. In addition, empirical studies and researches showed that adaptation is rapid and surely complete in response to positive experiences [22].

Therefore, this paper suggests that E-learning adaptability level is measured based on positivity total gain. Positivity and negativity total gain is calculated based on the results of calculating positive and negative effects by employing both Mosaic and Sieve diagrams. Sieve diagram exploration helps to differentiate positive and negative deviations. Mosaic diagram is used to identify the relationships between variables and show the positive responses. Moreover, the standardized Pearson residual (SPR) is used as measurement of positive effects and negative effects based on its value. The value of SPR is used to determine the impact of each factor in terms of positivity or negativity. SPR positive value means the actual value was more than the expected one which indicates positive impact. SPR negative value means the actual value was less than the expected one which indicate negativity. SPR is the difference between the observed response count and the actual response count [24] [25].

Figure 4 shows the proposed model, and its component which represents the main factors used to estimate E-learning adaptation level. It also shows the sub factors of each main factor and the relationships between them. The perceived usefulness of E-learning is estimated based on both students' evaluation and enjoyment of the system. In addition, each of low cost, open book exams, time and venue flexibility, and the availability of recorded lectures represents the positive sub factors. Moreover, negativity sub factors were derived from the negative feedbacks about E-learning in Iraq. It included unfair grade distribution, poor interaction between students and teachers, poor hand on practical experiments, lengthy computer work, and the availability of ready solution on the internet.

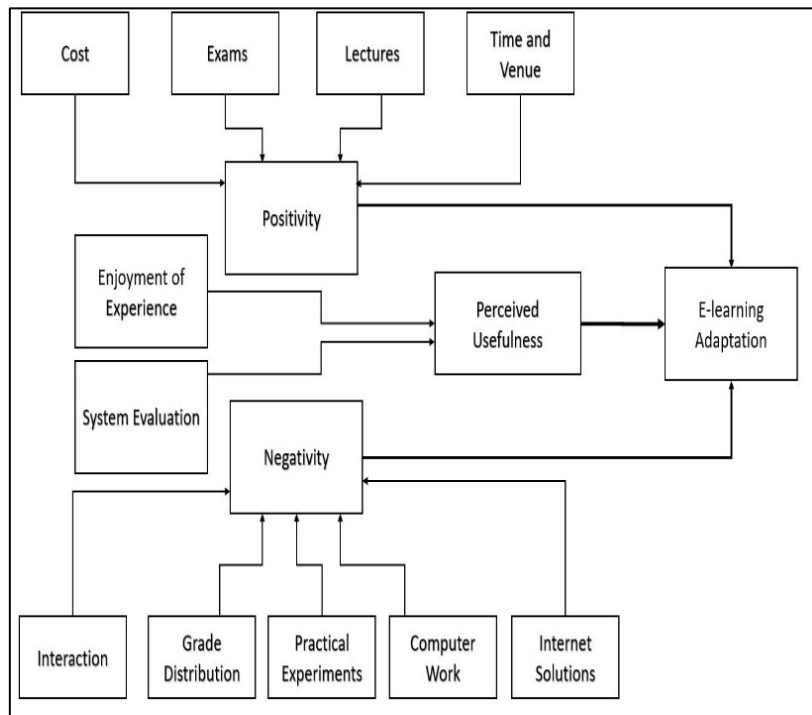


Fig. 4. The proposed model – PUNM

3 Results and discussion

The results reached in this paper is based on calculation of positivity effect of E-learning by using Mosaic and Sieve diagrams in order to perform data exploration of the dataset. In addition, the standardized Pearson residual is used to validate the positive and negative impact of each factor. There were 34% negative feedback in regard to E-learning evaluation, 20% average, and 46% excellent evaluation responses. Therefore, the total positive feedback of evaluation responses is 66%. The enjoyment of E-learning was implemented as 53% positive responses and 47% negative response. Hence, the

total positive impact from enjoyment factor was 53%. For the positivity factors and based on the data exploration process, 16% of positive effect of time and venue of lectures factor (TVF), and 47% of positive feedback of the availability of recorded lectures factor (ARL). The other two factors which are the open book exams (OPE) and low cost (LC) were reported as negative factors according to Sieve Diagram and SPR. calculations. Thereupon, the total positive effect of positivity factors was 63%.

