Examining teachers’ intentions of using technology as teaching tool: Using Structural Equation Modelling

Indu Nair, Dr. V. Mukunda Das

Abstract— Using two theoretical frameworks, the Technology Acceptance Model, and the Decomposed Theory of Planned Behaviour, the study aims at proposing a teachers’ technology acceptance model which helps to examine the relationship among factors that influence teachers' intentions to use technology in teaching. The model is tested using a sample of 208 secondary school teachers, teaching English, two Indian languages – Hindi and Malayalam and Social Sciences, in an Indian State, Kerala. The data was collected using a structured questionnaire; and tested against the research model using a structural equation modelling approach. Results indicated ‘perceived ease of use’ and ‘perceived ability to use’ as the most critical determinants of teachers’ intentions on technology integration in classroom teaching. Perceived ease of use and perceived ability influence attitude to use and attitude in turn was an important antecedent of user behaviour (the self reported use of technology). The model could explain 95% variance in attitude but only 35% variance in user behaviour in the technology use context of the secondary school teachers’ language and social-science teaching. The study gives recommendations for frequent, usage skills enhancing professional development programmes to improve the perceived ability factor among teacher.

Index Terms— Attitude towards use of ICT, TAM, Perceived ease of use, Perceived Usefulness, Perceived Ability, User Behaviour.

I. INTRODUCTION

Though acceptance and usage of technology among teachers has been a topic of research in the USA and European countries since last two decades, the literature review shows very little or no work on these line in Indian context hence the researchers have attempted to develop a model to understand the acceptance of Information and Communication Technologies (ICT) as instructional aide among the secondary school teachers in the State Schools of Kerala (India). The study is conducted in Kerala, where a lot of initiatives are taken up by the State Government in the last two years to help develop new thinking among teachers by the use of new teaching and learning practices by adopting ICT. A lot of efforts are put in for the infrastructure upgradation of schools by setting up of computer labs, providing broadband internet connectivity, multimedia content development for teaching and learning, creating School wiki for collaborative content development and providing an exclusive educational channel targeting students, teachers and parents.

The model used in this study is developed by using the theoretical framework provided by most widely used Technology Acceptance Model (TAM) [1] and Decomposed Theory of Planned Behaviour (DTPB) [2]. TAM which was based on the Theory of Reasoned Action (TRA) [3], is a simple model of IT adoption that claims that the overall IT acceptance or utilization is based on users’ beliefs like system’s perceived usefulness (PU) and systems’ perceived ease-of-use (PEOU), which are the major impact factors for their attitude towards use (ATT). In DTPB, an extended Theory of Planned Behaviour, apart from the attitude and subjective norms (as given in TRA), the perceived behavioural control component is added, which finds its roots from Self-Efficacy Theory (SET) proposed by Bandura [4]. Here, the Behavioural Control Component based on Self-Efficacy Theory can be interpreted as, the behaviour is influenced by the confidence that one has in one’s ability to perform that behaviour. Thus, the present research employs TAM and DTPB to examine the mediating role of factors like Perceived Ease Of Use (PEOU), Perceived Usefulness (PU) and Perceived Ability to use IT (PA) and their relationship with Attitude towards use (ATT) and User Behaviour (UB) (the external variables). The research proposes a structural and measurement Teachers’ Technology Acceptance Model (TTAM). The model is tested for validity against the sample of secondary school teachers using Structural Equation Modelling with AMOS.

Here, if the results are to be compared with similar studies conducted in some other Asian countries, the similarities in perceptions can be clearly traced. In a longitudinal study, examining the public school teachers’ resistance to technology through a model, using responses from 130 teachers attending a 4-week training programme on Microsoft PowerPoint™ in Hong Kong, similar results were found. The study indicated that until and unless the importance of the tool and relevance in teaching is not clearly given by the administrators; the teachers’ reluctance would continue. Similarly, being a longitudinal study the responses at the beginning of training and at the end were collected. The output analysis indicated that perceived ease of use appears to have limited direct effects on user acceptance at training start and end indicating that teachers are not going to use technology just because it is easy to use [5]. In another set of
recent studies held in Malaysia and Singapore, using the Technology Acceptance Model (TAM) framework, the major research findings in these multi-cultural studies were indicating that perceived usefulness, perceived ease of use and computer attitudes were significant determinants of both Singaporean and Malaysian pre-service teachers’ behavioural intention (BI) [6],[7],[8]. In one of the studies researcher extended the TAM by including additional user-related variables such as subjective norm (SN) and facilitating conditions (FC).

