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Examining the antecedents of ICT adoption in education using an Extended Technology Acceptance Model (TAM)

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ABSTRACT

This study assesses the determinants of ICT adoption by educators in the teaching and learning process in the context of a developing country, Mauritius. A hierarchical regression analysis is used, to firstly determine the incremental effects of factors from the technology acceptance model (TAM) while controlling for demographic variables such as gender, age group and qualification level and secondly, to find out the additional effects of other determinants of ICT adoption in education identified in the literature and an exploratory phase. The results suggest that demographic variables such as level of qualification do matter to some extent but are rendered insignificant when the two TAM factors, perceived usefulness (PU) and perceived ease of use (PEOU) are added to the model. Moreover, PU and PEOU substantially improved the model and were both found to have a significant positive direct effect on ICT adoption. Finally, two supplementary variables were found to positively and significantly affect the level of ICT adoption in the teaching and learning process in secondary schools, namely, "top management and peer support" and "competencies in using specialized ICT tools". The results provide a better understanding of the applicability of the TAM model to the Mauritian secondary education context and also enhance the understanding of other important variables in determining ICT adoption by teachers. A number of practical recommendations are also made based on the research findings.

Keywords: *ICT Adoption, Technology Acceptance Model, Educational Technologies, Teaching and Learning, Hierarchical Regression Analysis*

INTRODUCTION

Information and Communication Technology (ICT) is recognized as an essential tool for improving the quality of education (Blackwell, Lauricella, Wartella, Robb and Schomburg, 2013). Governments all over the world have accepted the fact that ICT does play a significant role in improving education and massive investments have been made in this area since a while (Kozma and Anderson, 2002; Pelgrum, 2001; Hennessy, Ruthven and Brindley, 2005; Goodison, 2003 and Kangro and Kangro, 2004). Inevitably, the adoption and effective use of ICT in the teaching and learning process is one of the most discussed issues in the contemporary education policy making process (Baturay, Gökçearslan and Ke, 2017). The knowledge and skills required to embrace the emergence of ICT is also a priority for all education authorities worldwide (Tatto, 2006). The importance of ICT in education has been supported by several researchers who found that the proper use of ICT as a facilitator in the teaching process do have positive effects and help in students' attaining better results (Burnett, 1994; Fitzgerald and Werner, 1996; Hennessy et al*.,* 2005; McGorry, 2002). Indeed, findings from the extant literature demonstrate that ICT has the ability to support education and provide opportunities for effective communication among educators and students across the curriculum in ways that have not been possible before (Tondeur, Aesaert, Pynoo, Braak, Fraeyman and Erstad, 2017).

The vital role of teachers in the effective adoption of ICT in education has been given prominence in latest studies in the field (Comi, Argentin, Gui, Origo and Pagani, 2017; Englund, Olofsson and Price, 2017; Nikolopoulou and Gialamas, 2016). More specifically, viewing teachers as the main

protagonists of ICT use in education, research studies have focused on the factors that influence their adoption of ICT in the teaching and learning process (Kale and Goh, 2014; Kreijns, Vermeulen, Kirschner, Buuren and Acker, 2013). Admittedly, having a better understanding of the determinants of ICT adoption in education enables the development of appropriate strategies to enhance the use of ICT in the teaching and learning process (Macharia and Pelser, 2014). Although the factors such as perceived usefulness and perceived ease-of-use from the Technology Acceptance Model (TAM) (Davies 1989) and the adoption of ICT in education have already been extensively studied before (Cassim and Obono, 2011; Terzis and Economides, 2011), much of the variation in ICT adoption remain unexplained and there is still lack of studies that investigated into the incremental effect of other determinants such as ICT literacy of educators and the school climate and support, especially in the Mauritian context (Papanastasiou and Angeli, 2008; Baturay, Gökçearslan and Ke, 2017). Paying heed to recent developments in the extant literature, this study proposes to test a model comprising of eight antecedents of ICT adoption in education. Furthermore, the study focuses on data collected in the Mauritian context, which is believed to be of particular interest given the emphasis of the Mauritian government on ICT integration in education. Gaining more knowledge about the importance of additional specific factors that affect the level of ICT adoption in teaching learning by educators in Mauritian secondary school would provide a better understanding of factors that predict ICT adoption in general but also make practical recommendations for the secondary education context in Mauritius.

The objectives of this study are to: (1) assess teachers' willingness to adopt ICT in the teaching and learning process, (2) identify the critical factors that influence teachers' adoption and integration of ICT in the teaching practice, (3) assess the relationship between adoption of ICT and its determinants.

