

USING THE THEORY OF PLANNED BEHAVIOUR TO PREDICT BRUNEIAN SCIENCE AND MATHEMATICS TEACHERS' INTENTIONS TO USE ICT IN TEACHING

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Abstract: The Theory of Planned Behaviour (TPB) (Ajzen, 1985) was utilised as the theoretical framework for predicting and explaining Science and Mathematics teachers' intentions and use of ICT in teaching. The study employed of six-part self-report survey questionnaire: (1) demographic information, (2) Attitudes towards use of ICT, (3) Subjective Norms, (4) Perceived Behavioral Control, (5) Intention to use, and (6) Use of ICT scales. 109 science teachers and 104 mathematics teachers from 15 secondary schools in one district in Brunei responded to the questionnaire. Structural equation modelling (SEM) using statistical software AMOS version 5.0 was used to assess the strength of the relationships between the observed and construct variables and the model fit. The results indicated that teacher' attitudes towards use of ICT and subjective norms significantly predict their intentions and subsequently intentions and perceived behavioural control significantly predict behaviour. However, perceived behavioural control was found not to have significant influence on intentions. The TPB theoretical model explains 20% of the variance in teachers' intentions to use ICT and 31% of the variance in actual use.

Introduction

The use of Information and Communication Technology (ICT) in teaching and learning has been initiated and encouraged in all schools in Brunei Darussalam. During the last decade the Department of ICT of the Ministry of Education, in its capacity as the monitoring authority, has been actively promoting the use of ICT in all aspects of education through its ICT master plan (MOE, 2000).

As part of the ICT master plan, schools are provided with the infrastructure that supports ICT implementation such as internet access, and teachers are trained to develop lessons that incorporated the use of ICT in teaching. Bruneian teachers are now persuaded to use ICT in their lessons (see Suriani, 2002) but evidence from research on Science and Mathematics teachers' state of readiness in using ICT in teaching (e.g. Sallimah & Leong, 2002) has shown that they may not be ready yet.

At this early stage, it may be desirable to acquire information about how ICT is perceived and used by teachers in the classroom and what expectations are associated with the actual use. Such information will enable monitoring authority to effectively plan and promote wide use of ICT and provide some justification for the costs of integrating ICT in school curriculum.

Predictors of Teachers' Use of ICT

The importance of studying teachers' perceptions regarding the use of ICT in teaching have been reported previously (Mumtaz, 2000; Williams, Coles, Wilson, Richardson, &

Tuson, 2000). Mumtaz's (2000) extensive review of literature associated with teachers' responses to ICT implementation revealed that teacher beliefs about teaching and learning with ICT are central for integration. Williams et al (2000) further supported the necessity for identifying teachers' perceptions of needs and factors influencing their ICT use. The common recommendation from both studies about successful ICT implementation was to provide teachers with a supportive environment. Supportive environment refer to the encouragement and assistance from the significant other people such as colleagues and principals as well as the classroom support in terms of availability of ICT materials and technical assistance.

The support from significant others or *subjective norms* are particularly important for motivating teachers to effectively use ICT in teaching (Marcinkiewicz, 1993-94, 1996). Subjective norms have been shown to be a significant variable for predicting teachers' intentions to use computers (Marcinkiewicz & Regstad, 1996).

Another factor that supports teachers' use of ICT pertains to the availability of relevant software, accessibility to suitable websites, and technical support. Teachers' perceptions of the availability of these factors to enable their use of technology effectively (termed context beliefs or *perceived behavioural control*) were also found to be significant predictors of teachers use of technology in teaching (Lumpe & Chambers, 2001).

Besides subjective norms and perceived behavioural control, teachers' attitudes towards ICT use in teaching are also an important variable for predicting teachers' intention and use of ICT. Support for the significance of *attitude towards ICT use* as a predictor variable has not been reported yet. However, Czerniak, Lumpe, Haney & Beck (1999) showed that teachers will use education technology if they possess positive attitudes towards the use of educational technology.

Most previous studies merely described teacher characteristics, factors affecting ICT use and frequency of use. This study attempted to identify fundamental mechanisms that explain the factors affecting the use of ICT by taking a rigorous theoretical approach to investigate some psychological determinants of ICT use: attitudes towards use, subjective norms, and perceived behavioural control, to predict and explain intention to use and actual behaviour of using ICT in teaching.

Zint (2002) compared three attitude-behaviour theories: theory of reasoned action, theory of planned behaviour and the theory of trying to determine which theory best predict science teachers' intention to incorporate environmental risk education. Using mail questionnaires with a large sample of 1336 teachers, she concluded that the theory of planned behaviour provided the best attitude-behavioural model for predicting science teachers to act. Therefore, this study will apply the TPB in an attempt to investigate Bruneian Science and Mathematics teachers' intentions and use of ICT in teaching.

