

# A structural equation modelling approach for adoption of e-book amongst mathematics and statistics (MAS) students at higher education institutions in Libya

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## Abstract

**Purpose** – The purpose of this paper is to investigate the factors that may impact on the acceptance of the e-book amongst mathematics and statistics (MAS) students at higher education institutions in Libya.

**Design/methodology/approach** – A theoretical model has been developed based on the technology acceptance model (TAM). The factors divided into three groups: intrinsic variables represent the first group of factors that are related to the user or the potential users itself, such as Self-Efficacy and Resistance to Change. Second, extrinsic variables include all the factors that reflect the characteristics of the e-book and the infrastructure for universities, which are Mobility (M), Facilities (F) and Library Service Quality (LS). TAM constructs from Perceived Ease Of Use (PEOU), Perceived Usefulness (PU), Attitude (AU) and Behaviour Intention (BI) represent the last group. Data relating to the constructs were collected through a self-administered survey in 2014. The developed model was measured and tested by structural equation modelling using AMOS (22.0).

**Findings** – The result confirmed that the structural model fits the data well. According to the results, TAM constructs have a significant impact on the acceptance of e-book among MAS students at universities in Libya. In addition, the intrinsic variables play the important role to predict students' BI. Although the extrinsic variables were less important, Facilities was the strong factor in this group.

**Originality/value** – The adoption of e-book amongst higher education students in Libya is still quite low. Hence, identifying the factors that may contribute to e-book adoption is crucial. The contribution of this paper is to determine the factors that effect on the acceptance of e-book amongst MAS students at higher education institutions in Libya.

**Keywords** Technology acceptance model, Structural equation modelling, E-book, Extrinsic variables, Intrinsic variables

**Paper type** Research paper

## Introduction

Due to the advent of technology and its use in many fields such as industry, economy and communications, it has become an urgent need to integrate technology in the education sector (Rhema, 2013; Duhaney and Zemel, 2000). Information and communications technology (ICT) provides new possibilities that can revolutionise traditional learning environments (Gutiérrez-Santiuste *et al.*, 2015). Technological development has created a boom in the education sector, where the teaching methods have developed and become heavily dependent on the use of technology in developed countries (Hashim, 2011; Anuradha and Usha, 2006). The educational application of computers has evolved from being basic stand-alone data processing machines in computer labs, to be able to access the internet, and to where computers are being used in a number of integrated web services that have applications in learning and teaching (Gerry, 2005). The use of ICT in teaching and learning, which is commonly referred to as education technology,



has quickly grown to become an essential method used in the general delivery of education, especially in developed countries.

Electronic education is found to have several different educational and interactive applications that could support a wide variety of different types of applications, such as using the electronic book (e-book). The e-book is defined by Poon (2014), Letchumanan and Tarmizi (2011) as a generic term that refers to the digital representation of printed material presented via electronic devices or mediums such as the personal computer, netbook, e-book reader, PDA, smartphone and iPad. The software of e-book readers allows for access on personal computers or any other e-readers devices, such as the Adobe Acrobat Reader, Microsoft Reader and Adobe Acrobat e-Book Reader (Embong *et al.*, 2012). The content of the e-book primarily includes an electronic copy of the printed materials such as books (i.e. textbooks), research, journals and magazines (Poon, 2014). Most e-books have features that can be provided in an electronic environment, like within-book or within-collection note taking, searching, highlighting, hypertext linking, bookmarking, annotating and multimedia objects (Khanh and Gim, 2014; Park and Kim, 2014; Sieche *et al.*, 2013; Annand, 2008; Vassiliou and Rowley, 2008).

Despite the boom that occurred because of the use of technology in the field of education, developing countries are still facing many challenges in using the e-book. However, very little studies in the field of the acceptance of the e-book have been conducted in developing countries (Jin, 2014; Letchumanan and Tarmizi, 2011). Thus, it prompted an urgent need to conduct extensive studies in this area, especially those related to study the factors that influence the adoption of the e-book. Libya is one of the developing countries that are still struggling to adopt the e-book in the higher education sector. The factors that affect the use of the e-book are still unknown to the present day. Therefore, the main objective of this study is to investigate some factors that may affect the acceptance of the e-book among MAS students at higher education institutions in Libya. The selected factors are Self-Efficacy (SE), Resistance to Change (RC), Mobility (M), Facilities (F) and Library Service (LS).

### Literature review and theoretical framework

Recently, many researchers focus on the role that technology plays in the development of the educational process, and specifically in the factors determining technology adoption and usage. Many models have been developed to aid in predicting technology acceptance. However, there are only a few studies that measure the effect of extrinsic and intrinsic factors on the acceptance of the e-book, especially in developing countries. There are two types of challenges facing the acceptance of the e-book. The first type represents the issues related to extrinsic factors. These challenges are either related to the e-book itself, i.e. Mobility (M) and Facilities (F); or those related to the institution that is responsible for providing the e-book, such as universities, i.e. the Library Service Quality (LS). This kind of challenge is very common in developing countries. The second type involves intrinsic factors such as RC and SE.

According to Ajzen (1991), the TAM is one of the most common theories that have been used extensively. The TAM has been recommended by many researchers for its ability to predict and explain users' behaviour towards the adoption of the technology. However, only a few researchers have used the TAM to explain the acceptability of the e-book (Letchumanan and Muniandy, 2013). Therefore, in this study, related literature that uses the TAM to describe the acceptance of the use of the e-book is reviewed.

The study conducted by Smeda *et al.* (2015) included the investigation of the factors affecting the acceptance of the e-book amongst MAS students at universities in Libya. The TAM was used and extended by using five factors that may affect the acceptance of e-book. Three of these factors belong to the category of extrinsic factors, which is related to the

infrastructure of the universities and the characteristics of the e-book such as accessibility, technology support and cost; the other two factors are classified under intrinsic factors, which are related to the users or potential users, such as SE and social influence. Based on the results, PU, PEOU and students' attitude are the strongest factors at all. Moreover, both intrinsic and extrinsic factors are important for predicting students' BI to adopt the e-book among MAS students at universities in Libya.