LITERATURE REVIEW

ICT Adoption in Education

The use of ICT in education improves the teaching and learning process by providing support to teachers and students and connecting them to each other and to a wide range of information in an efficient way (Kreijns et al, 2013). There is increasing evidence with regards to the benefits of ICT usage in education (Blackwell et al. 2013; Higgins, 2003; Tondeur et al, 2017). Perrotta (2013) observes that ICT usage in education assists teachers in carrying out various tasks which include: searching for information and preparing lesion materials; presenting information (e.g using power point presentations, interactive whiteboards and data projectors); collection and management of data about students' activities; collaborating with colleagues; communicating with students and parents; and sharing resources to the wider education community. Similarly, Williams (2008) suggests that the use of ICT which include the use of electronic media, internet platform and advanced educational technologies results in several benefits: accessibility to a broader circle of learning materials; better clarifications and insights on the subject taught, by using a plethora of presentation tools, thus fostering participatory pedagogies.

Despite the proven positive educational outcomes associated with the use of ICT in education, teachers have been found to be show reluctance to adopt ICT in the teaching and learning process (Ward, 2005). Indeed, while a few teachers seem to have no difficulties in integrating ICT in the educational process and have a largely positive opinion about the benefits of ICT in education, many educators do express some form of adverse reactions (Kreijns et al, 2013). Technology is even seen by some educators as being a source of threat to their traditional way of work (Williams, 2008). Consequently, it becomes important to identify the determinants of ICT adoption in education so as to increase its use in the teaching and learning process by teachers.

The intention of an individual to make use of a particular technology has been found to be highly associated with his or her actual usage of the technology and two main determinants of usage intention as suggested by the Technology Acceptance Model (TAM), are the user's ease of use and perceived usefulness of technology (Davis, 1989). Zhao and Cziko (2001) opine that three conditions are necessary for teachers to fully embrace ICT; the latter must have the belief that they have control over the technology used, its effectiveness and finally be assured that the medium used will not cause disturbances. The applicability of TAM to the education sector and the relevance of other determinants such as teacher self-efficacy and teacher ICT literacy are further discussed below.

Determinants of ICT Adoption in Education

TAM Dimensions: Perceived Usefulness and Perceived Ease of Use

The seminal work by Davis (1989), proposed the Technology Acceptance Model (TAM) which aimed to explain user's intention to adopt technology. Two main determinants of technology acceptance are suggested, namely, perceived usefulness ad perceived ease of use. These factors are intrinsic to the individuals and have been found to be applicable to the education sector (Cheung and Vogel, 2013; Schoonenboom, 2014). As Higgins and Moseley (2001) explain, educators' constructivist beliefs about integrating technology within teaching and learning are determining factors in the extent to which they are ready to adopt this innovation in their instructional setting. Similarly, Ertmer, Ottenbreit-Leftwich and York (2006) concluded that intrinsic factors like commitment, beliefs and confidence are much more important to be considered rather than extrinsic factors like accessibility to technology and the time factor.

Perceived usefulness is generally defined as the degree to which a user believes that a particular system will enhance his/her performance (Davis et al., 1989). Studies in the education setting have provided support to the applicability of the perceived usefulness construct. Watson (2006) found that understanding teachers' perception of innovation is vital to successful adoption of technology in learning. Similarly, Bhattacherjee (2001) and Benett (2003) suggested that users will eventually use technology, if they have the ultimate belief that they will acquire expected benefits by using it. The latter conducted their study on the impacts of instructional technology on faculty members' readiness to make use of technology in their teaching, which revealed that among the most important factors which hampered the adoption of ICT was the educator' beliefs and their reluctance to change and not lack of instructional facilities or financial funds.

The second TAM dimension, perceived ease of use, is defined as the degree to which an individual believes that using a particular technology would be relatively free from effort (Davies, 1989). Hence, in this context, teachers' perceived ease of use toward computer is viewed as a determining factor in respect to its integration in the teaching process. Watson (1993) stated that it is teachers' ability, skills and competencies in using computer technology for ICT-related tasks that render its usage much easier. The empirical research conducted by Chong, Sharaf and Jacob (2005) on secondary school teachers, revealed that the majority of them were directed in acquiring ICT skills needed to use computer, where the authors stated that educators' perceived ease of use directly lead to the adoption of technology in the teaching process. Furthermore, Askar, Usluel and Mumcu (2006) conduct a survey about the extent to which perceived innovation towards ICT-related tasks among 416 secondary school teachers in Turkey. Their findings indicated that tutors' perceived ease of use of ICT was a highly determining factor in respect to the preparation of teaching materials in school. In the same breadth, other empirical studies concluded that in order to successfully integrate ICT in their diffusion of knowledge, educators must first perceive technology as easy to use (Andoh, 2012; Bauer & Kenton, 2005; Franklin, 2007; Simonson, 2008; Wozney, Venkatesh and Abrami, 2006). In light of the above

discussion, the following hypotheses are proposed:

H_1: Perceived Usefulness has a positive direct influence on Adoption of ICT
H_2: Perceived Ease of Use has a direct positive effect on Adoption of ICT

