
Utilizing the Quantile Regression to Explore the Determinants on the Application of E-Learning

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In this research, the quantile regression is applied to investigate the affecting factors associated with the application of e-learning. The findings provide a comprehensive picture about the relationships between the application of e-learning and its determinants. It sheds light on these complicated relationships that, at the different quantiles of the conditional distribution of e-learning adopting levels, the influence of the determinants on the application of e-learning is different. Moreover, this research also offers statistical evidence on the moderating role of students' gender on the relationships between the application of e-learning and its determinants. The findings are useful to educational managers by offering them with a better understanding of the complex links associated with the application of e-learning. As a result, they can deliver better decisions on the choice and adoption of e-learning in their institutions.

Keywords: *Quantile regression, E-learning, Moderating role of gender*

Introduction

Educational organizations have recently taken interest in e-learning for their training and educational programs. The application of e-learning in the training process is deemed to bring benefits to teachers as well as to students due to its importance in facilitating the learning and teaching

procedures. However, the application of e-learning is dependent on several factors and conditions. Prior researchers have suggested that the application of e-learning is explained by the attitude toward using e-learning, the perception on the usefulness of e-learning, the perceived ease of use in e-learning, the internet experiences as well as the self-efficacy ([1]; [10]). Nevertheless, they examine the associations mainly based on the generalized linear model (GLM), which estimates the affecting factors on the conditional mean of applying e-learning. While estimating how 'on average' the factors affect the application of e-learning yields straightforward interpretations, this standard technique may ignore the different affecting levels at different points of the conditional distribution of e-learning adopting levels. It is necessary to investigate the relationships among the application of e-learning and its determinants with the quantile regression analysis, which analyzes different affecting levels at different points of the conditional distribution.

Moreover, Okazaki and Santos [10] highlight that the gender of students using e-learning plays a moderating role in the links related to the application of e-learning, but they only statistically investigate the moderating role of users' gender in the relationships among the attitude toward using e-learning, the perception on the usefulness of e-learning, the perceived ease of use in e-learning and the application of e-learning. They do not statistically examine the moderating role of users' gender in the associations among the internet experiences, the self-efficacy and the application of e-learning. The moderating role of the gender can affect and change the relationships associated with the application of e-learning; hence, this research seeks to extend the study of [10] by introducing two other factors, which are the internet experiences and the self-efficacy, into the research model and examine the moderating role of gender in the relationships between them and the application of e-learning.

Overall, this research attempts to examine the effect of the determinants on the application of e-learning in students with the quantile regression analysis. Additionally, it employs the hierarchical regression analysis to analyze the moderating role of the students' gender in the connections between the application of e-learning and its determinants. This research will be structured as follows. Next, the theoretical framework will review the related literature and build the hypotheses being tested. Subsequently, the research methodology is used to guide the data collection

and facilitate the data analyses, followed by the empirical results, which provides the empirical findings. The final section will offer some conclusions.

Theoretical Framework

The application of e-learning in students has been suggested as the consequence of the attitude toward using e-learning, the perception on the usefulness of e-learning, the perceived ease of use in e-learning, the internet experiences and the self-efficacy. Abbad et al. [1] propose that the internet experiences and the self-efficacy are the determinants of applying e-learning; whereas Okazaki and Santos [10] emphasize that the attitude toward using e-learning, the perception on the usefulness of e-learning and the perceived ease of use in e-learning are the causation of e-learning application in students. The effect of each factor on the application of e-learning will be discussed in detail below.

It starts with the two variables, which are the internet experiences and the self-efficacy, introduced by [1]. For the internet experiences, they refer to it as the frequency of using the internet by a user. Prior to [1], Kerka [7] and Morss [8] provide statistical evidence on the influence of students' experience of the information technology on the use of a learning management system. Following [7] and [8], [1] point out that students with the heavier frequency of using the internet are more likely to use e-learning for their study. With the self-efficacy, Bandura [3] stresses the importance of the self-efficacy in the social learning theory and mentions it as a user's belief about their ability to perform some jobs successfully. In addition, Brown and Inouye [4] and Wood and Bandura [12] contend that users' self-efficacy put a positive influence on their decision to carry out a tool for their job. Grounded on the above arguments, Abbad et al. [1] suggest that confident students in their command of the e-learning system are likely to apply e-learning for their study. The findings reveal that students that are confident in their ability to have a good command of the e-learning system will likely become users of e-learning for their study.