Theoretical Framework

Ajzen's (1985) Theory of Planned Behaviour (TPB) is considered a useful theoretical framework for this study because of its success in predicting and explaining various human behaviours (Ajzen & Fishbein, 1980) and empirical data supports its usefulness (Armitage

& Conner, 2001; Sutton, 1998; Zint, 2002). The TPB postulates that *behaviour* (B) may be predicted by *intention* (I) to engage in the behaviour (*viz.* in this study, the use of ICT) and *perceived behavioural control* (PBC), which is a measure of the anticipated ease or difficulty of performing the behaviour. Intentions, in turn, are influenced by *attitudes* (AB) towards the behaviour and *subjective norms* (SN), which are the perceived social pressures to perform or not perform the behaviour.

In this study, teachers' *attitudes* towards classroom use of ICT were measured using items in which teachers rated their perceptions about the outcome of their using ICT in teaching, such as making their teaching more interesting, more diverse, and improving their teaching, and their feelings towards using ICT, such as enjoyment and desire to use more ICT materials.

Items related to *subjective norms* (SN) probed teachers' perceptions of pressures from significant others such as principals, colleagues, students, the profession more generally and the government's aspirations for ICT use across the curriculum. *Perceived behavioural control* (PBC) were measured using items that represent the extent to which teachers perceive that the availability of resources and other factors such as support from parents, other teachers and technicians and time for planning and developing ICT resources may enable them to teach effectively using ICT. Samples of the ICTE questionnaire items are shown in Table 1.

Research Questions

This study used the TPB as a theoretical framework to examine how the theory constructs (AB, SN, and PBC) may be used to predict and explain science and mathematics teachers' intentions and use of ICT in teaching. The following specific research questions were formulated to achieve the aims of the study:

1. How are teachers' attitudes towards use of ICT in teaching (AB), the influence of subjective norms (SN) and perceived behavioural control (PBC) with regard to ICT related to teacher intention to use (I) and actual use of ICT (B)?
2. To what extent does the TPB provide a basis for predicting and explaining teachers' use of ICT in their teaching?

Methodology

A survey questionnaire was employed in this study to obtain quantitative data that was used to establish the basis for wider generalization. The items of the questionnaire were used as the observed variables to measure the constructs of the TPB (attitude, subjective norms, and perceived behavioural control) that underpins this research.

Instrumentation and Participants

The Information and Communication Technology in Education (ICTE) survey questionnaire consisted of 6-parts:

- 10 items relating to demographic characteristics;

- 11 items relating to teachers' attitudes towards ICT implementation in the classroom;
- 5 items for subjective norms;
- 12 items for perceived behavioural control;
- 5 items relating to teachers' intention to implement ICT in teaching; and
- 12 items related to the use of ICT in the classroom.

The participants were 109 science and 104 mathematics teachers from fifteen government secondary schools in one district in Brunei Darussalam.

Analysis of data

A path-analytic model in conjunction with a causal theory, Theory of Planned Behaviour was used to evaluate the predictor variables (attitudes towards the behaviour (AB), subjective norms (SN) and perceived behavioural control (PBC) for the dependent variables: teachers' intention to implement ICT in teaching (I), and behaviour of implementing ICT (B).

Both validity and reliability of the observed variables were assessed by standard regression weights (λ) and squared multiple correlation (SMC) respectively using exploratory factor analysis (EFA) and confirmatory factor analysis (CFA).

The strength of the relationships between the observed and latent variables and the model fit were determined by structural equation modelling (SEM) method of analysis. The statistical software (AMOS Version 5.0) was employed to assess the full model of SEM. A full SEM model consists of a measurement model (which includes a set of connections between the observed and latent variables) and a structural model (which includes the latent variables connecting to each other). In this study, the observed variables are made up of the items of the questionnaire, whilst the latent variables are the theory constructs.

Exploratory factor analysis using SPSS 10.0 was employed as a preliminary examination of the measurement model in order to investigate whether the *a priori* five-factor structure of the observed variables is the same as the proposed measurement model. For this study, the maximum likelihood (ML) extraction method was used with Promax rotations, a method of oblique factor rotations that allows for correlations among measures. A factor loading of .3 was used as the lower cut-off value as recommended for exploratory studies (Tabachnick & Fidell, 2000).

According to the results, 49.93% of total variation was accounted for in this factor solution. The EFA test results indicated some of the items were loaded to their hypothesized factor. Those factors that exhibited double loading and factor loading lower than .3 were removed from the subsequent analysis.

