Analytical Evaluation of Technology Acceptance in Teachers Training of Primary Mathematics Education in Hong Kong: A Preliminary Study

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Abstract: Digital technologies have been introduced for the purpose of enhancing the learning and teaching effectiveness, and many tools are designed specifically for mathematics education. However, whether pre-service teachers will actually intend to adopt the software or not in their future workspace is an important question. Even if they do, it is important to study the reasons behind their decision in this particular local context, and how the training curriculum can assist them in fulfilling their teaching goals. In this paper, our aim is to study the technology acceptance of our pre-service teachers in primary mathematics education, and investigate the incentives behind their decision of adoption in our local context based on their technology-enhanced learning experience in our Institute. Using multiple-regression analysis, we examine the factors influencing the technology acceptance of the pre-service teachers in their future teaching career. Our goal is to provide preliminary insights into how technology is perceived by these pre-service teachers in mathematics education training and career. This insight will help us build a better analytical model for a more formal analysis in our future study that fits both local and global contexts.

Keywords: Technology acceptance; TAM; UTAUT; Teachers training; Mathematics education; Multiple-regression analysis

1 Introduction

Educational technology is a core part of the mathematics teacher education curriculum in our Institution. Students (pre-service teachers) often come up with innovative ideas in their lesson plan, yet apparently only a few intend to actually put these into practice in their future teaching. Our experience working with in-service teachers also turns to a similar observation. It is therefore our interest to understand their concerns in order to inform the design of an effective teacher education curriculum.

This paper reports part of our larger study to identify the factors of technology acceptance for both pre-service teachers and in-service primary mathematics teachers in our local context. For each case, an explanatory mixed method approach (Creswell & Clark, 2006) is adopted to study the participants' concerns firstly by quantitative survey, and then secondly by in-depth qualitative interviews with selected participants to gain deeper understanding behind the statistics. Research in this area has been conducted mostly in the higher education setting (see, e.g. the meta-analyses in (Schepers & Wetzels, 2007; Šumak, Heričko, & Pušnik, 2011; Taiwo & Downe, 2013)), while to our best knowledge very little ongoing research has been done in the primary education sector especially in Hong Kong. Through our initiative efforts, the outcomes will inform the curricular design of pre-service teacher training programs and inspire further research in this area.

This paper covers the preliminary results of the quantitative survey with pre-service teachers. Background literatures are presented in Section 2, research methodologies in Section 3, and data analysis and discussion in Section 4. We will then conclude the paper and lay out the roadmap for future works in Section 5.

2 A Brief Description of Related works

The majority of existing studies in the area of technology acceptance take the approach of multi-variable quantitative analysis, which starts with a hypothetical model describing the relations among possible factors of technology acceptance. These studies consist of statistically testing the model using survey data in that particular context. Two popular models of this type are the Technology Acceptance Model (TAM) (Davis, 1985) and its successor, the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh, Morris, Davis, & Davis, 2003).

Early empirical studies following the TAM suggest that perceived usefulness and perceived ease of use of the technology are the fundamental determinants of the teachers' behavior intention to use the technology (Davis, 1989). These in turn depend on other factors such as computer self-efficacy and attitude towards computer (see, e.g. (Teo, 2010)). However, subsequent studies show that the results may not be that conclusive on change of context (Schepers & Wetzels, 2007). Recently, a meta-analysis of 37 studies using UTAUT show that only the perceived usefulness (renamed as performance expectancy in the model) has a strong relation with behavioral intention, while all the other factors are weak although statistically significant (Taiwo & Downe, 2013). In fact, most of the studies in the literature have been conducted in the Western context, while there is evidence that their results are possibly not be generalizable to non-Western contexts. For example, Yuen and Ma report that perceived usefulness is insignificant among 152 student teachers in a part-time teacher education programme in Hong Kong (Yuen & Ma, 2008). Similarly, Lai et. al. studied 264 undergraduate students in Hong Kong and found that perceived usefulness only had marginal significance (Lai, Wang, & Lei, 2012). This could be a cultural phenomenon demonstrated by non-Western users, but no further analysis has been conducted on top of the results to verify this claim.

3 Methodology

The present preliminary study aims to analyze the technology acceptance of a group of pre-service teachers studying primary mathematics education at the Hong Kong Institute of Education. The questionnaire begins with a statement defining educational technology as any digital computer technology that could assist teaching either in the classroom or in after-class learning activities, but excluding usage in teaching preparation or administrative tasks. The questions consist of two parts. The first part (see Table 1) consists of items used in TAM and UTAUT studies to collect the participants' perceptions on eight constructs related to technology acceptance, namely, Perceived Usefulness (PU), Perceived Ease of Use (PEU), Attitude (ATT), Social Influence (SI), Facilitating Conditions (FC), Self-Efficacy (EFF), and Anxiety (ANX), with minimal customization to fit into our specific context. The second part asks other general information about the participants, including their gender, year of birth, their experience of using educational technologies, whether or not they are willing to take part in the follow-up interviews of the study, etc.