The other three variables, namely the attitude toward using e-learning, the perception on the usefulness of e-learning and the perceived ease of use in e-learning are proposed by [10] as important factors leading to the application of e-learning in students. The relationship between the

attitude toward using e-learning in students and their application of e-learning is discussed in the studies of [13] and [14]. They offer empirical evidence on the positive impact of the attitude toward using e-learning on the application of e-learning. Furthermore, a study by [6] provides empirical evidence that the application of e-learning in students is determined by their attitude toward using e-learning. Next, the perceived usefulness of e-learning is also a vital driver of applying e-learning. Abbad et al. [1] in a study on e-learning ascertain that students' perception on the usefulness of e-learning will positively affect their application of e-learning. A few years later, Al-alak and Alnawas [2] and Okazaki and Santos [10] also deliver the similar suggestions on the relationship between the perception on the usefulness of e-learning and the application of e-learning in students. Another essential variable to the application of e-learning is the ease of use in e-learning perceived by students. Park [11] gives a suggestion that the ease of use in e-learning perceived by students will enhance the application of e-learning in them. In the same year, Abbad et al. [1] underline the perceived ease of use in e-learning is positively related to the application of e-learning in students for their study. They provide statistical evidence on the positive link between the perceived ease of use and the application of e-learning at the 0.005 significance level. Similarly, Al-alak and Alnawas [2] provide empirical evidence that the perceived ease of use puts a positive influence on the application of e-learning in students at the 0.01 significance level.

As above mentioned, the internet experiences, the self-efficacy, the attitude toward using e-learning, the perception on the usefulness of e-learning and the perceived ease of use in e-learning are suggested as the driving forces leading to the application of e-learning in students; consequently, the five following hypotheses linked to the application of e-learning in students can be arrived at for this research.

H1. Students who have more experience of the internet will more likely apply e-learning for their study

H2. Students who are more confident in their ability to use e-learning will more likely apply e-learning for their study

H3. Students who have positive attitude toward using e-learning will more likely apply e-learning for their study

H4. Students who have positive perception on the usefulness of e-learning will more likely apply e-learning for their study

H5. Students who have positive perception on the ease of use in e-learning will more likely apply e-learning for their study

Previous studies have discussed and justified the five following hypotheses on the determinants of applying e-learning; nevertheless, they have only investigated them mainly employing the generalized linear model (GLM) that analyzes the influencing factors on the conditional mean of applying e-learning. This project attempts to apply the quantile regression method to explore the relationships related to the application of e-learning at different influencing levels with different points of the conditional distribution of applying e-learning. In addition, although the application of e-learning in students is above posited as being determined by the internet experiences, the self-efficacy, the attitude toward using e-learning, the perception on the usefulness of e-learning as well as by the perceived ease of use in e-learning; these relationships can be moderated by the gender of students who are involved in e-learning ([10]). However, Okazaki and Santos [10] have just proposed the moderating role of the gender in the links between the attitude toward using e-learning, the perception on the usefulness of e-learning or the perceived ease of use in e-learning and the application of e-learning. This research tries to investigate the moderating role of the gender in the associations between the other variables “the internet experiences or the self-efficacy” and the application of e-learning, which has not been discussed and examined in previous research, by utilizing the hierarchical regression analyses. Nonetheless, there is a lack of previous empirical evidence on the moderating role of the gender in these two relationships; we conjecture the moderating hypotheses for the associations between the internet experiences or the self-efficacy and the application of e-learning in the null forms. Finally, we can come to the five following moderating hypotheses.

H6. The gender of a student has no moderating effect on the relationship between the application of e-learning and their internet experiences

H7. The gender of a student has no moderating effect on the relationship between the application of e-learning and their self-efficacy

H8. The gender of a student may moderate the relationship between the application of e-learning and their attitude toward using e-learning

H₉. The gender of a student may moderate the relationship between the application of e-learning and their perception on the usefulness of e-learning

H₁₀. The gender of a student may moderate the relationship between the application of e-learning and their perception on the ease of use in e-learning

After developing the hypotheses derived from the reviewed literature, we would like to explain in detail the research methodology that is employed to describe the data collection and the data analyses in the section below.

Research Methodology

The population of this research is composed of students in Vietnam National University of Ho Chi Minh. This university offers courses to about 35,000 students. We involved 1,350 students from this university in this research. Of them, 675 are female and the other 675 are male. We conducted the questionnaires with these 1,350 students; however, only 437 students offered good responses with adequate information for analyses needed for testing our suggested hypotheses.