Confirmatory factor analysis and structural equation modelling were conducted simultaneously using AMOS 5.0 by specifying the model using the observed variables that show factor loading above .3 and estimating using the maximum likelihood (ML) technique. The model was re-specified (see Figure 1) by removing items that showed validity lower than .7 or reliability lower than .5, the cut-off values for adequate analysis as recommended by Bagozzi & Yi (1988)

The final items of the re-specified model and their respective standardized regression weights and squared multiple correlations, used for SEM analysis are shown in Table 1. The standardized regression weights and squared multiple correlations for the observed variables in the re-specified model are significant at $p < .000$, hence confirming the reliability and validity of the observed variables in measuring the respective constructs. For instance, attitude towards ICT use are measured by the observed variables *more* ($\lambda = .8$, $SMC = .65$), *interest* ($\lambda = .94$, $SMC = .88$) and *improve* ($\lambda = .83$, $SMC = .68$).

SEM analysis depends upon assumptions of multivariate normality, linearity, and absence of outliers and is sensitive to missing variables and sample size (Tabachnick & Fidell, 2000). Using SPSS, these assumptions were assessed and the results provided support for the use of SEM. A relatively straight line in a normal probability plot of standardized residuals indicated normality and a rectangular pattern of distribution of residuals in a scatter plot point to the absence of multi-collinearity and singularity. There were no outliers or missing data. The sample size ($N = 213$) in this study is considered adequate as it fulfils the requirement of a minimum of 200 subjects for small to medium model (Boomsma, 1983). The re-specified structural equation model assessed the effects of three independent variables (AB, SN, and PBC) and two dependent variables (I and B).

Table 1
Measurement items, reliability and validity of re-specified model

Observed Variable	ICTE Questionnaire Item	λ	SMC
AB			
More	I would like to use more ICT in my teaching.	.80	.65
Interest	Using ICT in my teaching makes my lessons more interesting.	.94	.88
Improve	Using ICT improves the presentation of materials in my lessons.	.83	.68
SN			
Principal	My use of ICT is influenced by my principal's opinions.	.87	.76
Student	My use of ICT is influenced by my students' opinions.	.93	.86
Government	My use of ICT is influenced by my government's opinions.	.89	.79
PBC			
Resource	The following factors would enable me to teach effectively using ICT: Resources (educational software)	.81	.66
Professed	Professional development opportunities on using ICT in teaching.	.80	.64
Internet	Access to the Internet.	.79	.62
Quality	Quality software	.84	.70
Physical	Physical classroom structures	.72	.52
I			
Intend	I intend to use ICT in presenting my lessons this month.	.92	.85
Prepare	I am likely to use ICT in preparing for my teaching this month.	.87	.76
Instruct	I intend to instruct my students to use ICT materials during my lessons this month.	.93	.86
B			
Netuse	My teaching often requires students to use the internet for research purposes such as to seek out a solution.	.72	.52
Webuse	I utilize the newest software and web-based innovations in my instructions.	.75	.56

Note. Cut-off value: validity, $\lambda > .7$, item reliability, $SMC > .5$

Results

The first research question sought to examine the strength of each of the TPB constructs (AB, SN, and PBC) in predicting intention (I) and behaviour (B). The re-specified structural model (illustrated by ellipses with thick arrows connecting the latent variables in Figure 1) is examined. The standardized regression weights (λ), denoted by the number accompanying the path arrows in Figure 1 indicates the strength of relationships and are tabulated in detail in Table 2.

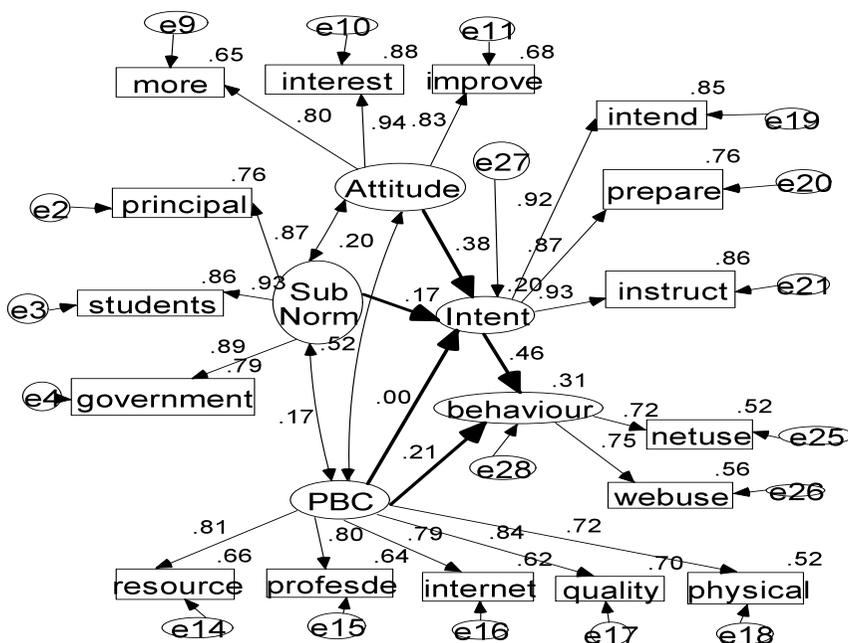


Figure 1. TPB Model specification, standardized estimates and squared multiple correlations.

