

# The Effect of Confounding Variables on Cloud Computing Adoption and Usage

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**KEYWORDS** Computer Use. Learners' Demographics. Internet Experience. Learners' Intention. Internet Self-efficacy

**ABSTRACT** This paper aimed to determine confounding variables that affect Cloud computing adoption and use among high school learners. Stratified random sampling was used to administer 286 questionnaires, and the response rate was 116. The data were later translated into correlations and ANOVA to study Cloud computing adoption and use based on confounding variables. The respondents' demographics, internet self-efficacy, and experience were measured as confounding variables in this paper. The  $r$  values for internet self-efficacy indicated a positive correlation and  $p$  values significant at 0.05 and 0.01. Nine sub-variables of Internet self-efficacy, fell within the required skewness range of  $s = -0.45$  and  $s = +0.45$  and met the assumption of normality, independence and linearity. Internet self-efficacy was found to be the main confounding variable in this paper. The paper recommends developing a technological infrastructure for education and also a methodological training framework to ensure successful implementation of e-learning.

## INTRODUCTION

The term Cloud first emerged in the 1990s, and usually an icon of a Cloud has been symbolising the entire Internet networks until today. Amazon's Web-based services began servicing readers since 2000. Later Yahoo and Google began to provide some eminent universities with Cloud computing for the development of new network services since 2006 (Chang et al. 2010).

Cloud computing technology can be adopted in all areas of society and in terms of education the e-learning solutions based on the Cloud promote a new era of learning, in which the lectures and labs are based on Cloud platform through virtualization. A variety of knowledge can be made available to teachers and students through Cloud-based services and these services can be accessed anytime, anywhere and on any device. On the other hand, providing educational services through Cloud computing technology enables them to acquire the skills needed in the global information society. Many universities have begun to comply with this initiative and there is evidence of a significant decrease in costs as a result of implementing Cloud solutions (Manro et al. 2012).

For instance, Google offers approximately 100 percent for educational applications and

looks to exceed this end-user satisfaction. The reason is that, the applications that can be accessed in the Cloud include the latest tools and features from innovative companies like Microsoft and Google; so the users can use free office applications without having to purchase, install and maintain these applications on their computers. There are enhanced collaboration possibilities; their data do not get lost, these are stored in the Cloud for free use and accessible from any location or from a range of devices such as mobile phone. Another use of Cloud computing in education is for hosting learning management systems (LMS) such as Blackboard or Moodle (Isaila 2014).

Although South Africa has introduced Cloudgate computers in 2014, very little is known about the current status of Cloud computing technology usage among South African learners. Cloudgate uses a South African built virtualization technology to deliver any Windows-based application to an Android device. It delivers a powerful desktop replacement at a fraction of the cost, zero pre-configuration, and reduced support. Cloudgate plugs into existing peripherals, including screen, keyboard and mouse (Swartbooi 2014). This paper therefore, investigates the factors influencing the adoption and use of Cloud technology among learners in a public school in East London, South Africa. In

addition, the paper tests the mediating effect of confounding variables towards behavioral intention to use Cloud computing. This paper will enrich the existing literature on Cloud computing adoption particularly from the developing countries' perspective.

### Research Objective

This main purpose of the paper was to investigate the confounding variables that affect Cloud computing adoption and application by high school learners in the East London district in South Africa.

Specifically, the present paper examines:

The effect of confounding variables (if any) on Cloud computing adoption and usage.

### Literature Review and Theoretical Framework

Confounding variables (third variables) are variables that the researcher failed to control, or eliminate, damaging the internal validity of an investigation (Shuttleworth 2008). This may cause the researcher to analyse the results incorrectly. The results may show a false correlation between the dependent and independent variables, leading to an incorrect rejection of the null hypothesis. However, if there is some other variable that changes along with the independent variable, then this confounding variable could be the cause of any difference (Shuttleworth 2008). The main gap discovered in the literature as a confounding variable that keeps on interfering with learning was lack of perfect learning environment. The traditional passive didactic learning experience is seen as one of the parts of the holistic pedagogical package, which is available.

This paper sought to determine other variables, which may adversely affect the relationship between the independent variables and the intention to adopt and use Cloud computing. This may cause the researcher to analyse the results incorrectly. Demographic factors, Internet self-efficacy, and experience of learners in using Internet devices have been examined in this paper using covariance as the measurement tool.