The questionnaires are constructed based on the six main variables used in this research, which are the application of e-learning, the attitude toward using e-learning, the perception on the usefulness of e-learning, the perceived ease of use in e-learning, the internet experiences and the self-efficacy. We use a five-point scale ranging from 1.strongly disagree, 2.disagree, 3.neutral, 4.agree, and to 5.strongly agree to evaluate the items that make up these six variables. These variables are assessed as below described. First, for “Application of E-learning (APE)”, we base it on the four items that are introduced by [10]. The four questions are employed to build these four items: (APE₁) I intend to apply e-learning as much as possible for my study, (APE₂) I intend to utilize e-learning to support my study, (APE₃) I intend to utilize online instructions to support my study and (APE₄) I intend to suggest the e-learning system to other students. Next, “Attitude toward using e-learning (ATE)” is assessed on the four items that are constructed from the four questions: (ATE₁) Using e-learning is a good idea, (ATE₂) In my opinion, it would be desirable to use e-learning, (ATE₃) I would feel that using e-learning is pleasant and (ATE₄) In my view, using e-

learning is a wise intention, adapted from [6]. Then, we evaluate “Perceived usefulness of E-learning (PUE)” on the three dimensions, derived from the three questions: (PUE₁) Using e-learning improves my productivity in my study, (PUE₂) Using e-learning improves my performance in my study and (PUE₃) I find e-learning to be useful in my study, suggested by [10]. Another variable is “Perceived Ease of Use in E-learning (PEE)” that is measured on the three items: (PEE₁) Learning to use e-learning is easy for me, (PEE₂) E-learning is easy to use for me and (PEE₃) My interaction with e-learning is clear and understandable, which is modified from [10]. In regard to “Internet Experiences (ETE)”, we employ two items to measure it. These items are derived from the questions: (ETE₁) I spend a lot of hours using the internet and (ETE₂) I frequently use the internet. Subsequently, we measure “Self-Efficacy (EFE)” with three items: (EFE₁) I am confident in using the internet without any one to show me how to do it, (EFE₂) I am confident in using the internet even if I have not used such a system before and (EFE₃) I am confident in using the internet as long as someone shows me how to do it. The measurements of “Internet Experiences (ETE)” and “Self-Efficacy (EFE)” are adapted from [1]. The final variable used in this research is the gender of students (GDE). We assign it as 1 if the student is male, otherwise it as 0.

Above discussed is the explanation of measuring our six main variables. Now we would like to describe the procedures employed to analyze the data. Before testing our hypotheses, we carry out the reliability analysis to check for the scale reliability of the data. After ensuring our data is good enough for analyses, we apply the quantile regression analysis to explore the influence of the determinants on the application of e-learning. Then the hierarchical regression analysis is used to test the moderating role of students’ gender in the causal relationships between the determinants and the application of e-learning in students. The above statistical techniques are used to analyze the data and offer the following results.

Practical Results

First of all, we perform the reliability analysis to test the scale reliability of the data. We involve seven main variables in this research. However, the variable “the gender of students” is made up from one single item; hence, it is no need for this variable to be analyzed with the reliability analysis to assess the internal reliability of items. The other six variables that consist of

more than one item are entered in the reliability analysis. The results are shown in Table 1. The findings show that nineteen items, which make up the six variables, achieve their item-total correlations of greater than 0.5, the acceptable level suggested by [9]. In addition, all the Cronbach's alphas pass 0.7 as the suggested limit by [5]. These findings indicate that the scales satisfy the internal reliability. Therefore, we can ensure that our data has the sufficiently reliable scales.

Table 1: Reliability Analysis

Factor	Item	Item-total correlation	Cronbach's Alpha	N of Items
ATE	ATE ₁	.654	.793	4
	ATE ₂	.605		
	ATE ₃	.589		
	ATE ₄	.581		
PUE	PUE ₁	.764	.869	3
	PUE ₂	.793		
	PUE ₃	.700		
PEE	PEE ₁	.645	.814	3
	PEE ₂	.702		
	PEE ₃	.648		
ETE	ETE ₁	.553	.707	2
	ETE ₂	.553		
EFE	EFE ₁	.708	.827	3
	EFE ₂	.706		
	EFE ₃	.650		
APE	APE ₁	.743	.881	4
	APE ₂	.787		
	APE ₃	.757		
	APE ₄	.700		