This study with a sample of 239 pre-service teachers found that perception of the FC was not significant in influencing Attitude but was significant in influencing perception about ease of use. Although teachers may not use computers because they are easy to use, but if computer technology was perceived as easy to use, teachers may perceive them as useful. On the other hand, computers are perceived to be useless to teachers if they believe that they do not know how to use them [9].

In another study held in Allama Iqbal Open University in Pakistan assessing teachers’ attitudes towards new technologies, teachers are found to be welcoming new technology implementation especially e-learning based options. However, facilitating condition and resource availability were the major concerns. A very high significance level was established for the variables, perceived ease of use, perceived usefulness, facilitating conditions and computer efficacy [10].

II. METHODOLOGY

Structural Equation Modelling (SEM), is a statistical methodology that takes a confirmatory (i.e., hypothesis testing) approach to the analysis of a structural theory bearing on some phenomenon. The term SEM conveys two main aspects of the procedure: (a) the causal process under study is represented by a series of structural (i.e., regression) equations, and (b) that these structural relations can be modeled pictorially to enable a clearer conceptualization of the theory under study.

The hypothesized model is then tested statistically in a simultaneous analysis of the entire system of variables to determine the extent to which it is consistent with the data. If the goodness-of-fit is adequate, the model argues for the apparently reasonable and valid plausibility of postulated relations among variables; if it is inadequate, the tenability of such relations is rejected [11]. In the proposed research model the key variable types are

1. Exogenous (Independent) variables – Perceived Usefulness (PU), Perceived Ease Of Use (PEOU) and Perceived Ability (PA).
2. Endogenous (Dependent) variables – The attitude of teachers towards use (ATT) and Usage Behaviour (UB) or the self reported use of technology in teaching. These dependent variables are influenced by the exogenous variables in the model, either directly or indirectly.

![Figure 1: Conceptual Model of TTAM](image)

The researcher tests the plausibility of the conceptual model as shown in Figure 1, based on sample data that has all observed variables in the model. The objective of the covariance-based SEM is to (1) show that the null hypothesis (the assumed research model with all its paths) – is insignificant and the paths specified in the model which is being analysed, are reasonable for the given sample data (2) establish overall model fit indices thru different measures showing various types of fit [12].

Hypotheses based on the proposed model, are tested to see whether these constructs PU, PEOU and PA have any significant effect on the ATT, also to see the influence of ATT on UB. The three predictors (connected by ➔) are allowed to be correlated but their relationship is not explained in the model [13]. The data was collected using a structured questionnaire (with yes/no answers and Likert scales) consisting of personal questions and 25 items representing all the above mentioned constructs [1],[14],[15]. The 215 questionnaire were distributed among language teachers (teaching English, Malayalam, and Hindi) and teachers teaching Social Science subjects.

III. RESEARCH HYPOTHESES

The Intentions to use technology in teaching is defined in terms of teachers’ perceptions about technology use and their attitude towards use of technology in teaching. The following hypotheses were considered for testing:

H1: Perceived usefulness has a significant effect on attitude towards using computers. (PU -> ATT)

H2: Perceived ease of use has a significant effect on attitude towards using computers. (PEOU -> ATT)

H3: Perceived Ability to use has a significant effect on attitude towards using computers. (PA -> ATT)

H4: Attitude has a significant effect on User Behaviour. (ATT -> UB)

In most of the previous studies of TAM the variance in the
self reported use was measured and not the system use. Even in cases where inclusion of additional variables is seen, TAM could hardly explain 40% of the variance in use. [16]

IV. DATA ANALYSIS

The proposed Teacher’s Technology Acceptance Model (TTAM) was put to test thru the Covariance based SEM package AMOS to generate statistics mainly to analyse the model at three levels : 1) at individual item and construct level, 2) the overall fit for model level, and 3) individual path analysis level. Reliability Analysis in SPSS 17, was done to test the Construct Validity and reliability, and the Cronbach’s Alpha (α), a measure for internal consistency, reliability for the scales or subscales, was found to be 0.825. All the constructs ( 25 items ) exhibited a α value greater than .81, much higher than the threshold value of 0.70 (Nunnally, 1978) and also above 0.8 demonstrating internal consistency of the scale. The total variance explained by the components was 90% [17].