Ngafeeson and Sun (2015) explored e-book adoption among undergraduate students in a campus in the Southern area of the USA. The investigation included 158 undergraduate students, who have used the technology of the e-book for learning in a southern USA university. The research examined the moderating role of personal innovativeness in the e-book on the TAM concepts. The results obtained in this study confirmed that the constructs of the TAM and the relationships are effective, reliable and applicable in measuring the acceptance of the e-book (Ngafeeson and Sun, 2015). The study revealed that there is a positive moderating effect of personal technology innovativeness on the relationship between BI to utilise the e-book and the actual usage of e-book technology. These results showed that while people who are more familiar with technology (as well as those who are less techno-savvy) have a higher intention of using online instructional innovations such as the e-book, only the extremely innovative individuals may translate their intention to actual use. These findings have a critical impact on adopters, implementers, as well as the users of learning technologies (Ngafeeson and Sun, 2015).

Conducted a study to investigate learners' adoption and the application of the textbooks to allow libraries to make more informed decisions concerning their e-books collections. The use of e-books as textbooks in education is a new paradigm (Embong *et al.*, 2012; Marques de Oliveira, 2012). Wiese and Plessis gathered data from a classroom and surveyed learners who are aware of e-textbooks and had adequate experience using them. The researchers used a self-administered questionnaire to get the results among 254 respondents at the University of Pretoria for Marketing Management in South Africa. When the TAM was applied, the participants did not find academic e-books user friendly, valuable and comfortable, in comparison to the printed textbooks. For that reason, academic e-books were not popular amongst these learners. The study interpreted this result as the need to emphasis on user-friendliness and observed the practicality of this technology. Students need to realise that e-textbooks are not simply the electronic versions of printed ones. E-books could offer students more benefits such as an interactive platform for participating in rigorous learning. These benefits need to be insisted on making sure that learners achieve the practicality of e-books. The study deduced that students need to be persuaded with regard to the helpfulness of e-textbooks in improving their studies and eventually their grades.

Lee (2013) explored aspects that resulted in the acceptance of the mobile e-book tool in South Korea. The study incorporated the dissemination of the innovation theory and the TAM with the model of technology resistance. He used this incorporated model in the setting of mobile and tablet mobile e-book acceptance by conducting a web-based appraisal. The findings of this survey demonstrated that individual innovativeness has substantial effects on PEOU and PU of mobile e-book technology. Additionally, both PU and PEOU influence not just the participants' intention to use, but technology resistance as well. The study also recorded a substantial negative impact on technology resistance on the intention to use. The perceived risks of mobile e-books raised the issue of technology resistance among the participants.

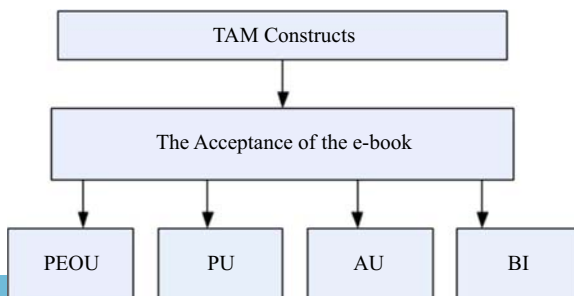
Letchumanan and Muniandy (2013) studied the factors that have an effect on the future intention to utilise e-books among non-using, Mathematics students of Universiti Putra Malaysia. The researchers provided several vital practical inferences. First, PEOU and Perceived Usefulness (PU) are pivotal predictors for non-users when it comes to creating a

positive Attitude towards e-books. The study further showed that PU is a more noticeable factor towards e-books than PEOU. This study shows that PU is more crucial than PEOU, which means that developers should consider this factor when designing an e-book for learning. The noteworthy relationship between PEOU and PU reveals that user friendliness is a crucial aspect of having the e-book as being effective. Relevant parties like e-book suppliers and library managements should organise seminars to present e-books to non-users by demonstrating their PEOU and PU. The findings of this study proved that AU towards the intention to use e-books is one of the vital predictors of the motive for using e-books. However, this model could explain only 25 per cent of the variance (Letchumanan and Muniandy, 2013).

**Theory research model and hypotheses**

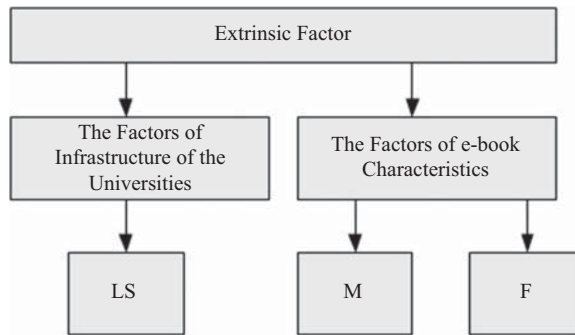
According to previous research of technology acceptance, five external factors have been selected to measure the acceptance of the e-book. Believe that the best method to determine the external variables is the review of literature because it provides a theoretical framework that can explain the relations between the variables of the model. The method of literature review can also assist in the development of a theoretical rationale for the causal relationships between the model variables, leading to the research hypotheses formulation (Al-Aulamie, 2013). The selection process undergoes two conditions (Al-Aulamie, 2013). First, the external factors should address the unique context of the e-book. Second, the external factors must have the ability to explain the acceptance of the e-book. The selected factors in this study came about after a thorough study of some experimental evidence and previous forecasts derived from existing literature.

Yoo *et al.* (2012), Venkatesh (1999) and Davis *et al.* (1992) confirm that both intrinsic and extrinsic factors have a significant impact on individuals’ adoption of IT. According to Yoo *et al.* (2012), research has begun to identify the factors that impact on users’ acceptance of IT since the beginning of the computer era, for example, in Davis’s (1989) study. Yoo *et al.* (2012) pointed out that the current literature has not been able to infer the role of external and intrinsic factors in the process of technology adoption. As a result, the literature often overestimates the impact of intrinsic factors in promoting e-books, while ignoring students’ extrinsic factors that come from the technology itself or the users’ environment. The possible reason may be that the constructs of TAM focus on the intrinsic factors. Previous research works have mostly concentrated on exploring intrinsic factors (i.e. TAM constructs and personal innovativeness) and overlooked the importance of extrinsic ones, as noted when reviewing the literature in the previous section. In fact, developing countries are still lacking in studies that combine the two types. Therefore, this study focused on both types. Figures 1–3 illustrate the developing model factors through collection between intrinsic factors, extrinsic factors and TAM constructs.