Before doing further analyses, we compute the composite variables by taking an average of their own items (ATE₁, ATE₂, ATE₃ and ATE₄ → ATE; PUE₁, PUE₂ and PUE₃ → PUE; PEE₁, PEE₂ and PEE₃ → PEE; ETE₁ and ETE₂ → ETE; EFE₁, EFE₂ and EFE₃ → EFE; APE₁, APE₂, APE₃ and APE₄ → APE). These composite variables are used for next analyses. Prior studies have examined the determinants of e-learning application, mainly relying on the generalized linear model (GLM), which estimates the effect of the determinants on the conditional mean of e-learning application. While

estimating how ‘on average’ the factors influence the application of e-learning in students produces straightforward explanations, this standard method may ignore the different affecting levels at different points of the conditional distribution of e-learning application. We investigate the relationships among the application of e-learning and its determinants by employing the quantile regression. This method analyzes different affecting levels at different points of the conditional distribution, in comparison with the OLS regression. The quantile regression analyses as well as the OLS regression analysis yield the results in Table 2.

Table 2: Results Of Ols And Quantile Regressions With Ape As The Dependent Variable

Independent Variable	OLS	Quantiles						
		0.05	0.10	0.25	0.50	0.75	0.90	0.95
ATE	.0849**	.1103	.0808	.0588	.0854*	.0787***	.0000	.0000
PUE	.5513***	.7239***	.8017***	.6146***	.5025***	.4399***	.0000	.0000
PEE	.1063***	.2394*	.1644***	.1141***	.1394***	.1079***	.0000	.0000
ETE	.0793***	.1374	.0937*	.0517	.0921***	.0359	.0000	.0000
EFE	.1134***	.0725	.0670	.1978**	.1256**	.0758**	.0000	.0000
(Pseudo) R ²	.5416	.3328	.3810	.3832	.3714	.1108	-	-

The results from Table 2 demonstrate that some important differences across different points in the conditional distribution of changes in the application of e-learning. With respect to the OLS regression, the findings show that all the five independent variables positively affect the application of e-learning at the statistical significance levels of 0.05 or 0.01. These results are similar to those from the quantile regression analysis at the 0.50 quantile, in which all the five determinants also put a positive influence on the application of e-learning at the statistical significance levels of 0.1, 0.05 or 0.01. These findings also offer statistical evidence to support our hypotheses H₁, H₂, H₃, H₄ and H₅, which state that students, who have more experience of the internet, positive attitude toward using e-learning, positive perception on the usefulness of e-learning and on the ease of use in e-learning as well as are more confident in their ability to use e-learning, have more tendency towards applying e-learning for their study. Our results are consistent with previous research. However, we have extension to

employ the quantile regression procedure to investigate the relationships related to the application of e-learning at different affecting levels with different points of the conditional distribution of applying e-learning. The quantile regression results show differences across different points in the conditional distribution of applying e-learning in students. At the higher side of the conditional distribution of applying e-learning, particularly at the 0.90 and 0.95 quantiles, all the five determinants have no effect on the probability to the application of e-learning. In contrast, at the lower levels of the conditional distribution of applying e-learning, almost all the driving factors put statistical effect on the application of e-learning. The perception on the usefulness of e-learning is shown as the causation of applying e-learning at the 0.05, 0.10, 0.25, 0.50 and 0.75 quantiles at the 0.01 significance level.

The results are similar for the affecting variable “the perceived ease of use in e-learning” at the 0.10, 0.25, 0.50 and 0.75 quantiles, but there is a difference at the lowest level of the conditional distribution of applying e-learning- the 0.05 quantile, in which the perceived ease of use in e-learning only imposes a statistical impact on the application of e-learning at the 0.1 significance level. In addition, the internet experience puts a statistical effect on the application of e-learning at some levels at the low side (less than 0.50 quantiles) of the conditional distribution of applying e-learning, just at the 0.50 and 0.10 quantiles of the conditional distribution. The statistical significance achieves 0.01 at the 0.50 quantile, but it obtains 0.1 at the 0.10 quantile. On the other hand, the attitude toward using e-learning only statistically affects the application of e-learning at the high side of the conditional distribution of applying e-learning, which achieves the significance levels of 0.1 and 0.01 at the 0.50 and 0.75 quantiles, respectively. Meantime, the self-efficacy places a statistical influence on the application of e-learning at the quantiles of around 0.50 (particularly at the 0.25, 0.50 and 0.75 quantiles) at the 0.05 significance level. Overall, at different quantiles of the conditional distribution of applying e-learning, the determinants explain the application of e-learning at different extents. The findings from the quantile regression technique offer a clearer picture about the link between the application of e-learning and its determinants, compared to those from the OLS regression method.