As Theory of Reasoned Action (Fishbein and Ajzen 1975) states, individual performance of a given behaviour is primarily caused by a person's intention to perform that behaviour.

The intention in turn is influenced by two major constructs, namely attitude towards the behaviour and subjective norm. In the context of attitude towards the behaviour, it is an individual's positive or negative feeling about performing the target behaviour. On the other hand, subjective norm is regarded as "the person's perception that most people (peers) who are important to him think he should or should not perform that behaviour in question" (Fishbein and Ajzen 1975: 302).

### Learners' Demographics

It has been noted that the gender differences on behavioural intention could be driven by cognitions related to gender roles (Lynott and McCandless 2000). Increased age has been shown to be associated with difficulty in processing complex stimuli and allocating attention to information when using technology (Plude and Hoyer 1985), both of which may be necessary when using software systems. Prior research supports the notion that constructs related to the ease of using technology will be stronger determinants of individuals' intention for females (Venkatesh and Morris 2000) and for older users (Morris and Venkatesh 2000).

### *Experience Adapted from the IDT Phases of Adoption*

This paper has theorised experience as a confounding variable, and the research question sought to address this concern. The modified theory for adopting information technologies (Moore and Benbasat 1991) includes seven attributes that influence the adoption of an innovation: Compatibility, Relative Advantages, Ease of Use, Result Demonstrability, Image, Visibility, Trialability, and Voluntariness. Rogers (2003) also describes five phases that a person goes through when adopting a new technology. In this paper, the learners who are investigated, go through the following decision process.

The process starts when the individual gets information about the innovation. Rogers describes this with the word Knowledge. The second phase of the process, Persuasion, occurs when an individual forms an attitude, positive or negative, towards the innovation. Already in this stage, the technology becomes favourable or unfavourable for the user. In the third step,

the individual decides if he or she wants to use the innovation or not. The fourth phase is Implementation and in this phase, the innovation is put into practice. In the last phase, Confirmation, the individual strengthens his or her decision to adopt the product, reduce the use of the product, or discontinue use of the product (West et al. 2006).

West et al. (2006) identifies patterns in the fourth phase, Implementation, of Rogers' Diffusion of Innovations model when implementing it to education. The five proposed phases of implementation are as follows: The first phase of Implementation is Experimentation. When adopting the innovation the user starts to experiment with the technology. The Experimentation is usually self-learning. The user tries to find out what the different applications do. Both Rogers (2003) and West et al. (2006) discovered that a user does not start using all features of a system in the beginning of adoption. This is called trialability as users test the system with a couple of features. After the early experimentation, the individual will face some Technical Challenges. The Technical Challenges (persistent use) include usage over time and the effectiveness of the innovation. After overcoming the Technical Challenges, the individual will face Integration Challenges. Most individuals know how to use new devices or learn to use them fast, but they do not know how to integrate them into a learning context. The fourth phase is naturally Increased Comfort Level (experience) after the challenges have been overcome. In the last phase, with an Increased Comfort Level, the user can adjust the innovation and a re-invention of some features occurs. The phases in the implementation process do not have to happen in a linear order, they can also overlap.

After the implementation process, the user makes a decision of whether to continue using the new technology. The decision is based on how well the implementation process proceeds and how the person adopts the new technology, in this case the online learning environment. West et al. (2006) notes three different outcomes that the user decides to do after the implementation process: continuation, reduction, or discontinuation. The continuation decision means that the user finds the technology useful and starts using it in work. Reduction implies that the user chooses to use the technology but only when necessary. The user does not feel committed to

the technology and can try new ones. The third option, discontinuation, is that the user does not start using the product.

### *Internet Self-efficacy Adapted from the Social Cognitive Theory (SCT)*

This paper has theorised Internet self-efficacy as a third confounding variable, and research question five sought to address this anxiety. Overall, Bandura's Social Cognitive theory (1986) explains the relationship between a person's behaviour, personal factors such as cognitive skills or attitudes, and the environment. Each can influence and be influenced by the other, or it influences one another. Social cognitive theory is a view that, individuals possess self-beliefs that enable them to exercise a measure of control over their thoughts, feelings, and actions, "What people think, believe, and feel affects how they behave" (Bandura 1986: 25). With that, Bandura presents a view of human behaviour in which the beliefs that people have about themselves are key functions in the exercise of control. So goes the saying "No man is an island", as human lives are not lived in isolation, people work together on shared beliefs about their capabilities and common aspirations to better their lives. Thus, environments and social systems influence human behaviour on an enormous scale.