In terms of the negativity factor, the only positive effect on E-learning adaptation was lengthy computer work (LCW) with 24% effect ratio. The adaptation level is estimated based on averaging the total effect of the four main factors and the result was approximately 52%. The achieved result is very close and accurate to the actual situation in real life. The following tables and Figures illustrates the achieved results.

The enjoyment factor exploration in regard to positive and negative impact is showed in Figure 5 which represents the results of Sieve diagram. The positive impact is represented in Blue with 53% level and 47% of negative impact which is represented in Red.

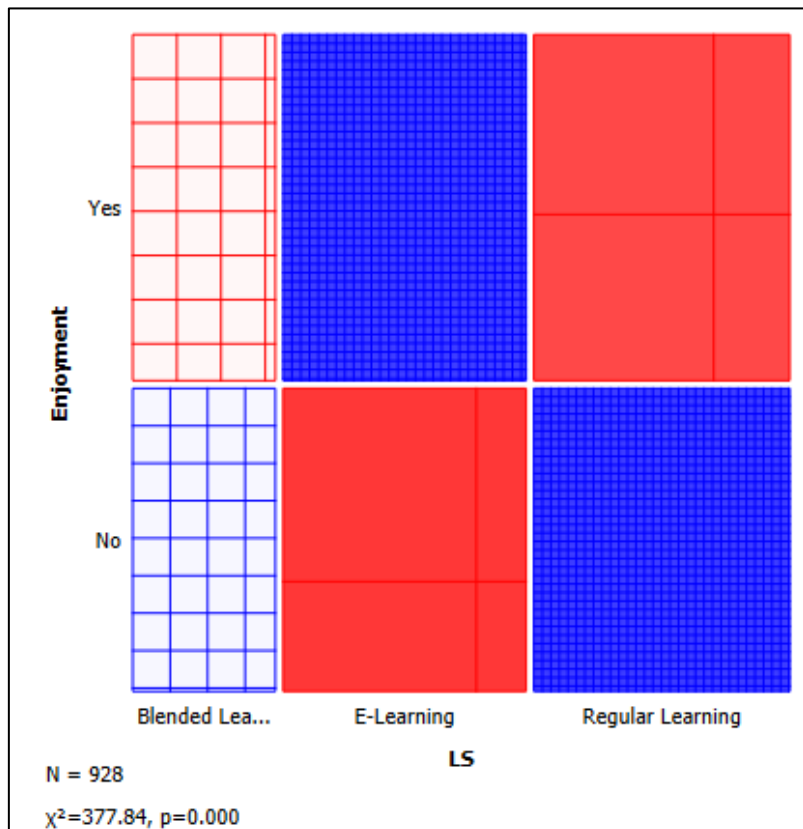


Fig. 5. Positive and negative impact of the enjoyment factor

In addition, Sieve diagram for the evaluation factor is showed in Figure 6. The positive effect in terms of evaluation factor is represented in Blue, and it represents both the excellent and average evaluation. The level of positivity in terms of evaluation factor is 66% while the Red which represents the negative effect of evaluation factor is 44%.