Table 3: Hierarchical Regression Results For Moderating Relationships

Dependent Variable	Independent Variable	Coefficients	Std. Error	t	Sig.
APE	ATE	.313	.048	6.563	.000
	ATE	.168	.049	3.437	.001
	GDE*ATE	.149	.020	7.447	.000
	PUE	.705	.036	19.565	.000
	PUE	.639	.042	15.119	.000
	GDE*PUE	.042	.014	2.934	.004
	PEE	.397	.038	10.420	.000
	PEE	.271	.042	6.443	.000
	GDE*PEE	.112	.018	6.117	.000
	ETE	.245	.036	6.745	.000
	ETE	.095	.041	2.291	.022
	GDE*ETE	.151	.023	6.653	.000
	EFE	.481	.037	13.103	.000
	EFE	.383	.041	9.359	.000
	GDE*EFE	.077	.016	4.918	.000

As above arguments, the gender of students can moderate the driving forces and the application of e-learning in students. The hierarchical regression method is utilized to examine the moderating effects. The interactions between the gender of students and the driving forces of e-learning application are created by multiplying the gender of students with the driving forces to complete the hierarchical regression. The results are displayed in Table 3. The interactions GDE*ATE, GDE*PUE, GDE*PEE, GDE*ETE and GDE*EFE all put a positive influence on the application of e-learning at the 0.01 significance level. Hence, we can conclude that the gender of students is statistically supported as a moderation in the links between the application of e-learning and its drivers. In addition to the evidence on the moderating role of students' gender in the relationships

between the attitude toward using e-learning, the perception on the usefulness of e-learning, the perceived ease of use in e-learning and the application of e-learning, which is consistent with those in the research by [10], this research also offers statistical evidence on the moderating effect of students' gender in the associations between the internet experiences, the self-efficacy and the application of e-learning. These findings statistically support our moderating hypotheses H8, H9 and H10, but they do not statistically support our null hypotheses H6 and H7. In short, the findings on the moderating role of students' gender in the relationship related to the application of e-learning indicate that the gender of students plays an important moderating role in the application of e-learning, in that the relationships between the application of e-learning and its determinants are stronger for male student than for female students.

Conclusions

Prior papers have examined the determinants of applying e-learning in students. However, they explored the relationships mainly relying on the generalized linear model (GLM), which estimates the effect of the determinants on the conditional mean of e-learning application. In addition, the gender of students is considered as an essential factor, which plays a moderating role in the relationships between the application of e-learning and its determinants. This research attempts to investigate the relationships between the application of e-learning and its determinants with the quantile regression, which analyzes different affecting levels at different points of the conditional distribution. Then, this research employs the hierarchical regression analysis to investigate the moderating role of students' gender in the associations between the application of e-learning and its determinants.

The findings reveal that on the conditional mean of the dependent variable "the application of e-learning" with the OLS regression or with the quantile regression, students, who have more experience of the internet, positive attitude toward using e-learning, positive perception on the usefulness of e-learning and on the ease of use in e-learning as well as are more confident in their ability to use e-learning, have more tendency towards applying e-learning for their study. However, at different quantiles of the conditional distribution of e-learning application, the effects of determinants on the application of e-learning are different. At the quantiles

around 0.50 (the 0.25, 0.50 and 0.75 quantiles) all the five determinants positively affect the application of e-learning. On the other hand, at the higher quantiles (the 0.90 and 0.95 quantiles) no determinants are statistically supported to have effect on the application of e-learning. At the lower quantiles (the 0.05 and 0.10 quantiles), only the perception on the usefulness of e-learning, the perceived ease of use in e-learning, the internet experience put statistical influence on the application of e-learning; whereas the attitude toward using e-learning and the self-efficacy have no effect on the application of e-learning. This research also offers statistical evidence on the moderating role of students' role in the links between the application of e-learning and its determinants. The links between the application of e-learning and its determinants are stronger for male student than for female students. This research makes some contributions. It is the first one to utilize the quantile regression to investigate the relationships between the application of e-learning and its determinants and provide a clearer and more exact picture about these relationships. Furthermore it is also the first to offer statistical evidence on the moderating role of students' gender in the linkages between the internet experiences, the self-efficacy and the application of e-learning. These findings offer educational managers with a better understanding of the complex relationships between the application of e-learning and its determinants. Hence, they can make better decisions on the application of e-learning for their educational programs.

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