Teachers' ICT Literacy

The term ICT literacy is primarily associated with activities like writing, reading or sharing information in an online environment (Correos, 2014). It also includes the user's ability to make use of ICT tools such as using a word processor, email, spreadsheet, presentation software, the World Wide Web or any other computer-related tasks (Manley, Sweaney and Valente, 2000). It is in this regard that Anao (2003) stresses upon the fact that the successful implementation and adoption of school programmes depends mainly on teachers' skills. Several past studies have revealed that there is a meaningful positive relationship between educators' ICT skills and the extent to which they are ready to adopt technology within the teaching process (Cavas et al., 2009; Pelgrum, 200; Ngah and Masood, 2006). For example, in a survey conducted in five European countries on the primary school teachers' competence and their level of confidence in using technology, Peralta and Costa (2007) found that the technical skills of Italian teachers primarily influenced the latter's use of technology in teaching. Similarly, Anao (2003) and Higgins and Moseley (2011) found that the lack of ICT competence foster teachers not to fully utilize ICT in the classrooms, where training programmes have to be dispensed so as for them to keep pace with the relevant innovative skills in the ever-changing technological environment. Two components of teachers' ICT literacy are considered in the present study, namely: (1) competencies in using specialized ICT tools; (2) competencies in using basic ICT tools. The following hypotheses are therefore proposed:

H_{3a}: Teachers' ICT Literacy (Basic ICT) has a direct positive impact on Adoption of ICT.
H_{3b}: Teachers' ICT Literacy (Specialised ICT) has a direct positive impact on Adoption of ICT.

Teacher Self-Efficacy

The term self-efficacy is defined by Bandura (1997) as an individual's beliefs or judgement in his capabilities to execute and organise relevant courses of action in order to attain designated types of performances. Thus, teacher self-efficacy is the ultimate belief that an educator has in relation to the latter's ability to execute multiple teaching tasks (Dellinger et al., 2008). Allinder (1994) found that teachers having strong self-efficacy beliefs are more prone to adopt ideas and implement strategies so as to improve their methods through the use of technologies. Similarly, Piper (2003) observed in her survey among 160 secondary school teachers, that there is a positive relationship between teachers' level of self-efficacy and the use of technology in the classroom. Further empirical studies supported the claim that self-efficacy is correlated with ICT adoption in the classroom (Albion, 1996; Compeau, Hammond et al., 2011; Higgins and Huff, 1999; Sang et al., 2010). Therefore it is hypothesised that:

H_4: Teacher Self-Efficacy has a direct positive effect on Adoption of ICT.

Teacher Computer Self-Efficacy

Compeau and Higgins (1995) state that computer self-efficacy can be referred to as one's beliefs and capabilities to use computers. They further add that individuals with high level of computer self-efficacy tend to use computer more in their related task compared to those having low self-efficacy toward computer. In the education context, teachers' computer self-efficacy has a direct

effect on the latter's use of ICT in teaching and learning (Liaw, Huang and Chen, 2007). The work of Albion (1996) revealed that educators' beliefs and their abilities to use computer technology in classroom is a substantial factor to be considered in determining their level of adoption of ICT. Furthermore a survey conducted by Becta (2004) indicated that out of the teachers surveyed, 21% said that the lack of confidence impacted on their use of technology. Similarly, Gibbs (2003) states that when teachers typically perceive technology as a means to enhance and support student learning, they will be more apt to integrate computer technology in this respective process. In the same breadth, Christensen and Knezek (2006) who defined "computer self-efficacy" as one's confidence in using a computer suggested that teachers' perceived competence in technology was a key factor in predicting the usage of ICT in schools. Consequently it is hypothesized that:

H_5: Teacher Computer Self-Efficacy has a direct positive impact on Adoption of ICT.

School Climate

Researchers have stressed upon the fact that a relevant school's vision for technology integration is vital for the successful implementation of the digital programmes (Pelgrum and Law, 2003). As observed by Veen (1993) and Zhao, Pugh, Sheldon and Byers (2002), the better the institutional support provided to the teachers the more they are motivated in using digital tools. Educators' perceptions on the school's technical support, accessibility to ICT infrastructure, instructional support and the availability of updated hardware and software are found to be determinants for tutors to adopt ICT (Gulbahar, 2007; Richardson, 2009). Several studies have confirmed that organisation support, adequate training development programmes and effective leadership are that factors that lead to the adoption of ICT (Braak, 2001; Butler and Sellbom, 2002; Fabry and Higgs, 1997; Norris, Sullivan and Poirot, 2003; Sherry et al., 2000). It has also been argued that support from cooperating teachers, the administration and the technical staffs are key factors in predicting the effective use of ICT in schools (Dexter & Riedel, 2003; Bullock, 2004). The following hypotheses are therefore proposed:

H_{6a}: ICT Infrastructure has a positive influence on Adoption of ICT.
H_{6b}: Top Management and Peer Support has a positive influence on Adoption of ICT.