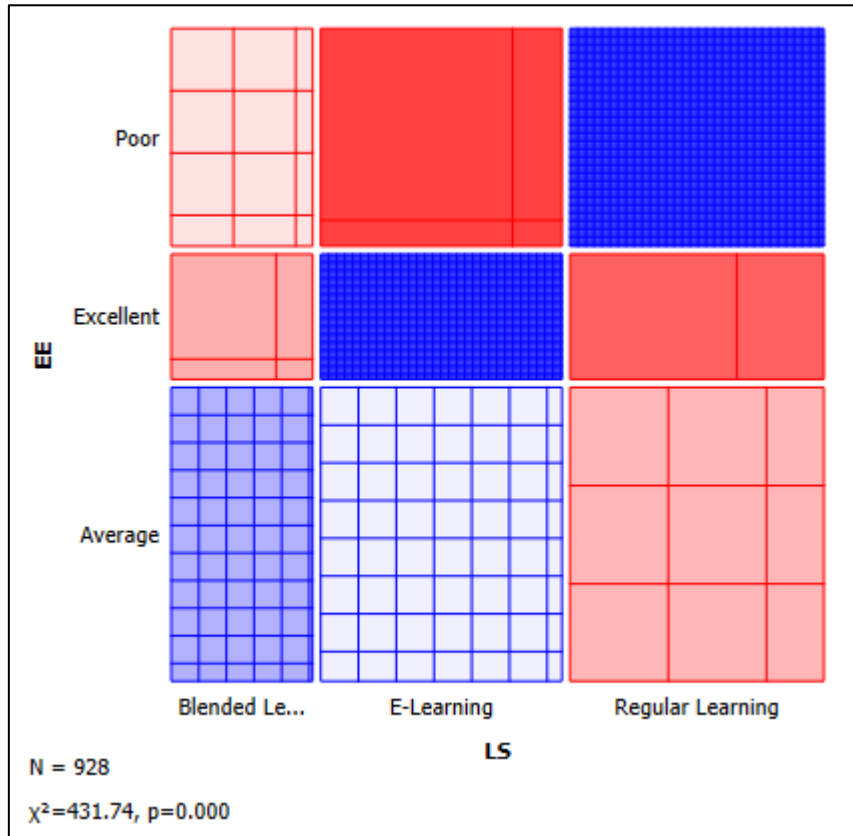


Fig. 6. Positive and negative impact of the evaluation factor

Moreover, the positive and negative outcome for the negativity sub factors are showed in Figure 7. It was negative outcome for the unfair grade distribution (UGD), ready internet exam solutions for exam (RISE), poor practical experiments (PPE), and poor interaction (PI) sub factors. While positive outcome is achieved for the lengthy computer based work (LCW) with 24% positive level.

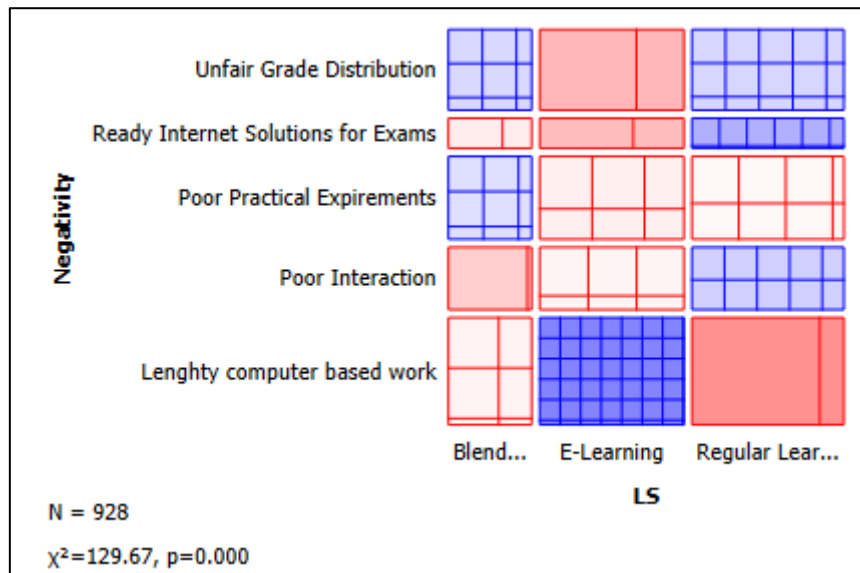


Fig. 7. Positive and negative impact of the negativity factors

The positivity factors and their related positive and negative results are showed in Figure 8. The sub factors of time and venue flexibility (TVF) and availability of recorded lectures (ARL) recorded positive impact of 63%. On the other hand, the sub factors of open book exams (OPE) and low cost (LC) achieved negative impact of 47%.