## METHODOLOGY

A quantitative approach based on positivist paradigm was used for the measurement of data, in order to determine the effect that the confounding variables (learners' demographics, Internet experience and Internet self-efficacy) have on Cloud computing adoption and use. The respondents were selected using simple random sampling technique.

The questionnaire used for this paper was developed by the researcher based on established procedures in literature. Section A comprised six questions and it focused on demographic information of learners: gender, age, grade, residential area, the kind of Internet devices they have, and major subjects taken at school. Section B was designed to know the ability of learners in using the Internet. The section contained 15 items which required the respondents to either select a 'yes' or a 'no'. Section C focused on the learners' experience of

Internet use for learning purposes, in this section they had to tick all the activities they have done before.

To test the instrument’s validity and reliability, a pilot study was conducted with 15 learners drawn from a high school in the East London district. The feedback obtained from this pilot study was used to revise the final questionnaire. The final instrument was tested for reliability using Cronbach’s Alpha reliability statistics. The reliability measurements obtained for the three sections of the instrument were,  $\alpha = 0.525$  (learners’ demographics),  $\alpha = 0.857$  (Internet self-efficacy), and  $\alpha = 0.834$  (experience in using Internet devices). Two hundred and eighty six copies of the questionnaire were distributed to randomly selected learners after the teaching time.

The learners’ responses were tabulated and compared after the standardised beta coefficient from the regression analysis was performed. The analysis was done to present the details of any confounding variables that may exist and affect the analysis of the results of the current paper. The analysis of variance (ANOVA) was used to measure the influence of confounding variables on behavioural intention.

**RESULTS**

As illustrated in Table 1, there was a significant influence of gender at the  $p < 0.05$  level, on the intention to continue using mobile Internet in the future [ $F(2, 113) = 3.173, p = 0.046$ ]. There was an insignificant influence of age at the level of  $p < 0.05$ , on the intention to continue using mobile Internet in the future [ $F(2, 113) = 2.122, p = 0.125$ ].

Reading from the results in Table 2, the thirteen sub variables for experience were above the  $p < 0.05$  level and as such they did not have a significant influence on the intention to use Cloud computing in the future. For IE4 the insignificance was very high at  $p = 0.661$  level and

this is far apart from 0.05. IE12 was moderately insignificant at 0.171 towards the intention to use mobile Internet devices in the future. For learners who may have been exposed to persistent use of Internet devices, the significance levels in Table 2 would be different.

For Internet experience the reliability statistics by Cronbach’s Alpha was 0.834. The Alpha value of this magnitude is good due to a positive average covariance among items and it corresponds with reliability model assumptions.

Through this theory, fifteen skills that learners are supposed to possess in order to be Internet savvy were asked and analysed as follows.

Out of the fifteen sub-variables analysed through ANOVA in Table 3, the seven items discussed in this paper had a significant influence on the intention to adopt and use Cloud computing. This explains the inclusion of Internet self-efficacy as a confounding variable.

There was a significant influence of setting a reminder or alarm for a coming event at the  $p < 0.05$  level, on behavioural intention [ $F(4, 111) = 4.991, p = 0.001$ ]. There might be better ways in which learners could use mobile devices to remind themselves about due dates for tests, assignments and important notices for parents’ meetings. This high level of significance requires teachers to introduce learners to other functions of mobile Internet technology.

There was a significant influence of using Internet to translate a foreign language at the  $p < 0.05$  level, on behavioural intention [ $F(4, 111) = 4.161, p = 0.004$ ]. The translation of difficult words from English to their mother tongue is applauded since it is part of learning a new vocabulary.

There was a significant influence of using Internet to access a social network site at the  $p < 0.05$  level, on behavioural intention [ $F(4, 111) = 2.785, p = 0.030$ ]. These results imply that social networks should be utilised by teachers when communicating some information as learners are inclined to use them almost every day.