METHODOLOGY

Measures

A survey questionnaire is developed to measure each construct of interest for this study. The measuring instrument comprises of nine sections. Eight sections relate to the constructs and one aims at capturing demographic information. Section one, measures the level of ICT adoption in education and consists of nine items adapted from Cassim and Obono (2011). The second section comprises of five statements measuring perceived usefulness and is also adapted from Cassim and Obono (2011). Section three related to teacher's ICT literacy and comprised of nine items. The next section, measures teacher self-efficacy and is based on the 'Ohio State teacher efficacy scale (OSTES)' (Moran and Hoy, 2001) containing 7 items. Teacher computer self-efficacy is measured in section five and contains 9 items. This scale is adapted from the Microcomputer Utilization in Teaching Efficacy Beliefs Instrument (Enochs, Riggs and Ellis, 1993). Ten items are included in section six which measures school climate and support and is adapted from Papanastasiou and Angeli (2008). Section seven measured teachers' perceived ease of use of ICT and is derived from an existing scale by Cassim and Obono (2011). Finally, the last section captures demographic details about the teachers' profile and the schools.

Data Collection Process

Using the confidence interval technique, the recommended sample size for this study is 365. For this study, data was collected using questionnaires which were distributed to secondary schools educators. This method is commonly used by researchers due to its flexibility in gathering large amount of data but also once the data is collected, it is easily quantified. Thus due to the busy schedule of educators, filling a questionnaire is less time consuming and the data collected remains confidential as well. In this respect, the questionnaires were self-administered and was distributed face-to-face to the rectors or any administrative officers which would then be handed to the respondents in all the 15 colleges.

Data Analysis Methods

Exploratory factor analysis using Varimax rotation and a cut-off point of 0.4 was used to test for construct validity (Hair *et al.*, 2006). Reliability of scales was tested using Cronbach Alpha test with values above 0.7 considered acceptable (Nunally, 1978). Hierarchical regression analysis was used to test for the relationship between the determinants (independent variables) and adoption of ICT in the teaching and learning process (outcome variable) while controlling for the effect of various set of predictors. When performing a hierarchical regression, the independent variables are entered step by step in a pre-determined order and the R^2 and partial coefficients are calculated as each independent variable are added (Cohen & Cohen, 1983). The order of entering the variables into the analysis is essential and should be done following strong theoretical justifications (Hair et al., 2006). Relevant tests were also conducted to test for the assumptions of hierarchical regression analysis, which are, normality of error terms, homoscedasticity, independence of error terms and no multicollinearity between independent variables (Hair et al., 2006).

RESULTS AND DISCUSSION

Preliminary Analysis

Sample Characteristics

A total of 378 educators responded to the survey, out of which 368 usable responses were obtained. Out of the 368 educators, 43% of the respondents were male and the remaining 57% of the educators surveyed represented the female population. Most of the respondents were BA/BSc holders and were in the age band of 30-39 years. Moreover, 61% of the teachers surveyed do not hold any managerial position and only 3 % of the whole population are either rectors or deputy rectors. With regards to the level of subjects being taught, most of the educators do teach up to HSC level (82%). 61 % of the respondents have stated that the schools in which they teach have either regulatory mechanism, plan or policy related to ICT.

Reliability Analysis and Exploratory Factor Analysis

The following is a description of the results of the reliability and exploratory factor analysis conducted to test for the reliability and the construct validity of measurement scales corresponding to each construct. Table 1 relates to the dependent variable, that is, teachers' adoption of ICT in the teaching and learning process. The EFA results revealed that the construct was uni-dimensional and possessed sufficient convergent validity with factor loadings all above the 0.4 threshold value (Hair *et al.*, 2006). The reliability of the scale was also ensured with an acceptable Cronbach Alpha score of 0.761.

Table 1: *Results of EFA and Reliability Analysis (ICT Adoption)*

Factors	Constructs	Factor Loading	Cronbach's Alpha
	Adoption of ICT		
	I regularly use word processors (e.g. Microsoft Word, Open Office Writer) for preparing test materials and class notes.	.836	0.761
	I regularly use personalization software to generate individualized word problems exercises for learners.	.815	
	I regularly use spreadsheet applications to capture learners' marks and to analyze their strengths and weaknesses	.726	
	I often keep a computer database of lesson examples and exercises on a personal computer.	.705	
	I regularly use online games to make my word problems lessons exciting.	.680	
	I regularly use the Internet (e.g. Google) to search and download videos, notes and practice examples to use in my lessons.	.606	