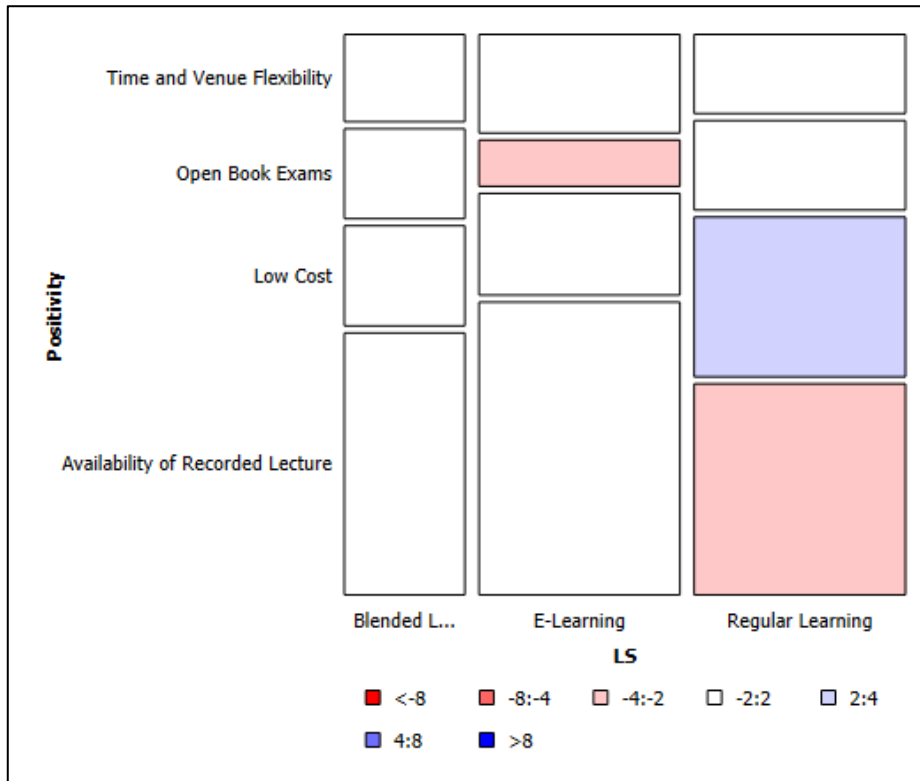


Fig. 8. Positive and negative impact of the positivity factors

Furthermore, the Mosaic diagram is used to validate the relationship between the factors presented in the proposed model PUNM. In addition, it is used to compute the standardized Pearson residual (SPR) in order to confirm the positive and negative effect of each sub-factor. Figure 9 represent the Mosaic diagram for the enjoyment factor with SPR value of 9.6.

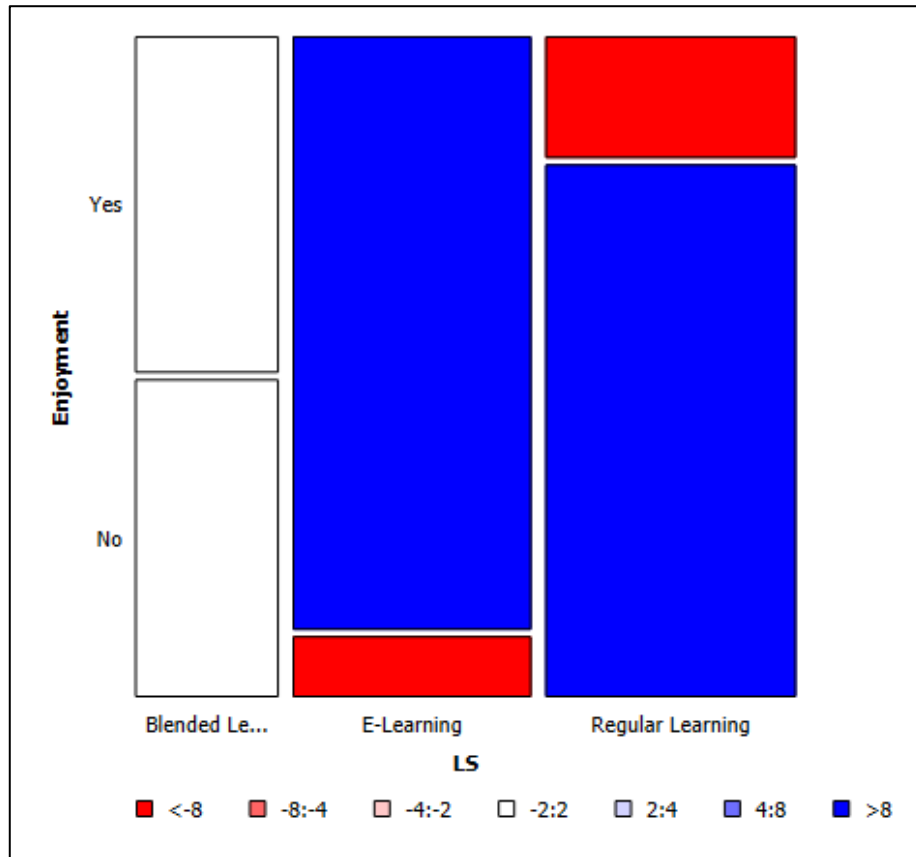


Fig. 9. SPR of the enjoyment factor

The Mosaic diagram for the evaluation factor is showed in Figure 10. The SPR value for the evaluation of E-learning is 11.9. It reflects excellent and average evaluation feedback of E-learning.

