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Unpacking teachers' acceptance of technology: Tests of measurement invariance and latent mean differences

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A R T I C L E I N F O

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A B S T R A C T

This study examines the factors that explain teachers' technology acceptance. A sample of 673 primary and secondary school teachers gave their responses to a 16-item technology acceptance measure for pre-service teachers (TAMPST). Results of this study showed teachers have a generally positive level of technology acceptance and that the TAMPST is a valid tool to be applied to teachers although it was originally developed to test pre-service teachers. Tests for measurement invariance and latent mean differences on the five factors in the TAMPST provided support for full and partial configural, metric, and partial scalar invariance by gender, length of service in teaching, and teaching level. The tests of latent mean differences found significant differences by gender for perceived ease of use, with male teachers rating higher than their female counterparts. Between teachers with shorter and longer years of teaching service, statistical significance was found in the mean differences for perceived ease of use and attitude towards technology use. No significant mean differences in each of the five factors were found between the primary and secondary teachers.

1. Introduction

Since the 1970s, technology acceptance has been a key area of interest among researchers in business and information systems disciplines. Among the research themes has been a focus on identifying the conditions or factors that drive technology integration among business users (Legris, Ingham, & Collerette, 2003). Arising from these efforts, several theories and models have been proposed as frameworks to enable researchers to identify significant variables that both explain and predict technology acceptance at individual and organizational levels. In their review of 99 studies on information technology acceptance/adoption, Jeyaraj, Rottman, and Lacity (2006) identified at least 10 theories that had been proposed between 1983 and 2003. In addition, these authors reported 135 independent and 8 dependent variables in their review. In recent years, researchers have adapted some of these theories to investigate their capability in understanding technology acceptance of users in education (e.g., Hammond, 2011; Teo, 2009; Teo, Koh, & Lee, 2011). Of these theories, the technology acceptance model (TAM) (Davis, 1989), the theory of planned behaviour (TPB) (Ajzen, 1991), and the unified theory of acceptance and use of technology (UTAUT) (Venkatesh Morris, Davis, & Davis, 2003) have received much attention and been widely applied and tested in educational contexts with students and teachers as user groups.

In any school, teachers play a key role in the effective integration of technology for teaching and learning. Teachers decide on the type, frequency, and quantity of technology tools they use in their curriculum design and lesson delivery. Although, it may appear that technology integration is part of their job requirements, teachers exercise complete volition over their intention and actual usage of technology within the professional space. With rapid advancements in technologies, there is greater pressure on teachers to engage various types of tools in conceptualising, preparing, and delivering their lessons. In addition, with covert expectations from their increasingly technologically savvy students, teachers may feel that engaging technology in the instructional process as an option that they cannot exercise.

Despite the significant role of technology in effective instruction, there is evidence to suggest that teachers have lacklustre responses towards using technology for teaching and learning in many parts of the world (Zhao & Cziko, 2001). For example, Becker (2001) found that

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teachers in the United States were not regular users of the computer for teaching and, when they did, the computers were used for low-level purposes such as games and drills in the classroom. In the United Kingdom, BECTA (2004) found that teachers cited a lack of technical support, their own lack of confidence, and a lack of belief in the advantages of using technology for instruction as some of barriers they faced in achieving technology integration in the classroom. In Australia, Birch and Burnett (2009) cited a lack of clear institutional direction concerning course design and delivery time as major issues teachers have to cope with in the development of e-learning environments.

The extent to which technology has been effectively employed for teaching and learning depends largely on the level of teachers' acceptance. An individual's acceptance of technology is referred to as the level at which he or she is willing to use the technology for which it was designed (Teo, 2010a). When teachers do not use technology in the way it was designed to serve, the affordances of technology cannot be maximised for effective teaching and learning to take place. The literature suggests that many acceptance studies focused on the identification of factors that affect users' technology acceptance. These included personal factors such as: attitudes towards using computers (Teo, 2009); perceived enjoyment thereof (Teo & Noyes, 2011); and emotional attachment (Read, Robertson, & McQuilken, 2011), technical factors such as technological complexity (Thong, Hong, & Tam, 2004); and environmental factors such as facilitating conditions (Venkatesh, Brown, Maruping, & Bala, 2008).