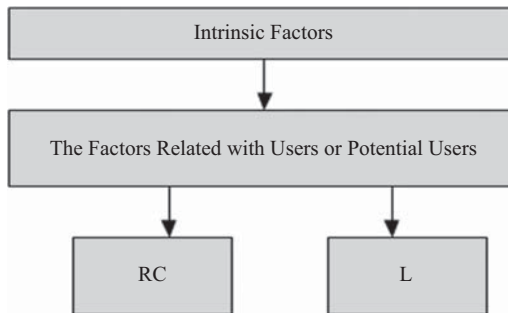


**Figure 1.** TAM constructs group

**Figure 2.**  
Extrinsic variables  
group



**Figure 3.**  
Intrinsic variables  
group

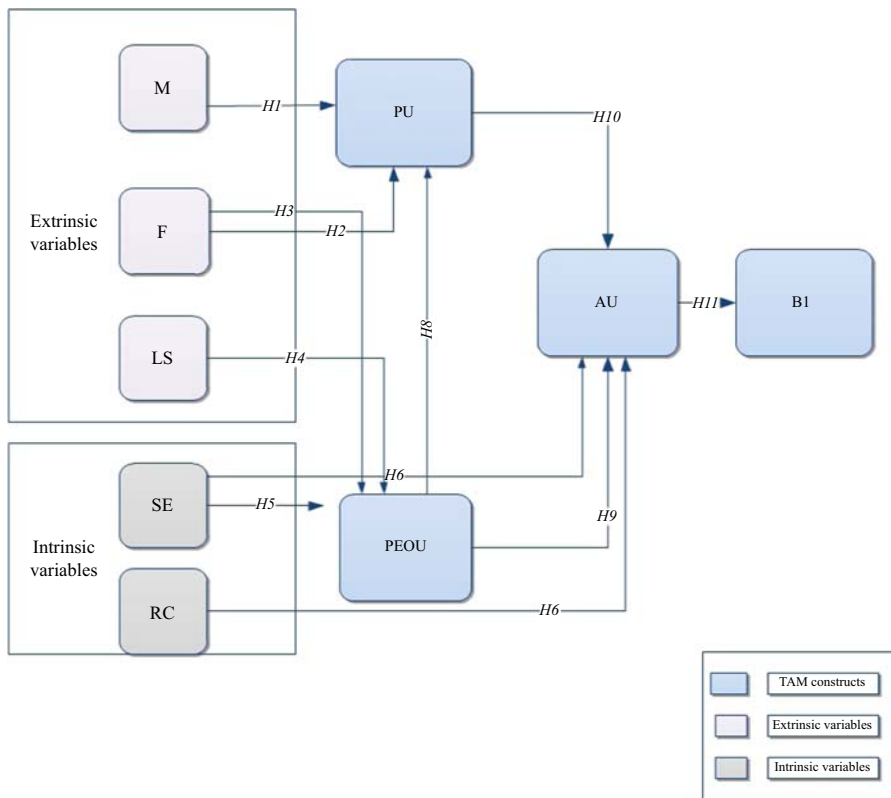


The theoretical framework of this study is shown in Figure 4. The relationship between the factors represents the hypotheses of the study. As shown in Figure 4, 11 hypotheses have been subjected to the measurement.

### Methodology

#### *SEM process*

SEM is a powerful statistical modelling technique which is widely used in sciences that require sophisticated statistical analyses. Researchers can determine the confirmatory factor models, the regression models and the complex path analysis models (Hox and Bechger, 1999). In SEM, the theoretical construct represents the latent variables. The relationships between the theoretical constructs are often represented via the coefficients of path or regression between the factors (Hox and Bechger, 1999). The similarities between traditional methods (i.e. regression, correlation and analysis of variance) and SEM lie on several points. For example, both methods depend on linear statistical models. Also, statistical tests related to both methods are correct, if certain assumptions are met (Suhr, 2006). However, there are many features that distinguish SEM from traditional methods, and this variance has prompted the researcher to use SEM technique (Suhr, 2006). First, SEM is characterised by a high degree of flexibility and a comprehensive methodology that may be lost in traditional methods (Suhr, 2006). Moreover, SEM requires a certain specification of the model to be estimated and examined, while traditional methods determine the default model. SEM is also used to support the hypotheses of the study and to identify the relationships in advance (Suhr, 2006). Also, SEM is a multivariate method which integrates the observed variables (measuring) and



**Figure 4.**  
The proposed theoretical framework

unobserved variables (latent constructs), whereas traditional methods only measure observed variables (Suhr, 2008). In addition, SEM allows the researcher to determine the measurement error precisely, while traditional methods assume the occurrence of the measurements without error (Golob, 2003). Unlike traditional methods, SEM strategy is not straightforward tests to identify the fit of the model. Instead, the study of multiple tests is the best strategy to assess the model fit (i.e. goodness-of-fit (GFI), adjusted goodness-of-fit index (AGFI), root mean square error of approximation (RMSEA), comparative fit index (CFI), standardised root mean residual (SRMR) and Tucker–Lewis Index (TLI) (Golob, 2003). Finally, graphic language provides a convenient and effective way of understanding and representing complex relationships in SEM. Diagrams are converted into a set of equations that solve simultaneously to measure the model fit and estimate the model parameters (Suhr, 2006).

*Instrument*

This study is fundamentally based on a quantitative survey process that recognises the significance of locating the project within a particular cultural, social and historical context (Creswell, 2013). The questionnaire was divided into six parts: demographics, current use of e-book, the acceptance of e-book, the factors related to users or potential users, the factors related to infrastructure of the university and the factors related to the characteristics of e-book. The variables questionnaire items were around 61 items.

*Sample of population*

As shown in Table I, the sample size required was approximately 392 participants. The Yaman table was used to calculate the sample size in this study. Information from the participants was collected using a structured questionnaire in 2014. Participants were being recruited from three public universities, which are: Tripoli University (TU) that is located in the capital city and is one of the oldest Universities in Libya with a student population of 115,000. It was established in 1957 (Rhema, 2013). Al- Zawia University (ZU) which is a local university situated in Tripoli. It is around 48-kilometres westwards. Al- Zawia University was founded in 1983, and the number of undergraduate students is about 47,322 students (sourced from the respective university websites). Al-Jabal Al-Gharbi University (GU) is a regional university situated exterior to the capital city Tripoli. It is almost 100 km to the southwest with a student population of 20,000. It was established in 1985 (Rhema, 2013).