**Table 1: ANOVA for learners’ demographics**

		<i>Sum of squares</i>	<i>df</i>	<i>Mean square</i>	<i>F</i>	<i>Sig.</i>
<i>Gender</i>	Between groups	1.496	2	.748	3.173	.046
	Within groups	26.642	113	.236		
	Total	28.138	115			
<i>Age of Respondents</i>	Between groups	2.425	2	1.212	2.122	.125
	Within groups	64.566	113	.571		
	Total	66.991	115			

**Table 2: One way ANOVA for internet experience**

	<i>Squares</i>	<i>Sum of square</i>	<i>df</i>	<i>Mean</i>	<i>F</i>	<i>Sig.</i>
(IEx1) I have used Internet devices for library	Between groups	.707	4	.177		
	Within groups	24.844	111	.224		
	Total	25.552	115			
(IEx2) Downloaded school documents	Between groups	1.538	4	.385	1.554	.192
	Within groups	27.462	111	.247		
	Total	29.000	115			
(IEx3) Downloaded an application to learn new knowledge	Between groups	.943	4	.236	.993	.415
	Within groups	26.367	111	.238		
	Total	27.310	115			
(IEx4) Used Internet to search for knowledge in class	Between groups	.617	4	.154	.604	.661
	Within groups	28.374	111	.256		
	Total	28.991	115			
(IEx5) Used social network for discussion	Between groups	.918	4	.230	.957	.434
	Within groups	26.625	111	.240		
	Total	27.543	115			
(IEx6) I communicated with teachers through Internet	Between groups	.973	4	.243	1.368	.250
	Within groups	19.742	111	.178		
	Total	20.716	115			
(IEx7) Set a reminder on mobile device for a deadline	Between groups	.973	4	.243	.982	.420
	Within groups	27.476	111	.248		
	Total	28.448	115			
(IEx8) Used Internet to communicate with classmates	Between groups	.918	4	.229	.917	.457
	Within groups	27.772	111	.250		
	Total	28.690	115			
(IEx9) Checked study information via email or SMS	Between groups	1.227	4	.307	1.363	.251
	Within groups	24.980	111	.225		
	Total	26.207	115			
(IEx10) Recorded information during class	Between groups	.618	4	.155	.793	.532
	Within groups	21.623	111	.195		
	Total	22.241	115			
(IEx11) Written notes on a mobile device in class	Between groups	1.135	4	.284	1.459	.220
	Within groups	21.581	111	.194		
	Total	22.716	115			
(IEx12) Read an article or assignment from the Internet	Between groups	1.531	4	.383	1.634	.171
	Within groups	26.012	111	.234		
	Total	27.543	115			
(IEx13) Played an educational game on the Internet	Between groups	.637	4	.159	.625	.645
	Within groups	28.285	111	.255		
	Total	28.922	115			

There was a significant influence of using Internet to remotely control personal computer at the  $p < 0.05$  level, on behavioural intention [ $F(4, 111) = 3.081, p = 0.019$ ]. This means that, teachers can upload information on a particular website created to extract information, and learners could be able to access that information anywhere they feel like doing so.

There was a significant influence of the use of Internet to subscribe to some services by sending messages at the  $p < 0.05$  level, on behavioural intention [ $F(4, 111) = 3.026, p = 0.021$ ]. There are Internet sites to which learners could subscribe where they could have access to more resources that they probably do not have in their

schools. This would enhance their learning and broaden their knowledge beyond the textbooks used in the classroom.

There was a significant influence of the use of Internet to search needed information at the  $p < 0.05$  level, on behavioural intention [ $F(4, 111) = 2.919, p = 0.024$ ]. This search of needed information needs to be facilitated and fast tracked by the school management so that it does not happen once and cease because it is not applied in the learning context. For learners to access academic content from the Internet, it is important that they have the necessary skills. Wang and Su (2006) also support this view and assert that in order to benefit from the Internet, learn-

ers should improve their information and computer literacy skills.

There was a significant influence of the use of Internet to play games at the  $p < 0.05$  level, on behavioural intention [ $F(4, 111) = 3.768, p = 0.007$ ]. High school learners are not immune to playing games, but this should be channelled to a positive direction where they are encouraged to play educational games that sharpen their cognitive skills.