V. MODEL EVALUATION

A. Figures and Tables

A structural equation modeling approach was adopted to test the hypothesized TTAM using AMOS. The parameter estimates using the maximum likelihood method provided by AMOS were used to assess the model fit. AMOS gives fit statistics such as the Chi-square ($\chi^2$), DF, its degrees of freedom, with P the probability value. The smaller the $\chi^2$ value, the better the fit for the model. It has been suggested that a $\chi^2$, two or three times as large as the degrees of freedom is acceptable, but the fit is considered better the closer the $\chi^2$ value is to the degrees of freedom for a model [18]. So, in this case $\chi^2$ value being almost double the degree of freedom, a mixed results for the model fit is indicated using the $\chi^2$ statistics. According to Kline (1998), a value of a relative chi-square index of 3 or less suggests adequate model fit however, according to a Byrne, chi-square/df ratio less than 2 indicates a good fit. Here, a relative chi-square fit index (Normed $\chi^2$), given as 1.897 (=508.47/268), shows that the model fits moderately well.

The value of RMR = 0.066, can be interpreted as indicating that the model explains the correlations to within an average error of .066 . With the values of GFI and AGFI being 0.830 and 0.794 respectively, it can be concluded that the hypothesized model doesn’t fit the data too well, considering the thresholds. The CFI value of 0.822, 0.692 for NFI and the values of IFI and TLI being recorded as 0.826 and 0.801 respectively, seems to be consistent with the previous fit statistics. RMSEA value for the hypothesized model is .066, with the 90% confidence interval ranging from .057 to.075, representing a below average degree of precision. Hence, considering the $\chi^2$ statistics and rest of the model fit indices we can conclude that the initially hypothesized model fits the data only marginally.

To get a better model fit, model modification was carried in this current study. Researchers had the option of using AMOS feature for modification indices to get the expected reduction in the chi-square value and to improve the model by considering possible paths that can be added to the model and/or the option of deleting some variables which have minimal impact, based on the multiple R$^2$ values. Two variables obtained using negative questions seeking response on the learning the technology tools for usage leading to frustration and eating into the valuable learning time indicated large errors hence were removed for further evaluation. The modification indices suggested also had some paths with high MI values , and thus a re-specified model shown in Figure 2, was subjected to further tests to indicate the following model fit chi-square test statistic as shown in Table 1.

<table>
<thead>
<tr>
<th>$\chi^2$</th>
<th>DF</th>
<th>$P$</th>
<th>Normed $\chi^2$</th>
<th>RMR</th>
<th>GFI</th>
<th>AGFI</th>
</tr>
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<tbody>
<tr>
<td>282.07</td>
<td>202</td>
<td>.00</td>
<td>1.396</td>
<td>.041</td>
<td>.894</td>
<td>.868</td>
</tr>
<tr>
<td>NFI</td>
<td>CFI</td>
<td>TLI</td>
<td>IFI</td>
<td>RMSEA</td>
<td>LO</td>
<td>HI</td>
</tr>
<tr>
<td>.799</td>
<td>.93</td>
<td>.92</td>
<td>.933</td>
<td>.044</td>
<td>.031</td>
<td>.055</td>
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Table 1. Modified fit statistics for the modified model

The Incremental Fit Index (IFI) and Standardized Root Mean Square Residual (RMR) were given as 0.93 and 0.041, respectively, to suggest a good fit to the data. Other fit indices were also within acceptable limits, these include AGFI, RMSEA, TLI, and CFI, having values as 0.868, 0.044, 0.922, and 0.932, respectively. While analyzing the goodness of fit for the model after modifying the same, showed the favourable statistics in the RMSEA fit statistics with the obtained value of .053, just below the desired cut-off of .06, and chi-square value of 229.647 with 146 degrees of freedom and normed chi-square of 1.573, well below 2 but for the TLI result of .913, which is just below the required threshold of .95 [19].