**Data analysis and the model results**

The structural equation modelling (SEM) process is carried out through two approaches, namely, the measurement model and structural model analysis. Many researchers have recommended using these two approaches to building models (Mulaik *et al.*, 1989; Anderson and Gerbing, 1988). The developed model was measured and tested by SEM using AMOS (22.0). Confirmatory factor analysis (CFA) was performed to examine the reliability, construct validity, convergent validity and goodness of fit of an individual factor and measurement models. The testing of the structural model is the step that comes after the completion of the evaluation of the measurement model (Hair *et al.*, 2010; Khodabandelou *et al.*, 2014).

*Measurement of the developed model*

In measuring the model and test the relationships between the constructs, exploratory factor analysis (EFA) was used to test the validity of the variables proposed and compared the initial reliability of the scales. Then, CFA was used to measure the goodness of fit and constructs' validity. In this study, the cut-off point selected for a significant factor loading is 0.30 (see Table II). After removing the items having a factor loading lower than 0.30, Cronbach's  $\alpha$  reliability (CR), convergent validity and discriminate validity of all the multiple-item scales were examined. Hair *et al.* (2006) suggested that for convergent validity to be satisfactory, the value of average variance extracted (AVE) should be 0.5 or higher, while the recommended value for CR by Hair *et al.* (2010) is 0.7 or more for good reliability. Moreover, Al-Hadad (2015), Kannan and Narayanan (2015) and Awang (2012) suggest that in testing the discriminate validity of the developed model, the AVE values of each factor should be compared to the maximum shared variance (MSV). The value of AVE has to be higher than the MSV to ensure discriminate validity. The measurement properties are shown in Table III. Reliabilities in the measurement model ranged from 0.74 to 0.90; it is above the recommended cut-off of 0.70 and convergent validity and discriminates validity was achieved. The results are reported in Tables II and III.

**Table I.**

Descriptive statistics of participants' demographic information

Variable	Category		
	Male	Female	Per cent
Al-Zawia University (ZU)	97	84	45.6
Tripoli University (TU)	69	73	36.2
Al-Jabal Al-Gharbi University (GU)	33	35	18.2
Total	199	192	100

	RC	PU	Factors LS	PEOU	BI	M	F	AU	SE
RC2	0.911								
RC4	0.915								
RC8	0.755								
PU1		0.597							
PU2		0.735							
PU3		0.571							
PU4		0.800							
PU5		0.728							
LS1			0.888						
LS2			0.874						
LS3			0.818						
PEOU1				0.480					
PEOU2				0.518					
PEOU3				0.860					
PEOU4				0.743					
BI1					0.782				
BI3					0.776				
BI4					0.736				
M1						0.752			
M2						0.842			
M3						0.712			
F1							0.719		
F2							0.805		
F3							0.611		
AU1								0.571	
AU2								0.721	
AU4								0.669	
AU5								0.636	
SE1									0.599
SE2									0.745
SE3									0.727
SE4									0.828

**Table II.**  
The factors loading for the measured variables

Factors	CR	AVE	MSV
AU	0.74	0.50	0.39
PU	0.79	0.55	0.33
RC	0.90	0.75	0.08
LS	0.90	0.75	0.25
PEOU	0.78	0.54	0.39
BI	0.80	0.58	0.26
F	0.78	0.54	0.16
M	0.82	0.60	0.16
SE	0.81	0.59	0.24

**Table III.**  
Criteria for convergent validity and constructs' validity

In investigating the goodness-of-fit of the measurement model in the presented research, six measures have been selected to evaluate the validity of the developed model. They are, namely, Chi-Square test ( $\chi^2$ ), Goodness-of-fit (GFI) and AGFI, RMSEA, SRMR) CFI and TLI (Hair *et al.*, 2010). Table IV shows the indicators of goodness-of-fit for the initial measurement models. The  $\chi^2$  is 1.36, which is less than the suggested value ( $< 3$ ); the CFI is 0.80, which is



less than the recommended value ( $< 0.9$ ); RMSEA and SRMR are 0.03 and 0.04, respectively, which are less than the recommended value ( $< 0.08$ ); the result of TLI, being 0.77, is not in the recommended range ( $> 0.8$ ) and GFI is less than 0.9. The value of AGFI recommended by Al-Aulamie (2013) is 0.80 or more ( $AGFI > 0.8$ ). The value of the AGFI obtained is 0.83. To achieve the model fit measurement, the measured variables that have a value lower than the recommended value (lower than 0.5) becomes a candidate for removal (Hair *et al.*, 2010). The items AU2, PEOU1, PU3 and SE1 were excluded. Table IV shows the results of the mode fit of measurement model after removing these items.

#### Structural model and testing of hypotheses

The testing of the structural model is the step that comes after the completion of the evaluation of the measurement model (Hair *et al.*, 2010; Khodabandelou *et al.*, 2014). The structural model hypotheses are tested using three criteria, which are GOF, the Significance of Estimated Model Coefficients and the Explanation Power of the Variance in the dependent variables. The criteria that have been used to the measurement model were used again to measure the goodness of fit (GOF) for the structural model. The outcomes obtained of the GOF were satisfactory and emphasised the acceptance of the proposed model. The findings were within the range of the recommended value, except GFI which was very close to the recommended value (0.90); and this result recommended to be acceptance by Lee *et al.* (2014), Arteaga Sánchez *et al.* (2013) and Ong and Lai (2006). Table IV shows the results of the mode fit of this study. The last step in the process of data analysis involves verifying the hypotheses of the proposed model using path analysis; the results are shown in Table V. The study hypotheses were tested by using path analysis via standardised path coefficients,

**Table IV.**  
Goodness of fit results  
of the measurement  
and structure model

GOF	Recommended	Measurement value	Structural model
$\chi^2$		918.59	1,090.79
df	n/a	587	642
$\chi^2/df$	$> 0.3$	1.56	1.70
CFI	$> 0.9$	0.96	0.95
RMSEA	$< 0.08$	0.04	0.04
SRMR	$< 0.08$	0.04	0.05
TLI	$> 0.8$	0.96	0.95
GFI	$> 0.9$	0.89	0.88
AGFI	$> 0.8$	0.86	0.85

**Table V.**  
Results of path tests

Hypothesis	Path	Critical raito	p-value	Hypothesis result
H1	M → PU	0.14	0.89	Not sig
H2	F → PEOU	3.41	***	Sig
H3	F → PU	1.69	0.09	Not sig
H4	LS → PEOU	0.45	0.89	Not sig
H5	SE → PEOU	4.84	***	Sig
H6	RC → AU	-2.54	**	Sig
H7	PEOU → PU	6.27	***	Sig
H8	PEOU → AU	4.28	***	Sig
H9	PU → AU	5.40	***	Sig
H10	AU → BI	7.65	***	Sig

Notes: \*\*p-value  $< 0.01$ ; \*\*\*p-value  $< 0.001$

the significance of the estimated coefficients (critical ratio) and probability value ( $p$ -value). The acceptance hypothesis should be  $(-0.05 \leq p\text{-value} \leq 0.05)$  as well as the critical ratio which is more than  $+1.96$ , or less than  $-1.96$  (two tails). All hypotheses of the developed model in this study have been successful in overcoming these conditions.