Almost all the items for Internet self-efficacy met the assumption of normality for the dis-

tribution of skewness, except for ISE2, ISE3, and ISE5<sup>1</sup>. To correct this violation of the assumption of normality, these sub variables were removed from the analysis.

**DISCUSSION**

Venkatesh and Zhang (2010) conducted a longitudinal study to validate the UTAUT theory cross-culturally, focusing mainly on differences and similarities between US and China. Despite the US was the original home for the

**Table 3: One way ANOVA for Internet self-efficacy**

		<i>Sum of squares</i>	<i>df</i>	<i>Mean square</i>	<i>F</i>	<i>Sig.</i>
ISE1	Between groups	1.141	4	.285	.971	.427
	Within groups	32.609	111	.294		
	Total	33.750	115			
ISE2	Between groups	.631	4	.158	.458	.766
	Within groups	38.197	111	.344		
	Total	38.828	115			
ISE3	Between groups	.090	4	.023	.340	.850
	Within groups	7.358	111	.066		
	Total	7.448	115			
ISE4	Between groups	.711	4	.178	.407	.803
	Within groups	48.461	111	.437		
	Total	49.172	115			
ISE5	Between groups	.710	4	.177	1.194	.318
	Within groups	16.497	111	.149		
	Total	17.207	115			
ISE6	Between groups	.525	4	.131	.654	.625
	Within groups	22.260	111	.201		
	Total	22.784	115			
ISE7	Between groups	2.711	4	.678	1.907	.114
	Within groups	39.461	111	.356		
	Total	42.172	115			
ISE8	Between groups	6.669	4	1.667	4.991	.001
	Within groups	37.081	111	.334		
	Total	43.750	115			
ISE9	Between groups	7.144	4	1.786	4.161	.004
	Within groups	47.640	111	.429		
	Total	54.784	115			
ISE10	Between groups	2.168	4	.542	2.278	.065
	Within groups	26.410	111	.238		
	Total	28.578	115			
ISE11	Between groups	2.185	4	.546	2.785	.030
	Within groups	21.772	111	.196		
	Total	23.957	115			
ISE12	Between groups	6.447	4	1.612	3.081	.019
	Within groups	58.062	111	.523		
	Total	64.509	115			
ISE13	Between groups	4.905	4	1.226	3.026	.021
	Within groups	44.983	111	.405		
	Total	49.888	115			
ISE14	Between groups	1.139	4	.285	2.919	.024
	Within groups	10.827	111	.098		
	Total	11.966	115			
ISE15	Between groups	2.527	4	.632	3.768	.007
	Within groups	18.611	111	.168		
	Total	21.138	115			

theory, their results supported the universality of the theory. The only difference they found was about the moderation role of gender, age, and voluntariness, which were not significant in the context of China. In Table 1 of this paper, the results also do not show any significant influence of gender and age towards Cloud computing adoption and usage. We may assume that the younger the respondents are, the more they perceive cloud computing as easy to use (Aharony 2015).

### Internet Experience

According to Weiss et al. (2012), challenging transitions may influence differently those who are high or low in openness to experience. Those who are high may approach these situations with curiosity, emphasizing the new possibilities offered to them. However, those who are low in openness may be threatened and try to avoid them by adhering to predictable environments.

Ajzen and Fishbein (2005) note that feedback from previous experiences will influence various beliefs and, consequently, future behavioural performance. In this context, persistent use is a perceptual construct that reflects the results of prior experiences. The empirical findings about the role of routine behaviour in technology use have delineated different underlying processes by which routine influences technology use. Related to the operationalization of routine as prior use, Kim and Malhotra (2005) state that prior use was a strong predictor of future technology use hence it (experience) has been added as a confounding variable.

Given that there are detractors to the operationalization of routine as prior researchers use some work, such as that of Limayem et al. (2007), has embraced a survey and perception-based approach to the measurement of habit. Such an operationalization of routine has been shown to have a direct effect on technology use over and above the effect of intention and to moderate the effect of intention on technology use such that intention is less important with increasing habit (Limayem et al. 2007). In this paper, the researcher has adopted the above-discussed conceptual definitions of experience and routine (persistent use). The researcher has operationalised experience in keeping with prior research as the passage of time from the initial use

of Internet technology. This brings our discussion to Internet self-efficacy as a factor that is brought about by experience (confidence) gained in using Internet devices.