Table 2 shows the EFA and reliability analysis results for the independent variables, namely, perceived usefulness, teacher's ICT literacy, teacher self-efficacy, computer self-efficacy, school climate and support and perceived ease of use. The first factor perceived usefulness, comprised of a total of seven items all having factor loadings higher than the 0.4 cut-off point as recommended by the Hair *et al.* (2006). The internal consistency of the scale was also tested and found to be satisfactory with a Cronbach Alpha score of 0.718. Teacher's ICT literacy was found to be best represented by two factors, namely, competencies to use specialized ICT tools comprising of five items with factor loadings ranging from 0.718 to 0.835 and competencies to use basic ICT tools with factor loadings ranging from 0.719 to 0.865. The next factor was teacher self-efficacy consisting of seven items with loadings ranging from 0.630 to 0.778 and a reliability score of 0.816. This was followed by computer self-efficacy which comprised of nine items also having loadings higher than the 0.4 threshold value and a Cronbach Alpha score of 0.899. School climate and support was represented by two factors, namely, top management and peer support and ICT infrastructure. Finally, perceived ease of use was found to be unidimensional and contained seven items ranging from 0.548 to 0.824 and with a Cronbach Alpha score of 0.817.

Table 2: *Results of EFA and Reliability Analysis (determinants)*

Factors	Constructs	Factor Loading	α
	Perceived Usefulness		
	Spreadsheets are usually helpful to me for the analysis of learners' performances.	.841	0.718
	Word processors usually help me to set tests and exams question papers	.827	
	The general use of ICT for teaching usually reduces learners' boredom as it makes my lessons more interesting.	.688	

Factors	Constructs	Factor Loading	α
	E-learning platforms such as moodle usually allow me to introduce my learners to new learning strategies.	.686	
	SMSs, emailing, blogs, and forums, etc, usually allow me to interact with other teachers after teaching hours.	.638	
	Databases usually allow me to keep a proper record of teaching materials and other information such as marks, registers, disciplinary records, etc.	.623	
	The WWW usually offers me a wider range of interesting teaching resources (e.g. textbooks, notes).	.508	
Teachers' ICT Literacy			
Competencies to Use Specialized ICT Tools	Programming Languages (e.g. Visual Basics, LOGO, C++)	.835	0.832
	Graphics (e.g. Paint, Adobe Photoshop, CorelDraw)	.748	
	Web 2.0 tools (Blogs, Wikis)	.730	
	Using Interactive White Boards	.720	
	Statistical Tools	.718	
Competencies in using Basic ICT Tools	Internet Browsing and Emailing	.865	0.736
	Participating in an online social network or forum(e.g., Facebook, Yahoo)	.808	
	Microsoft Office (Word, PowerPoint, Excel, Access)	.719	
Teacher Self-Efficacy			
	How much can you do to get children to follow classroom rules?	.788	0.816
	How much can you do to calm a student who is disruptive or noisy?	.733	
	To what extent can you use a variety of assessment strategies?	.709	
	How much can you do to motivate students who show low interest in schoolwork?	.700	
	To what extent can you craft good questions for your students?	.637	
	How much can you do to get students to believe they can do well in schoolwork?	.635	
	How much can you do to get children to follow classroom rules?	.630	
Computer Self-Efficacy			
	I do not know what to do to turn students onto computers	.825	0.899
	I am not very effective in monitoring students' computer use in my classroom	.798	
	I find it difficult to explain to students how to use the computer	.767	
	Even when I try very hard, I do not use the computer as well as I do other instructional resources	.762	
	I wonder if I have the necessary skills to use the computer for instruction	.728	
	Whenever I can, I avoid using computers in my classroom	.726	
	When students have difficulty with the computer, I am usually at a loss as to how to help them	.726	
	Given a choice, I would not invite the principal to evaluate my computer-based instruction	.696	

Factors	Constructs	Factor Loading	α
	I generally employ the computer in my classroom ineffectively	.681	
School Climate and Support			
Top Management and Peer Support	Other teachers encourage me to integrate computers in teaching and learning	.775	0.844
	The ICT coordinator encourages me to integrate computers in teaching and learning	.770	
	I often exchange ideas about technology integration with other teachers	.758	
	The principal encourages me to integrate computers in teaching and learning	.666	
	Teachers in my school are well informed about the value of computers in teaching and learning	.660	
	There are other teachers in my school who use computers in teaching and learning	.630	
	In staff meetings, we frequently discuss the subject of integrating computers in the school curriculum	.607	
ICT Infrastructure	The technical support in my school is adequate	.921	
	The instructional support in my school is adequate	.883	0.898
	A variety of computer software is available for use in my school	.851	
Perceived Ease of Use			
	Using a spreadsheet application to create registers and mark sheets	.824	0.817
	Using a word processor application (e.g. Microsoft Word, Open Office Writer) for tests, exams, and lesson notes	.747	
	Using Google to search for textbooks, lessons notes, and worksheets, etc, and download them	.712	
	Delivering PowerPoint lessons presentations to a class	.698	
	Creating formulas to analyze learners' marks from databases	.697	
	Sending emails & SMSs to share teaching ideas and teaching resources with other teachers	.677	
	Interacting with E-learning systems such as moodle	.548	

The final factor structure for ICT adoption determinants therefore comprised of eight factors and a total of 47 items possessing satisfactory level of convergent validity and reliability.