### *The results of hypothesis testing*

The relationship between constructs represents the direct effect (hypothesis). The hypotheses of this study were examined by using path analysis through regression weights for the parameters ( $\beta$ ), the critical ratio ( $t$ -values), standardised path coefficients between models constructs and probability value ( $p$ -value). The standardised coefficient (SE) indicates the estimation value of the dependent variables and independent variables. As a statistical result, six hypotheses were accepted, whereas two hypotheses were rejected (see Table V). In accepting the hypothesis, the probability value must be in the following range:  $(-0.5 \leq p\text{-value} \leq 0.05)$ . The critical ratio ( $t$ -values) is obtained by dividing the values of the path by their standard errors (Abbad *et al.*, 2009). It has been used for testing whether the path values are significantly different from zero (Abbad *et al.*, 2009). The path values are significantly different from zero if the critical ratio is more than  $+1.96$ , or less than  $-1.96$  (two tails) and, therefore, the significance level is  $(-0.05 \leq p\text{-value} \leq 0.05)$ . Otherwise, the hypothesis will be rejected.

Based on the result of a causal relationship with estimated path coefficients and critical ratio ( $t$ -test), the outcomes showed that all the acceptance of e-book hypotheses (TAM constraints) were accepted with  $(-0.05 \leq p\text{-value} \leq 0.05, -1.96 \geq t \geq +1.96)$ . PEOU had a strong impact on AU towards using e-book (H9); and had a strong direct impact on PU of e-books (H8) with  $(\beta = 0.33, p\text{-value} \leq 0.001, t = 4.28)$ , and  $(\beta = 0.48, p\text{-value} \leq 0.001, t = 6.27)$ , respectively. Moreover, PU (H10) had a significantly influence on students' AU towards using e-book with  $(\beta = 0.42, p\text{-value} \leq 0.001, t = 5.75)$ . Finally, AU towards using e-book (H11) had a strongest determinate on BI to adopt e-book  $(\beta = 0.53, p\text{-value} \leq 0.001, t = 7.65)$ .

The factors of SE and RC are the most important of the intrinsic factors, which relate to users or potential users. Both hypotheses of SE (H5, H6) and RC (H7) were accepted. SE has a direct impact on PEOU of the e-book (H5) and students' AU (H6)  $(\beta = 0.32, p\text{-value} \leq 0.001, t = 4.84)$  and  $(\beta = 0.18, p\text{-value} \leq 0.001, t = 3.03)$ , whereas RC (H7) hypothesis has a direct negative impact on students' AU  $(\beta = -0.13, p\text{-value} \leq 0.05, t = -2.54)$ .

From the extrinsic factors regarding the characteristics of e-book is M and F. Mobility hypothesis (H1) had a  $p$ -value higher than the recommended value  $(-0.05 \leq p\text{-value} \leq 0.05)$ . Therefore, it was rejected. The hypothesis of F (H2) was accepted to have a positive impact of the F factor on PEOU of the e-book  $(\beta = 0.22, p\text{-value} \leq 0.001, t = 3.41)$ , whereas rejected towards PU (H3). The results of extrinsic factors also confirmed that the factor related to the infrastructure of universities was insignificant. The hypothesis of LS (H4) towards PEOU of e-book was rejected.

### **Total effect**

There are two types of effects in the path model: direct and indirect. The total effect is the sum of the direct and indirect effects. When the independent variable or even the dependent variable does not have an indirect effect on the dependent variable through the mediator variable (i.e.  $LS \rightarrow PEOU, PEOU \rightarrow PU$ ), the total effect is equal to a direct effect. Otherwise, some of the indirect effects are equal to the total effect, when there is no direct impact of these variables (i.e.  $PEOU \rightarrow BI, PU \rightarrow BI$  and  $SE \rightarrow BI$ ). Based on Table VI, AU, PEOU, PU and SE are identified as the important predictors to students' BI, according to the total effect estimates. PEOU, PU and SE also appear as good predictors to the students' AU. F only has an indirect effect on students' AU. Although the total effect of F on PEOU is good, the direct

Factor	Determinant	Direct effect	Indirect effect	Total effect
PU ( $R^2 = 0.30$ )	PEOU	0.48	–	0.48
	M	0.01	–	0.01
	F	0.12	0.11	0.23
	LS	–	0.01	0.01
	SE	–	0.16	0.16
PEOU ( $R^2 = 0.29$ )	F	0.22	–	0.22
	LS	0.02	–	0.02
	SE	0.32	–	0.32
	PEOU	0.33	0.20	0.53
AU ( $R^2 = 0.60$ )	PU	0.42	–	0.42
	LS	–	0.01	0.01
	SE	0.18	0.17	0.35
	F	–	0.17	0.17
	AU	0.53	–	0.53
BI ( $R^2 = 0.40$ )	F	–	0.09	0.09
	LS	–	0.01	0.01
	RC	–	–0.07	–0.07
	PEOU	–	0.28	0.28
	SE	–	0.20	0.20
	PU	–	0.22	0.22

**Table VI.**  
Indirect effect and  
total effect

effect of F is insignificant, while PEOU is a good predictor to PEOU. There are no indirect effects to the factors on PEOU; therefore, the total effect of F and SE factors is the same as the direct effect.

### Discussions and conclusion

The results of TAM were shown that PU played an important role in affecting attitude towards adoption of e-book and students' BI to use e-book. Students' feeling that the e-book opens a wider field to understand the different topics in mathematics and statistics (MAS) makes them more optimistic about the use of an e-book in the future. Our results were consistent with studies done by Park (2009). Park (2009) pointed that PU is an important factor in affecting on attitude towards e-learning.

PEOU and AU had a statistically significant relationship. Several studies have obtained the same results (Letchumanan and Muniandy, 2013; Chang *et al.*, 2012; Davis, 1989). This result is logical for participants who complain about the limited knowledge about technology applications in general, and that lack of knowledge of how to find and use e-books pushes them to choose to use the e-book if it was easy to handle.