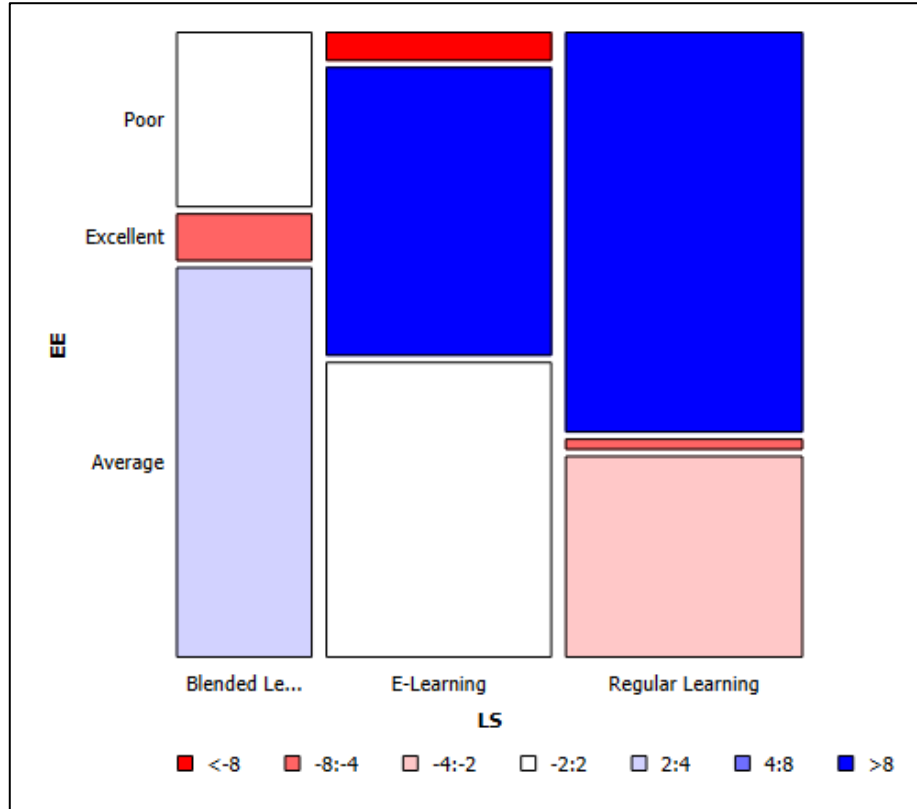


Fig. 10. SPR of the evaluation factor

The positivity and negativity impact of the negativity sub factors is validated using the Mosaic diagram in Figure 11. The UGD sub factor achieved SPR value of -3.5, the RISE recorded SPR value of -3.3, the value of SPR for the PPE was -0.8, the PI achieved SPR value of -0.5, and the SPR value of LCW sub factor was positive and equal to 6.1.