Descriptive Analysis

Table 3 presents the descriptive statistics for each construct. All measures were on a 5 point Likert scale. The sampled secondary school teachers report an average score of 3.43 (s = 0.75) regarding the level of ICT adoption in the teaching and learning process. This rating indicates that the respondents view that they use ICT above moderate level. The skewness (-0.83) and kurtosis (- 1.03) values are within the acceptable range of -3 to +3 for skewness and -8 to +8 for kurtosis as recommended by Kline (2011).

Table 3: *Descriptive Statistics*

Constructs	Mean ($\bar{x}$)	Std Dev (s)	Skewness	Kurtosis
Adoption of ICT in Education	3.43	.75	-.83	1.03
Perceived Usefulness of ICT	3.95	.61	-1.05	4.32
Competencies in using Specialized ICT Tools	2.78	.90	-.02	-.68
Competences in using Common ICT Tools	4.11	.68	-.55	-.22
Teacher Self-Efficacy	4.23	.52	-.52	-.15
Computer Self-Efficacy	2.36	.74	.27	.15
Top Management and Peer Support	3.50	.68	-.51	.74
ICT Infrastructure	3.13	1.00	-.35	-.40
Perceived Ease of Use	4.01	.62	-.53	.03

With regards to determinants of ICT adoption in education, the highest score obtained was for teacher self-efficacy followed by perceived ease of use. Both having mean scores higher than 4.0 indicating a high degree of that self-efficacy and perceived each of use respectively. The lowest values were attributed to computer self-efficacy and competencies in using specialized ICT tools which both had mean scores lower than the mid value of 3.0, indicating that teachers perceive their level of computer self-efficacy and ability to make use of advanced ICT tools to be quite low.

Hierarchical Regression Analysis

This section describes the hierarchical multiple regression analysis performed to test the regression model and the hypothesized relationships. Hierarchical regression analysis allows for the estimation of path relationships while taking into account the effects of control variables.

Control Variables

As recommended by Cohen and Cohen (1983), demographic variables such as gender, age and level of qualification were included as control variables. Also included as control variables were, level of managerial responsibility, level of subject being taught and ICT policy in school. All of those can be qualified as “status variables” (Cohen and Cohen, 1993), that usually precedes the other theoretical factors included in this study. The control variables of the study were dummy-coded as suggested by Field (2013). Gender was coded as 0 = female and 1 = male. Age groups 30-39, 40-49 and 50 and above were dummy coded, while the category 18-29 years old was taken as the reference group.

For level of managerial responsibility, the four categories were transformed into two categories. The category none indicating no position of managerial responsibility was coded as 0 while the three other categories were merged into a new category, “managerial position” and coded as 1. Level of qualification had two categories, undergraduate level and postgraduate level, it was coded as 1 = postgraduate level and 0 = undergraduate. For level of subject being taught the three categories were transformed into two categories. It was coded as 1 = HSC Level and 0 = Lower than HSC level. Finally a dummy code was assigned to the variable school policy on ICT, coded as 1 = yes and 2 = no. A total of five dummy variables were therefore considered as control variables.

Testing of Assumptions

Preliminary tests were conducted to ascertain that the assumptions of linear multiple regression analysis was met. First scatter plots linking the IVs to the DV showed that the relationships all satisfied the condition of linearity. Independence of error terms was tested using the Durbin-Watson statistic which was found to be 2.13, close to the 2.0 value (Watson, 1951). The assumption of homoscedasticity was tested by plotting the standardized predicted value against the standardized residuals. Inspection of the scatter diagram showed no pattern structure that might have indicated the presence of heteroscedasticity (Field, 2013).

The assumption of absence of multicollinearity was also tested and satisfied using the variance inflation factor index which was within the recommended threshold values of a minimum of 1 and a maximum of 10 (Field, 2013). Normality was verified using the standardized residuals histogram and normal P-P plot (Field, 2013). All the assumptions, namely, linearity, independence of error terms, homoscedasticity, no multicollinearity and normality of error terms were satisfied.

Results of the Hierarchical Linear Regression Analysis

As shown in table 4 below, the control variables are first entered as Model 1 (Adoption of ICT = Intercept + gender + age group + managerial responsibility + level of qualification + school policy) of the hierarchical regression equation. Findings indicate a significant model (F = 3.88, p < 0.05) and show that these variables account for 8% (R^2 = .08) of the variation in adoption of ICT in teaching and learning.