The importance of the PEOU was also through its direct and indirect effects via PU on students' AU towards using e-book. Students believe that the ease of use of e-book increases the chance to benefit from e-book features that help them to study MAS subjects. Students' attitude has a strong influence on students' behavioural intention. Positive attitude generates a positive behaviour towards the use of e-book. This result comes in line with (Elkaseh *et al.*, 2016). Therefore, as in previous studies (Park, 2009; Lee, 2006), this research stressed that TAM is a useful theoretical model to understand and interpret students' BI to use e-book, where all the TAM factors appeared to have a significant impact on the acceptance of e-book among MAS students at universities in Libya. For this reason, there is potential for practical application in the adoption of e-book among MAS students at Libyan universities.

According to the previous results related to the characteristics of e-book, M and F were found insignificant towards PU. Otherwise, facilities had the strongest effect on PEOU,

making it the most important factor in the extrinsic variables group. Mobility appeared to have an insignificant effect on PEOU. The M factor has no effect on students' BI through PEOU and students' AU towards using the e-book. It could be due to the slow internet speed used in Libyan universities, especially since the average internet connection speed in Libya is 0.5 Mbps in 2014, the slowest in the world (McIntyre, 2014). There are a large number of users who still rely on the dial-up connection to access the internet. The most popular method to obtain e-books is to download the files from several e-book websites to be read by the computer or any e-reader devices, especially when there is a lack of university libraries, such as Libyan universities, that offer e-books. This result was supported by Phan and Daim (2011). Although F has not directly affect PU, it has an indirect influence on PU during PEOU. F also has an indirect impact on students' BI to use an e-book. There are many functional features of the e-book, such as tools that assist in clarifying the contents of the e-book, i.e. citation creation, highlighting, bookmarking, note taking, searching, integration with the multimedia, sound and animation, as well as annotating (Annand, 2008). These features can help students use e-books more efficiently and may enhance their perception towards the adoption of the e-book. Mustafa *et al.* (2014, p. 125) reported that "features offered by the e-book are very critical in ensuring the reading process continue to progress".

The results related to the infrastructure of universities have shown that the relationship between LS and PEOU was insignificant. In fact, the result is not surprising because most universities in Libya are still struggling to improve the quality of their services, especially those related to the provision of e-books. Therefore, the students rely on other sources, such as from the internet (whether those offered for free or paid), to get e-books. This explains why the students ignore the importance of the electronic library service in the Libyan universities. Also, the lack of students' experience and knowledge about the importance of e-book services in the libraries of the universities can be a major cause as well.

Moreover, the factors representing the user or potential user themselves are RC and SE. The results of this research indicate that RC has a negative impact on the acceptance of e-books among MAS students at universities in Libya, whether through a direct effect on students' AU or indirect impact on students' BI. RC can be the result of the difficulties faced by students when they use the e-book. Many obstacles prevent the use of e-books and generate a resistance (of the student) to change. For example, some of the problems are related to the student himself, such as not wanting to change his studying habits or lacking the harmony with the technology of the e-book. Also, it can be traced to not having a desire to change to some technological problems facing the students when using e-books. Bhattacharjee and Hikmet (2007) hypothesise that users' RC has a negative relationship with subsequent IT usage behaviours and the outcomes come to support this hypothesis. The findings of the present research show that SE is the first strongest factor that influences PU of use of e-books. The findings also contend that SE has a positive effect on students' AU towards using e-books. It also has a high and indirect positive effect on the BI of using e-books through PEOU and students' AU. The findings can be explained by the user's confidence in their abilities to use e-books associated with their judgment on the PEOU of the devices that are used to download and read e-books. Thus, by developing students' skills in the use of computers or other devices that can be used to read e-books, it will have a positive impact in attracting more students towards the utilisation of e-books.

Although the current literature cannot conclude on the roles of intrinsic and extrinsic factors in the area of technology adoption (Yoo *et al.*, 2012), most of the literature overestimate the impact of intrinsic factors in promoting e-books while ignoring the role of the extrinsic factors. The results obtained in this study confirmed that the intrinsic factors appear as the strongest indication of students' BI. SE and RC emerge as good predictors for students' BI; whether through direct or indirect impact via PU, PEOU and students' AU. On the other hand, the extrinsic factors such as F should also be taken into account as a

good predictor of students' BI. SE was the first strongest factor that has a direct effect on e-book acceptance in both groups. Indeed, the users' confidence in their ability to use reading devices seems to be high.