As shown in Table 2, attitude towards the behaviour ($\lambda = .38$, $p = .000$) and subjective norms ($\lambda = .17$, $p = .016$) significantly predict teachers' intentions. Teacher's intentions also predict behaviour ($\lambda = .46$) significantly at $p = .000$. Perceived behavioural control does not predict intention ($\lambda = .00$) but predicts behaviour ($\lambda = .21$) significantly at $p < .01$.

The squared multiple correlation coefficients (denoted by the number at the top right hand corner of the relevant ellipses in Figure 1) indicate the amount of variance explained

by the variables. It can be seen that AB, SN and PBC explained only 20% of the variance in intentions (I), whilst AB, SN, and PBC explained 31% of the variance in behaviour (B).

Table 2
Standardized Regression Weights (λ) for model paths

MODEL PATH			λ	Significance
Intent	<---	Attitude	.38	p=.000
Intent	<---	Subjective Norm	.17	p=.016
Intent	<---	PBC	.00	p=.952
Behaviour	<---	PBC	.21	p=.009
Behaviour	<---	Intent	.46	p=.000

The second research question sought to examine the extent to which the TPB provides a basis for predicting teachers' intentions and use of ICT in their teaching. The full model was assessed using the overall fit indices provided by AMOS 5.0. The result of the model assessments is presented with the criteria for acceptable model fit (Bagozzi & Yi, 1988) in Table 3.

Table 3
Assessment of model fit for TPB

Fit	Measurement Model	Recommended values for acceptable fit
Chi-square (χ^2)	$\chi^2_{96}=131.29$ (p = 0.000)	Small chi-square (p > 0.05)
Normed chi-square (χ^2/df)	1.368	Between 1.0 and 2.0
Goodness-of-Fit Index (GFI)	.932	Over .9
Adjusted Goodness-of-Fit Index (AGFI)	.904	Over .8
Normed Fit Index (NFI)	.944	Over .9
Tucker-Lewis Index (TLI)	.980	Over .9
Root Mean Square Residual (RMR)	.050	Lower than .08
Root Mean Square Residual Error of Approximation (RMSEA)	.050	Lower than .08

The TPB model meets all the "goodness of fit" indices as indicated in Table 3 except for the criteria of insignificant chi-square. However, the model fit assessment is based on a combination of various goodness-of-fit criteria which indicates an acceptable fit to the data and that there is not enough evidence to reject the model. The model can predict 20% of the variance in teachers' intentions to use ICT and 31% of the variance in actual use

Conclusions and recommendations

Ajzen's theory of planned behaviour (TPB), a widely applied social-psychological model, was employed to provide theoretical understanding of the influence of teachers' attitudes and their perceptions of the opinions of significant others on their use of ICT for predicting their actual use of ICT in teaching.

The assessment results of the TPB model indicated a good fit in explaining and predicting teachers' intentions and behaviour. Teachers' attitudes towards use of ICT and subjective norms significantly predict their intentions and subsequently intentions and perceived behavioural control significantly predict behaviour. However, perceived behavioural control was found not to have significant influence on intentions.

The TPB model was shown to be a good fit for explaining intention and behaviour of teachers in using ICT. However, it performs comparatively poor in terms of explaining power for intention, which meta-analyses shows that TPB model explains 40%-50% average of the variance in intention. Nevertheless, it performs well within the 19%-38% average of the variance in behaviour (Sutton, 1998). In this study, the TPB explains 20 % of the observed variance in intentions and 31% of the observed variance in behaviour.

In conclusion, these findings show that a combination of teachers' attitudes, subjective norms and perceived behavioural control explain a small percentage of teachers' intentions to use ICT in teaching and their actual use. The influence of other latent variables may also contribute to teacher decisions about ICT use, such as the effect of demographic variables (Ajzen & Fishbein, 1980), other variables such as past behaviour/habit, moral norms, self-identity, and affective beliefs (Conner & Armitage, 1998). It is therefore recommended that future research include these variables in investigations.

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