Table 4: *Hierarchical Regression Analysis (Model Summary)*

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.283	.080	0.057	.6914	.080	3.472	9	358	.000	
2	.660	.435	.418	.5433	.355	111.933	2	356	.000	
3	.746	.556	.535	.4856	.121	15.927	6	350	.000	2.127

Next, the two TAM variables, that is, perceived usefulness and perceived ease of use are entered in Model 2 (Adoption of ICT = Intercept + gender + age group + managerial responsibility + level of qualification + school policy + perceived usefulness + perceived ease of use) to analyze their contribution to predicting adoption of ICT in teaching and learning. Entry of these variables lead to an overall significant model (F *(2,356)* = 24.95, p < 0.05) and result in an R^2 change of 35.5% (ΔR^2 = .355), which is statistically significant (ΔF = 111.93, p < 0.05).

In Model 3, additional variables identified from the literature and through the exploratory phase are entered, namely, competencies in using common ICT tools, competencies in using specialized ICT tools, teacher's self-efficacy, teacher's computer self-efficacy, top management and peer support and ICT infrastructure (Model 3: Adoption of ICT = Intercept + gender + age group + managerial responsibility + level of qualification + school policy + perceived usefulness + perceived ease of use + competencies in using common ICT tools + competencies in using specialized ICT tools + teacher's self-efficacy + teacher's computer self-efficacy + top management and peer support + ICT infrastructure).

Entry of these variables lead to an overall significant model (F *(6, 350)* = 25.83, p < 0.05) and results in an R^2 change of 12.1% (ΔR^2 = .121), which is statistically significant (ΔF = 15.93, p <

0.05) The final model accounts for 55.6% of variance in the outcome variable, that is, level of ICT adoption in the teaching and learning process. The results provide evidence that the explanatory power of the regression model is substantial, given than more than half of total variation in ICT adoption by teachers is explained by the model.

Table 5: *Hierarchical Regression Analysis (ANOVA)*

	Model	Sum of Squares	df	Mean Square	F	Sig.
1	Regression	14.941	9	1.660	3.472	.000
	Residual	171.158	358	.478		
	Total	186.099	367			
2	Regression	81.019	11	7.365	24.953	.000
	Residual	105.080	356	.295		
	Total	186.099	367			
3	Regression	103.556	17	6.092	25.829	.000
	Residual	82.543	350	.236		
	Total	186.099	367			

Initial *β and t*-statistic values in Model 1, indicate that male and female respondents do not differ with regards to their level of ICT adoption (β = .13, t = 1.72, $p > 0.05$). Similarly no effects are found to exist by age, level of managerial responsibility and level of subjects being taught. However, level of qualification and ICT policy at school do have a significant effect. Respondents having a postgraduate degree report a higher level of ICT adoption in the teaching and learning process compared to those having undergraduate degrees only (β = .18, t = 2.26, $p < 0.05$). Having an ICT policy at the school is also associated with a higher level of ICT adoption (β = .17, t = 2.11, $p < 0.05$).

The final *β and t*-statistic values in Model 3 indicate that the demographic variables are no longer significant when the theoretical constructs are added to the model. Perceived usefulness of ICT positively and significantly influenced adoption of ICT (β = .35, t = 5.78, $p < 0.05$), confirming H1. Competencies in using specialized ICT tools exert a significant positive influence on adoption of ICT (β = .13, t = 3.69, $p < 0.05$), lending support to H2b. Top management and peer support (β = .43, t = 8.25, $p < 0.05$) and perceived ease of use (β = .22, t = 3.63, $p < 0.05$) are also found to have a statistically significant effect on adoption of ICT, thus supporting H5a and H6.

Finally, the standardized regression coefficients indicate that the strongest determinant of ICT adoption in the teaching and learning process is the top management and peer support, followed by perceived usefulness, perceived ease of use and competencies in using specialized ICT tools.