## References

- Abbad, M., Morris, D., Al-Ayyoub, A.-E. and Abbad, J. (2009), "Students' decisions to use an elearning system: a structural equation modelling analysis", *International Journal of Emerging Technologies in Learning (ijET)*, Vol. 4 No. 4, pp. 4-13.
- Ajzen, I. (1991), "The theory of planned behavior", *Organizational Behavior and Human Decision Processes*, Vol. 50 No. 2, pp. 179-211, available at: [http://dx.doi.org/10.1016/0749-5978\(91\)90020-T](http://dx.doi.org/10.1016/0749-5978(91)90020-T)
- Al-Aulamie, A. (2013), "Enhanced technology acceptance model to explain and predict learners' behavioural intentions in learning management systems", PhD thesis, University of Bedfordshire.
- Al-Hadad, N.F.A. (2015), "Working women and their rights in the workplace", doctor of philosophy thesis, Faculty of Law, University of Wollongong, New edition, Ashgate.
- Anderson, J.C. and Gerbing, D.W. (1988), "Structural equation modeling in practice: a review and recommended two-step approach", *Psychological Bulletin*, Vol. 103 No. 3, pp. 411-423.
- Annard, D. (2008), "Learning efficacy and cost-effectiveness of print versus e-book instructional material in an introductory financial accounting course", *Journal of Interactive Online*, Vol. 7 No. 2, pp. 152-164, available at: [http://murdoch.summon.serialssolutions.com/2.0.0/link/0/eL vHCXmwtV1LS8NAEF6seBBEfnL6wLnopaTk1TWOhkQUd96s55BsNtKDUZot9A\\_4v93JZLNppKAHL0vYwCaZb5h95JtvGPPciW31YgLVlgxj4eTCEwHnvs2dOEt5looiojRWZ6hpkZf oUdd\\_s\\_gVZ-CHhNp\\_wB-06jqUNfKBVSrnEC1v3KDZ330IVArAmu7UyJbJS2icuhoh8znx byUYRpLKuxsHD9jVx1rTCLeSapFFTmAznmQDVBgrH4o75otTtSU4FCXSyqdbaRWQHxp5Fp\\_QpjkjzVcq9v5nSibJiXhnyvzygiw6WaiCau-mqrGIO-qA68Yce\\_3E4dUjTtpmPHVI5X5fK7k1hLbEQJ5NxFAX2DSqnv-dzLm9Fab2DNjAC6d6y91syD0XS2jvYP7PsuosK2YHbL-xBtwRcodsS5RHWEq7od0csy9tEtAlgrIL\\_EQQPggqoEQRCEAhBWEMQNIKqW40DX\\_QShRRAMgkAlnrCrx4fZ\\_ZNFx5F8kKhJ0lrCO2V7KWZLILLOqsyHDDj3wtAuMo4\\_trNARH7BUyclvDyP\\_dDNR-y6N5ybVG5ij1OsVY7aIU6QyJUcseGmx55tvnXOdo2TXLBTzQRx2dbv-gbx9mZA](http://murdoch.summon.serialssolutions.com/2.0.0/link/0/eL vHCXmwtV1LS8NAEF6seBBEfnL6wLnopaTk1TWOhkQUd96s55BsNtKDUZot9A_4v93JZLNppKAHL0vYwCaZb5h95JtvGPPciW31YgLVlgxj4eTCEwHnvs2dOEt5looiojRWZ6hpkZf oUdd_s_gVZ-CHhNp_wB-06jqUNfKBVSrnEC1v3KDZ330IVArAmu7UyJbJS2icuhoh8znx byUYRpLKuxsHD9jVx1rTCLeSapFFTmAznmQDVBgrH4o75otTtSU4FCXSyqdbaRWQHxp5Fp_QpjkjzVcq9v5nSibJiXhnyvzygiw6WaiCau-mqrGIO-qA68Yce_3E4dUjTtpmPHVI5X5fK7k1hLbEQJ5NxFAX2DSqnv-dzLm9Fab2DNjAC6d6y91syD0XS2jvYP7PsuosK2YHbL-xBtwRcodsS5RHWEq7od0csy9tEtAlgrIL_EQQPggqoEQRCEAhBWEMQNIKqW40DX_QShRRAMgkAlnrCrx4fZ_ZNFx5F8kKhJ0lrCO2V7KWZLILLOqsyHDDj3wtAuMo4_trNARH7BUyclvDyP_dDNR-y6N5ybVG5ij1OsVY7aIU6QyJUcseGmx55tvnXOdo2TXLBTzQRx2dbv-gbx9mZA)
- Anuradha, K. and Usha, H. (2006), "Use of e-books in an academic and research environment: a case study from the Indian institute of science", *Program: Electronic Library and Information Systems*, Vol. 40 No. 1, pp. 48-62.
- Arteaga Sánchez, R., Duarte Hueros, A. and García Ordaz, M. (2013), "E-learning and the University of Huelva: a study of WebCT and the technological acceptance model", *Campus-Wide Information Systems*, Vol. 30 No. 2, pp. 135-160.
- Awang, Z. (2012), *Structural Equation Modelling Using AMOS Graphic*, 5th ed., Universiti Teknologi Mara Kelantan, Kota Baru Malaysia.
- Bhattacharjee, A. and Hikmet, N. (2007), "Physicians' resistance toward healthcare information technology: a theoretical model and empirical test", *European Journal of Information Systems*, Vol. 16 No. 6, pp. 725-737.
- Chang, C.C., Yan, C.F. and Tseng, J.-S. (2012), "Perceived convenience in an extended technology acceptance model: mobile technology and English learning for college students", *Australasian Journal of Educational Technology*, Vol. 28 No. 5, pp. 809-826.
- Creswell, J.W. (2013), *Research design: Qualitative, Quantitative, and Mixed Methods Approaches*, Sage.
- Davis, F.D. (1989), "Perceived usefulness, perceived ease of use, and user acceptance of information technology", *MIS Quarterly*, Vol. 13 No. 3, pp. 319-340.
- Davis, F.D., Bagozzi, R.P. and Warshaw, P.R. (1992), "Extrinsic and intrinsic motivation to use computers in the workplace", *Journal of Applied Social Psychology*, Vol. 22 No. 14, pp. 1111-1132.
- Duhaney, D.C. and Zemel, P.C. (2000), "Technology and the educational process: transforming classroom activities", *International Journal of Instructional Media*, Vol. 27 No. 1, pp. 67-72.