### Internet Self-efficacy

This paper has theorised Internet self-efficacy as a confounding variable, and the research question sought to address this anxiety. Detailed descriptive statistics regarding learners' ability to use Internet services skilfully, and the number of learners choosing each option, are shown in Table 3. Questions that required a 'yes' or a 'no' response were asked. Out of 116 respondents, 94 selected yes to using Internet for e-booking and e-shopping, 16 selected no, and 6 learners did not respond to the statement. This could be an indication that, 94 learners were more likely to adopt and use Cloud computing as a service for e-booking and e-shopping when available for use. On the other hand, 108 learners chose the third option (to download applications), which had the highest frequency. These results can be associated with previous findings that Internet self-efficacy affects the intention to use information technology (Aharony 2014).

Bandura's Cognitive theory (1997) explains the relationship between a person's behaviour, personal factors such as cognitive skills or attitudes, and the environment. Each can influence and be influenced by the other, or it influences one another. The Social Cognitive Theory holds a view that, individuals possess self-beliefs that enable them to exercise a measure of control over their thoughts, feelings, and actions. What people think, believe, and feel affects how they behave (Bandura 1997). With this, Bandura presents a view of human behaviour in which the beliefs that people have about themselves are key functions in the exercise of control. In other words, if learners believe that they cannot cope with the challenge of using new technologies this belief might hamper their Internet self-efficacy. Learners ought to learn from one another so that their belief systems change for the betterment of their Cloud computing skills. Thus, environments and social systems influence human behaviour on an enormous scale. This paper has borrowed from the Social Cognitive Theory, by seeking to determine the ability of each learner to use Internet services skilfully.

### Linear Regression Assumptions and the Correction of Violations

In the lack of fit test, the probability of the  $F$  test statistic ( $F = 1.395$ ) was  $p = 0.230$ , greater than the alpha level of significance of 0.05. This means that the assumption of linearity was met. The Durbin-Watson statistic for this problem was 2.14, which fell within the range of 1.50 to 2.50. The analysis results satisfied the assumption of independence of errors. Ten out of fifteen sub variables for Internet self-efficacy fall within the required range of (-1.0 and +1.0) in order to meet the assumption of normality (skewness). Hence, the conclusion that, the distribution is significantly normal, with some values negatively skewed and some positively skewed. All the items under the following ISE1, ISE4, ISE6, ISE7, ISE8, ISE9, ISE10, ISE11, ISE13, and ISE14 meet the assumption of normality for the distribution of skewness, except for ISE2, ISE3, and ISE5. To correct this violation of the assumption of normality, the three sub variables were removed from the analysis.

### CONCLUSION

Experience with computers was shown to have a significant impact on the acceptance of technology indicated by the significance levels found in the paper. In fact, interpretation of the model with the data extracted for those who have used Internet devices persistently in the past has a much higher intention of adoption and use than the sample as a whole. This has a direct effect on performance expectancy, effort expectancy, social influence and facilitating conditions. Computer experience was found to be a factor of concern, particularly if the computer use could have started in primary and junior secondary level for the respondents.

### RECOMMENDATIONS

Experience as a moderating factor should be further evaluated to determine if it is a factor in other populations. This moderating factor could be measured in a (Kindergarten to Grade 12) study to measure the impact of first computer use on both the teachers and the learners in schools.

On the other hand, Internet self-efficacy does have an impact on learners' intention to use Cloud computing. Out of fifteen questions asked in

the questionnaire, eight items did not have any significant influence on the learners' behavioural intention. Self-efficacy could further be studied in another study of R-12 learners and teachers in order to verify its importance and permanent inclusion on the adoption and use of the technology model.

The lack of Internet self-efficacy was identified as the main problem, which is also due to lack of infrastructure (facilitating conditions). There is therefore an urgent need for investment by the corporate sector and the government in not only developing a technological infrastructure for education but also a methodological training framework to ensure successful implementation of e-learning. The proliferation of technologies and their attendant methodologies in places like Europe, is an encouraging sign for the future of e-learning pedagogy in any country that wants to keep up with changing times.

### NOTE

<sup>2</sup> ISE2 = For e-booking and e-shopping. ISE3 = To download applications. ISE5 = To watch videos and listen to music.

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