B. Significance tests with parameter estimates

Table 2 shown below is the selected output of AMOS, giving the Estimate, the Standard Error (S.E.) and Critical Ratio (C.R.), which is nothing but the estimate divided by S.E., also referred as t-value, followed by Probability Value (P) associated with the null hypothesis, in various columns. All regression weights in t-test the hypothesized TTAM using AMOS. The param

<table>
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<tr>
<th>Estimates</th>
<th>S.E.</th>
<th>t</th>
<th>p value</th>
</tr>
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<tbody>
<tr>
<td>ATT</td>
<td>.28</td>
<td>.04</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>PU</td>
<td>.34</td>
<td>.06</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>PE</td>
<td>.45</td>
<td>.08</td>
<td>&lt;.05</td>
</tr>
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Table 2. Estimated parameter values

Though ATT had a significant impact on User behaviour UB with CR =2.646 (> 1.96).
With all around development in network infrastructure and ICT tools, integrating technology into classrooms in a meaningful way has become a challenge and necessity for the schools today. The study analyses the factors influencing technology acceptance among the secondary school teachers of Government aided secondary schools in Kerala. By using a mixed methodological approach, the research has attempted examining teachers’ computer usage beliefs, attitudes, intentions and self-reported usage of technology in classroom [20]. The research examines usage of the Technology Acceptance Model (TAM), with the perceived ability construct added from the Theory of Decomposed Planned Behaviour (DTPB) for assessing usage behaviour [1], [21]. The critical factors identified through this research along with some practical guidelines can be laid out for the school administrations and ICT tool designers for an effective IT adoption.

In this context, since there are hardly any studies undertaken in Indian education scenario using TAM to assess acceptance of technology as a teaching tool, the researchers’ effort in conducting this study with the purpose of identifying salient beliefs that teachers have about using ICT as teaching tools in India found to have findings very similar to studies mentioned elsewhere in introduction. Empirical results clearly indicated that the research model, developed using TAM and DTPB, exhibited reasonable power for explaining the secondary school teachers’ (a sample of 208 teachers) intentions to use IT to teach. The results provide insight on teachers’ perceptions toward teaching with IT for the sample and can be summarized as follows: (a) perceived ease of use and perceived ability are strong indicators of teachers’ intentions to use technology tools for teaching; (b) the attitude to use technology for teaching has significant impact on user behaviour; (c) perceived ability is not only clearly indicating to have an influence on attitude towards use but on perceived ease of use as well; and (d) perceived usefulness seems to have very insignificant affect on attitude but has a strong correlation with perceived ease of use.

These findings indicate a significant role of perceived ability to use technology in teachers’ acceptance of technology integration. As the perception about usefulness of technology tools in teaching doesn’t seem to be a major impact factor, it is only the ease of use and ability to use technology to be focused upon by the administrators. The methods to improve the ability to use technology among these teachers can definitely help the initiatives taken up by the Government to introduce new teaching techniques using technology in schools. A positive attitude to use technology as a tool can lead to more likelihood of them really using those tools in classroom teaching.

VIII. CONCLUSION

This research study has examined the basic factors influencing secondary school teachers’ intentions toward incorporating IT tools into teaching. The study confirms...
perceived ease of use and perceived ability as strong indicators of teachers’ positive attitude toward teaching with technology tools. This research is of significant relevance to the department of education which is responsible for ushering in new developments and changes in the education system. Bringing in new technology is one of the major factors of change and overcoming the user’s resistance to change has been the major issue in change management always. So, for effective and smooth technology acceptance in a changed education scenario, as this one now, the study clearly indicates that department should give enough importance to facilitating conditions and development of apt teaching tools, along with adopting apt training methods to bring in positive change in the perception of teachers about the use of technology as teaching tool.

To make the teachers comfortable in using technology in classrooms, the most important task seems to be providing them training programme on latest IT tools on a regular basis and build their self-confidence. Initially, they would need a sort of hand holding through these professional development programmes with focus on the diffusion of IT in teaching. Once they gain confidence in handling the pedagogical technology, the integration would follow. This research model TTAM, can be used as an assessment tool for examining other subject teachers’ intentions to use technology as well, as the sample used for this study was specifically Social Science and Language teachers who are not very conversant with using technology. TTAM provides system developers and educators with a useful framework for understanding why teachers are more agreeable to implement IT in teaching in the State. Future research scope in the Indian context can be an examination of acceptance of different teaching tools among teachers using TTAM and to explore its validity and to Study how TTAM can be enhanced to be used in predicting actual usage of technology better.

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