- Elkaseh, A.M., Wong, K.W. and Fung, C.C. (2016), "Perceived ease of use and perceived usefulness of social media for e-learning in Libyan higher education: a structural equation modeling analysis", *International Journal of Information and Education Technology*, Vol. 6 No. 3, pp. 192-199.
- Embong, A.M., Noor, A.M., Hashim, H.M., Ali, R.M. and Shaari, Z.H. (2012), "E-books as textbooks in the classroom", *Procedia – Social and Behavioral Sciences*, Vol. 47, pp. 1802-1809, available at: <http://dx.doi.org/10.1016/j.sbspro.2012.06.903>
- Gerry, W. (2005), "Beyond the horseless carriage: harnessing the potential of ICT in education and training", *Education. au Limited. Retrieved October*, Vol. 30.
- Golob, T.F. (2003), "Structural equation modeling for travel behavior research", *Transportation Research Part B: Methodological*, Vol. 37 No. 1, pp. 1-25.
- Gutiérrez-Santiuste, E., Gámiz-Sánchez, V.-M. and Gutiérrez-Pérez, J. (2015), "MOOC & blearning: students' barriers and satisfaction in formal and non-formal learning environments", *Journal of Interactive Online Learning*, Vol. 13 No. 3, pp. 88-111.
- Hair, J.F., Black, W.C., Babin, B.J. and Anderson, R.E. (2010), *Multivariate Data Analysis: A Global Perspective*, Pearson, Upper Sadler River, NJ.
- Hair, J.F., Tatham, R.L., Anderson, R.E. and Black, W. (2006), *Multivariate Data Analysis*, Vol. 6, Pearson Prentice Hall, Upper Saddle River, NJ.
- Hashim, M.O.A. (2011), "Factors affecting the adoption of web-based learning management system by students in higher education: the case of Jordan", doctoral dissertation, George Washington University, available at: <http://dl.acm.org/citation.cfm?id=2231445>
- Hox, J.J. and Bechger, T.M. (1999), "An introduction to structural equation modeling", *Family Science Review*, Vol. 11, pp. 354-373.
- Jin, C.-H. (2014), "Adoption of e-book among college students: the perspective of an integrated TAM", *Computers in Human Behavior*, Vol. 41, pp. 471-477.
- Kannan, K. and Narayanan, K. (2015), "A structural equation modelling approach for massive blended synchronous teacher training", *Training*, Vol. 18 No. 3, pp. 1-15.
- Khanh, N.T.V. and Gim, G. (2014), "Factors influencing mobile-learning adoption intention: an empirical investigation in high education", *Journal of Social Sciences*, Vol. 10 No. 2, pp. 51-62.
- Khodabandelou, R., Jalil, H., Wan Ali, W. and Mohd Daud, S. (2014), "Moderation effect of gender on relationship between community of inquiry and perceived learning in blended learning environments", *Contemporary Educational Technology*, Vol. 5 No. 3, pp. 257-271.
- Lee, S. (2013), "An integrated adoption model for e-books in a mobile environment: evidence from South Korea", *Telematics and Informatics*, Vol. 30 No. 2, pp. 165-176.
- Lee, Y.-C. (2006), "An empirical investigation into factors influencing the adoption of an e-learning system", *Online Information Review*, Vol. 30 No. 5, pp. 517-541.
- Lee, Y.-H., Hsiao, C. and Purnomo, S.H. (2014), "An empirical examination of individual and system characteristics on enhancing e-learning acceptance", *Australasian Journal of Educational Technology*, Vol. 30 No. 5, pp. 562-579.
- Letchumanan, M. and Muniandy, B. (2013), "Migrating to e-book: a study on perceived usefulness and ease of use", *Library Hi Tech News*, Vol. 30 No. 7, pp. 10-16.
- Letchumanan, M. and Tarmizi, R. (2011), "Assessing the intention to use e-book among engineering undergraduates in Universiti Putra Malaysia, Malaysia", *Library Hi Tech*, Vol. 29 No. 3, pp. 512-528, available at: <http://dx.doi.org/10.1108/07378831111174459>
- McIntyre, D.A. (2014), "Libya leads the World in slowest internet connection speeds", available at: <http://finance.yahoo.com/news/libya-leads-world-slowest-internet-104001791.html> (accessed 25 April 2015).
- Marques de Oliveira, S. (2012), "E-textbooks usage by students at Andrews university: a study of attitudes, perceptions, and behaviors", *Library Management*, Vol. 33 Nos 8/9, pp. 536-560.
- Mulaik, S.A., James, L.R., Van Alstine, J., Bennett, N., Lind, S. and Stilwell, C.D. (1989), "Evaluation of goodness-of-fit indices for structural equation models", *Psychological Bulletin*, Vol. 105 No. 3, p. 430.

- Mustafa, B., Harun, N.H. and Endin, M.Z. (2014), "Understanding e-book acceptance through Technology Acceptance Model (TAM model)", *Information and Communication Technology (ICoICT)*, 2014 2nd International Conference, IEEE, pp. 122-126.
- Ngafeeson, M.N. and Sun, J. (2015), "E-book acceptance among undergraduate students: a look at the moderating role of technology innovativeness", *International Journal of Web-Based Learning and Teaching Technologies*, Vol. 10 No. 3, pp. 37-52.
- Ong, C.-S. and Lai, J.-Y. (2006), "Gender differences in perceptions and relationships among dominants of e-learning acceptance", *Computers in Human Behavior*, Vol. 22 No. 5, pp. 816-829.
- Park, S.Y. (2009), "An analysis of the technology acceptance model in understanding university students' behavioral intention to use e-learning", *Educational Technology & Society*, Vol. 12 No. 3, pp. 150-162.
- Park, E. and Kim, K.J. (2014), "An integrated adoption model of mobile cloud services: exploration of key determinants and extension of technology acceptance model", *Telematics and Informatics*, Vol. 31 No. 3, pp. 376-385, available at: <http://dx.doi.org/10.1016/j.tele.2013.11.008>
- Phan, K. and Daim, T. (2011), "Exploring technology acceptance for mobile services", *Journal of Industrial Engineering and Management*, Vol. 4 No. 2, pp. 339-360.
- Poon, J. (2014), "Empirical analysis of factors affecting the e-book adoption—research agenda", *Open Journal of Social Sciences*, Vol. 2 No. 5, p. 51, available at: <http://dx.doi.org/10.4236/jss.2014.25011>
- Rhema, A. (2013), *An Analysis of Experiences and Perceptions of Technology-Based Learning in Higher Education Institutions in Libya: Informing the Advancement of E-Learning*, doctoral dissertation, Victoria University.
- Sieche, S., Krey, B. and Bastiaens, T. (2013), "Investigating students' usage and acceptance of electronic books", *Journal of Educational Multimedia and Hypermedia*, Vol. 22 No. 4, pp. 465-487.
- Smeda, A.M., Shiratuddin, M.F. and Wong, K.W. (2015), "Factors affecting the e-book adoption amongst mathematics and statistics students at universities in Libya: a structural equation modelling approach", *International Journal of e-Education, e-Business, e-Management and e-Learning*, Vol. 5 No. 4, pp. 237-248, doi: 10.17706/ijeeee.2015.5.4.237-248.
- Suhr, D. (2006), "The basics of structural equation modeling", presented SAS User Group of the Western Region of the United States (WUSS), Irvine, CA.
- Suhr, D. (2008), "Step your way through path analysis", paper presented at the Western users of SAS software conference proceedings.
- Vassiliou, M. and Rowley, J. (2008), "Progressing the definition of 'e-book'", *Library Hi Tech*, Vol. 26 No. 3, pp. 355-368.
- Venkatesh, V. (1999), "Creation of favorable user perceptions: exploring the role of intrinsic motivation", *MIS Quarterly*, Vol. 23 No. 2, pp. 239-260.
- Yoo, S.J., Han, S.-H. and Huang, W. (2012), "The roles of intrinsic motivators and extrinsic motivators in promoting e-learning in the workplace: a case from South Korea", *Computers in Human Behavior*, Vol. 28 No. 3, pp. 942-950.

### Further reading

- Wiese, M. and Du Plessis, G. (2014), "The battle of the e-textbook: libraries' role in facilitating student acceptance and use of e-textbooks", *South African Journal of Libraries and Information Science*, Vol. 80 No. 2, pp. 17-26.

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