1.1. Theoretical background

From the literature, the theory of reasoned action (TRA) (Fishbein & Ajzen, 1975), the theory of planned behaviour (TPB) (Ajzen, 1991), the technology acceptance model (TAM) (Davis, 1989), and the unified theory of acceptance and use of technology (UTAUT) (Venkatesh, Morris, Davis, & Davis, 2003) have been widely reported to be effective in predicting acceptance among users in educational settings. In the TRA, behaviour is posited to be determined by an individual's intention to perform the behaviour and intention is a function of that person's attitude toward the behaviour and his or her 'subjective norm' (Ajzen & Fishbein, 1980). While attitude toward behaviour refers to the amount of pleasure a person derives from performing a behaviour, subjective norm is defined as the extent to which an individual is motivated to comply with the views others hold about the behaviour. The TPB is an extension of the TRA, which includes perceived behavioural control, defined as what factors influence an individual's decision through that person's perception of how easy or difficult it would be to perform a behaviour (Ajzen, 1991).

The TAM was proposed by Davis (1989) with an expressed desire to explain a user's level of technology acceptance. In the TAM, actual technology use is determined by one's behavioural intention to use a particular technology. Behavioural intention is affected by attitude toward usage, and by the direct and indirect influences of perceived usefulness and perceived ease of use. Both perceived usefulness and perceived ease of use jointly affect attitude toward usage, whereas perceived ease of use has a direct impact on perceived usefulness (Davis, 1989). Having reviewed the above and five other models of technology adoption, Venkatesh et al. (2003) proposed the UTAUT to explain users' intentions to use technology and subsequent usage behaviour. This theory relies on four key constructs (performance expectancy, effort expectancy, social influence, and facilitating conditions) to predict both usage intention and behaviour.

Considering the evidence drawn from empirical studies that employed the above theories and models, Teo (2010a) developed a model depicting technology acceptance as a multidimensional construct comprising five factors: perceived usefulness; perceived ease of use; attitude towards technology use; subjective norm; and facilitating conditions (Fig. 1)

1.2. Measurement invariance

When examining user acceptance, researchers were also interested in making comparisons across groups using the data obtained from the same instrument or measure. These groups may be across gender, age, types of technology, or educational levels. Methodologically, such comparisons are predicated on the equivalence of the responses although evidence to support this assumption is rarely reported in research on technology acceptance (e.g., Teo, Ursavas, & Bahcekapili, 2012; Wong & Teo, 2009; Wong, Teo, & Russo, 2013). In not doing so, researchers have implicitly assumed that their data were sufficiently invariant to allow comparison across groups (e.g., males and females) without first establishing measurement invariance. Borsboom (2006) defined measurement invariance as the same attribute relating to the same set of observations in the same way in each group. This means that the mathematical function that relates latent variables to the observations must be the same in each of the groups involved for meaningful comparison between groups or persons to be made and failure to do so may result in biased estimates leading to erroneous interpretations of the findings based on scores that were obtained due to chance or stained by error. To avoid this situation, measurement invariance is often tested before between-group comparisons are made.

1.3. Steps in establishing invariance

After an extensive review of the literature, Vandenberg and Lance (2000) proposed several steps to establishing measurement invariance in increasingly restrictive stages. In addition to configural invariance, they suggested examining whether (1) the rating scales are used similarly in different groups (metric invariance) and (2) the quantifiable meanings of the scale are the same across groups (scalar invariance). Prior to further tests of invariance and substantive analysis being performed, metric invariance should be established (Steenkamp & Baumgartner, 1998) and, if we wish to compare the mean differences of constructs across groups, scalar invariance is required (Meredith, 1993). Although it is possible to test for other forms of invariance, such as equality of error variances and covariances across groups, these tests are considered to be excessively rigorous (Byrne, 2010). Before testing for measurement invariance across groups, the one-sample models are tested separately (configural invariance). This provides an overview of how consistent the model results are. This will be followed by testing for metric and scalar invariance.

Configural invariance acts as the baseline and is satisfied if the pattern of fixed and non-fixed parameters in the model is invariant across groups. Because the configural invariance model provides the basis for comparison with all subsequent models in the invariance hierarchy, if the data do not support configural invariance, they will not support the more restrictive metric and scalar models either (Bollen, 1989). The metric invariance is more restrictive than the baseline model and is conducted by constraining the factor pattern coefficients (loadings), which reflect the relationship between latent scores and observed scores, to be equal across groups. When metric invariance is supported, it