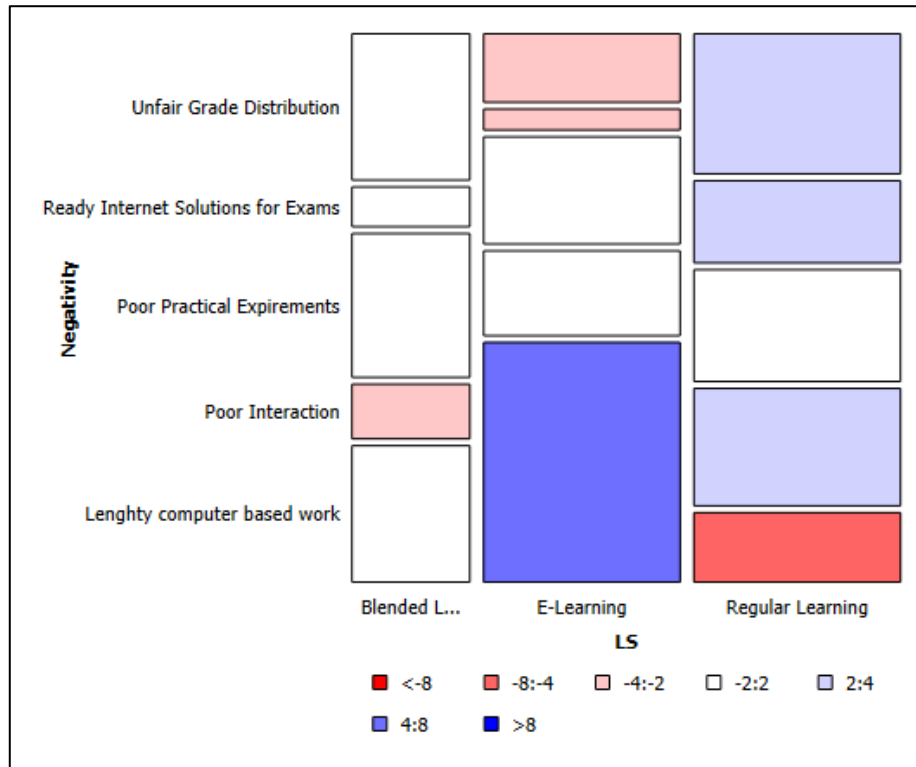


Fig. 11. SPR of the negativity

The Mosaic diagram showed in Figure 12 is for the positivity sub factors. Both ARL and TVF sub factors recorded positive SPR value of 2.0 and 0.9 respectively. While, the LC and OPE sub factors achieved negative SPR value of -1.6 and -2.5 respectively.

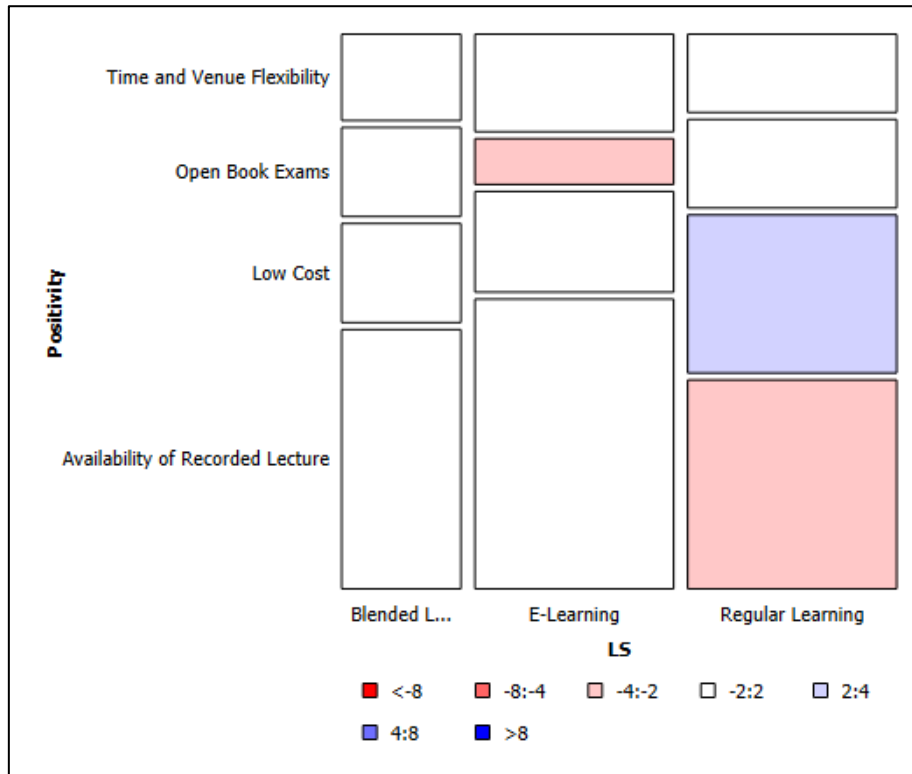


Fig. 12. SPR of the positivity factors

The values of SPR of each sub factor is combined in Table 2 to clearly recognize and distinguish the positive effect for each sub factor in order to calculate the overall positive impact contribution to find out the level of adaptation.