Table 6: *Hierarchical Regression Analysis (Model 3) (Coefficients)*

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
3	(Constant)	-.698	.391		-1.785	.075		
	30-39 Years [a]	.105	.072	.074	1.469	.143	.501	1.996
	40-49 Years Old [a]	-.010	.096	-.005	-.102	.919	.552	1.810
	50 Years and Above [a]	.026	.096	.014	.277	.782	.489	2.045
	Head of Department [b]	-.160	.165	-.108	-.971	.332	.102	9.836
	Male [c]	.001	0.055	.001	.026	.979	.865	1.156
	Postgraduate [d]	.024	0.057	.016	.413	.680	.855	1.169
	HSC [e]	.005	.070	.003	.074	.941	.873	1.145
	ICT Policy [f]	-.010	.063	-.007	-.153	.878	.684	1.461
	Perceived Usefulness	.347	.060	.263	5.778	.000	.611	1.638
	Perceived Ease of Use	.220	.061	.192	3.634	.000	.454	2.201
	Teachers' Ability in using Specialised ICT Tools	.131	.035	.166	3.686	.000	.628	1.592
	Teachers' Competences in using Common ICT Tools	-0.058	0.056	-0.056	-1.037	.300	.436	2.292
	Teacher Self-Efficacy	0.055	0.053	.040	1.044	.297	.844	1.185
	Computer Self-Efficacy	-.006	.043	-.006	-.132	.895	.626	1.598
	Top Management and Peer Support	.431	0.052	.409	8.250	.000	.515	1.941
	ICT Infrastructure	-.025	.031	-.035	-.802	.423	.668	1.497

a. Dependent Variable: ICT Adoption

Notes: [a] Reference group is 18-29; [b] Reference group if educators ; [c] Reference group is female; [d] Reference group is undergraduate; [e] Reference group is Form I to V; [f] Reference group is no school policy

DISCUSSION AND CONCLUSIONS

The aim of this research, which is based on the TAM model, is to gain a better understanding of the antecedents of ICT adoption by teachers in the teaching and learning process. The study focuses on secondary schools and empirical evidence is gained from data collected in the context of Mauritius. A hierarchical regression analysis is used to test for the incremental influence of additional explanatory variables identified from the exploratory phase of the study after the effects of control variables and TAM factors have been accounted for. The TAM model developed by Davis (1989), establishes that users' acceptance of a particular technology is influenced by the

latters' perceptions with respect to the usefulness and ease-of-use of the technology. The model was originally developed for Information Technology Systems. Perceived usefulness is defined as "*the degree to which a person believes that using a particular system would enhance his or her job performance*" (Davis, 1989) and perceived ease-of-use is defined as "*the degree to which a person believes that using a particular system would be free of effort*" (Davis, 1989, p.320).

In the present study the two factors from TAM are added to the regression model after having controlled for demographic variables such as gender, age and level of qualification. Moreover, several other factors are identified from past literature on ICT adoption and an exploratory phase which consisted of focus group discussions with secondary school teachers in Mauritius. These other factors are added in stage three of the hierarchical regression analysis. As presented in the last section, the final model explains 55.5% of variance in ICT adoption. It is also observed that the two TAM factors have the greatest influence on ICT adoption in the teaching and learning process, though it is still worth highlighting that the model did result in a statistically significant improvement when the additional variables are included. The other factors having a statistically significant effect on adoption of ICT in schools were top management and peer support and teacher's competencies in using specialized ICT tools.

The findings are in line with previous studies which found that perceived usefulness was an important determinant of ICT usage. These studies point out that perceived usefulness of ICT is one of the major predictors for users' adoption of computer technology within the teaching and learning context. Similarly, the results showing that perceived ease of use is also a significant explanatory variable of ICT adoption conquers with previous research, namely, that of Cassim and Obono (2011), which stipulate that perceived ease of use played a key role in user's acceptance of technology and this is supportive of the results obtained by the seminal studies on TAM (Davis, 1986; Venkatesh and Davis, 1996).

As discussed previously, another contribution of this study is that it also tests for the effects of additional variables on intention to adopt ICT in education. Empirical evidence demonstrates that two other factors, top management and peer support and competencies in using specialized ICT tools significantly influence teachers' level of ICT usage in the teaching and learning process. Top management and peer support is actually found to be the most important determinant of ICT adoption in the teaching and learning process, even more influential than perceived usefulness. Much emphasis should therefore be put on the increasing interaction between teachers and their peers with regards to the use of ICT in the teaching and learning process. This also includes leadership showing commitment towards the value of integrating ICT to facilitate and improve the learning experience of students. This finding is backed by previous studies, for instance, Bullock (2004) opined that support from cooperating teachers and technical staffs are key determinants influencing teachers' use of technology resources. Some control variables were also found to matter and given the significant effects of postgraduate qualification level and school policy before the theoretical models were added, it would be worthwhile to encourage teachers to pursue postgraduate studies and it is also recommended that schools do implement a strategic plan for ICT integration in the teaching and learning process.

The study presents some limitations which also lead to recommendations for future studies. The study did not consider the possible indirect effects between variables such as ICT infrastructure and ICT adoption through perceived ease of use. The literature suggests that such indirect effects could exist. It is therefore suggested that future studies test for mediating effects in the context of ICT adoption in the teaching and learning process. This research was based solely on data collected in Mauritius. While Mauritius represents an interesting case of a developing country, generalizations to other countries should be done with caution. It is therefore recommended that this study be replicated in other contexts. Future studies can also examine more in depth the variables that were found to have the greatest explanatory power such as management and peer

support and perceived usefulness using qualitative research methods.

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