Table 2. SPR value for each factor

Variable	Factor	SPR
Positivity	LC	-1.6
	ARL	2.0
	OPE	-2.5
	TVF	0.9
Usefulness of Use	Enjoyment	9.6
	Evaluation	11.9
Negativity	UGD	-3.5
	RISE	-3.3
	PPE	-0.8
	PI	-0.5
	LCW	6.1

Table 3 and Table 4 represent the percentage of contribution of each sub factor of the proposed model PUNM. The percentage is calculated based on the results of responses received and analyzed using data processing techniques described earlier. The distribution of the positive and negative impact of each sub factor in Table 3 and Table 4 is based on the results obtained using data exploration by employing Sieve and Mosaic diagrams alongside with SPR values.

Table 3. Adaptaiton and Inadequacey level for each fator

	Evaluation	Enjoyment	Positivty	Negativity	Level Gain
Adaptability Level	66%	53%	63%	24%	51.5 %
Inadequace Level	34%	47%	63%	76%	48.5%

Table 4. E-learning Adaptation level

E-Learning Evaluation (EE)					
<i>Poor</i>	<i>Average</i>	<i>Excellent</i>		<i>E-learning Gain</i>	
34%	20%	46%		66%	
E-learning Enjoyment					
<i>Yes</i>		<i>No</i>		<i>E-learning Gain</i>	
53%		47%		53%	
Positivity Factors					
<i>TVF</i>	<i>OPE</i>	<i>LC</i>	<i>ARL</i>	<i>E-learning Gain</i>	
16%	14%	23%	47%	47%	
Negativity Factors					
<i>UGD</i>	<i>RISE</i>	<i>PPE</i>	<i>PI</i>	<i>LCW</i>	<i>E-learning Gain</i>
22%	9%	23%	17%	24%	24%

As a result, the final results achieved are shown in Table 4. It shows that the adaptation level of Iraqi students towards E-learning during COVID-19 pandemic and based on the proposed model PUNM is almost 52%.

4 Conclusion

E-learning is the alternative learning and teaching system utilized by the Iraqi academic institutes to face the sudden and wide spread of COVID-19. It helped to reduce and mitigate the number of infections among students and staff during the past two academic years. In Iraq, the application of E-learning faced many challenges and limitations which made the service provided of average quality. There is the issue of electricity cutoff which sometimes happens during online exams or during interactive lectures. In addition, the poor IT infrastructure and low quality of internet services provided in the country caused E-learning to be affected negatively. Furthermore, the weak

technological background for most of the staff and students was another factor to co-exist along the application of E-learning process in Iraq.

Therefore, there is important and critical need to understand the current actual level of Iraqi students' adaptation to the new education system (E-learning). A system that requires availability of electricity, high quality internet services, and good background in IT techniques and tools. Knowing the actual level of students' adaptation helps to identify weak points of the applied system in order to find permanent solutions and improve the overall experience of E-learning. A powerful E-learning system means high quality academic throughput and achievements.

This study helped to find out very approximate accurate results of the adaptation level of students after using and experience E-learning for two academic years in Iraq. The authors proposed new model to measure adaptability level. The new model is based on the general model used to measure technology acceptance (TAM). The suggested model is more specific to measure adaptability of students towards E-learning. Therefore, it is E-learning specific model. The proposed model is called PUNM because it depends on three factors when measuring adaptability. The three main factors of the new proposed model are Positivity, Usefulness, and Negativity.

The proposed model utilizes the applications of data processing techniques on sample dataset to measure adaptability. The target were colleges' and universities' students who are based in Basra city as sample dataset. The dataset size consisted of 928 record represents data collected based on students' feelings and opinions. The data included students' evaluation of E-learning, enjoyment, digital device used, positivity factors affected students, negativity factors, preferred classroom platform, and favorited interactive lecture platform. The dataset is analyzed and processed using Sieve and Mosaic diagrams in Orange visual programming environment which is used to calculate positivity versus negativity associated with each factor. Finally, the results obtained from data exploration is fed to the new proposed model to calculate the adaptability level. The output of the PUNM model showed that the current level of adaptation towards E-learning in Iraq is nearly 52% based on students' feedbacks. The results and the other data collected in this research can help to launch other researches which specify weak points that can be rectified to improve the adaptation level and enhance the overall experience of E-learning in Iraq.

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