Table 1: Items used in the first part of the questionnaire

Construct	Code	Item
Perceived usefulness (PU)	PU1	I would find educational technology useful in my teaching.
	PU2	Using educational technology enables me to accomplish teaching tasks more quickly.
	PU3	Using educational technology increases my productivity (i.e. accomplishes more with less effort and time).
	PU4	Using educational technology will increase my chances of getting a promotion.
Perceived ease of use (PEU)	PEU1	My interaction with educational technology would be clear and understandable.
	PEU2	It would be easy for me to become skillful at using educational technology.
	PEU3	I would find educational technology easy to use.

	PEU4	Learning to use educational technology is easy for me.
Attitude (ATT)	ATT1	Using educational technology is a good idea.
	ATT2	Educational technology makes my work more interesting.
	ATT3	Educational technology is fun.
	ATT4	I like using educational technology in teaching.
Social Influence (SI)	SI1	I believe that people who influence my behavior will think that I should use educational technology.
	SI2	I believe that people who are important to me will think that I should use educational technology.
	SI3	I believe that the school will support the use of educational technology.
Facilitating conditions (FC)	FC1	I believe that I will have the resources necessary to use educational technology.
	FC2	I have the knowledge necessary to use educational technology.
	FC3	I believe that a specific person or group (e.g. technical support team) will be available for assistance with difficulties using educational technology.
Computer self-efficacy (EFF)		I could complete a job or task using educational technology…
	EFF1	… even if there was no one around to tell me what to do as I go.
	EFF2	… if I could call someone for help if I got stuck.
	EFF3	… if I had enough time.
	EFF4	… if I had access to the instruction manuals for the technology.
Anxiety (ANX)	ANX1	I fear about using educational technology.
	ANX2	It scares me to think that I could ruin my teaching using educational technology by making a small mistake.
	ANX3	I hesitate to use educational technology for fear of making mistakes I cannot correct.
	ANX4	Educational technology is somewhat frightening to me.
Behavioral intension of use (BI)	BI1	I intend to use educational technology in my future teaching.
	BI2	I predict I would use educational technology in my future teaching.
	BI3	I have actual plan to use educational technology in my future teaching.

Instead of using the structural equation modeling (SEM) approach in TAM and UTAUT, we use a multiple-regression model as follows: First, an initial model is formulated, named R0, which assumes that behavioral intention (BI) to use technology is a linear function of all the other seven constructs. Moreover, as inspired by UTAUT, gender (GDR) is considered a moderator of perceived ease of use, social influence, and perceived usefulness, while experience (EXP) is considered a moderator of perceived ease of use, social influence, and facilitating conditions. Both moderators are included as categorical variables in the linear equation. Experience is classified as either low, medium, or high according to the students' past exposure to educational technologies. Next, stepwise regression (Hocking, 1976) is applied to eliminate variables from the initial model by minimizing its AIC (Akaike, 1974). The resulting model is named R1 and the coefficients are used to identify the important constructs. This approach of variable selection is only possible in multiple-regression. Although not as sophisticated as SEM, it allows us to examine different variants of the model empirically to find alternative models that better fit the data and are still theoretically reasonable. This insight will help us build more reasonable models for our next stage of study using SEM.

4 Results And Analysis

4.1 Results of the Responses

A total of n=166 valid observations were collected in the study. For the final model R1 consisting of 10 independent variables, this exceeds the rule of thumb suggested by Tabachnick & Fidell (2012) requiring at least $50 + 8 \times 10 = 130$ observations for regression. The corresponding student gender profile is tabulated in Table 2, and the experience profile in Table 3. Descriptive statistics of the constructs are given in Table 4. Inspection of the box plot of these distributions shows that they are not exactly normally distributed but all follow a bell shape. We will therefore use the data as-is without transformation.

Table 2: Gender profile

	Year of Studies				
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Total**
Female	28	72	12	7	119
Male	18	21	2	6	47
Total	46	93	14	13	166

Table 3: Experience profile

	Year of Studies				
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Total**
EXP(Low)	18	32	8	2	60
EXP(Medium)	20	33	4	2	59
EXP(High)	8	28	2	9	47
Total	46	93	14	13	166

Table 4: Descriptive statistics of UTAUT constructs

Construct	**Mean**	**Standard deviation**		**Construct**	**Mean**	**Standard deviation**
PU (Perceived Usefulness)	3.74	0.60		FC (Facilitating Conditions)	3.61	0.60
PEU (Perceived Ease of Use)	3.55	0.76		EFF (Self-Efficacy)	3.67	0.58
ATT (Attitude)	3.81	0.67		ANX (Anxiety)	2.72	0.85
SI (Social Influence)	3.48	0.61		BI (Behavioral Intention to Use)	3.59	0.68

The resulting R1 model explains 56.39% of the variation in BI. The variables included in both models, as well as the R1 coefficients and their statistical significance are indicated in Table 5. Coefficients with p-value greater than or equal to 0.05 are marked as "N/S" (not significant) in the table.

Table 5: Model specifications and R1 regression coefficients (*: p<0.05, **: p<0.01, ***: p<0.001)

R0	**R1**	**Results**		**R0**	**R1**	**Results**
(Intercept)	(Intercept)	N/S		EXP(Medium) x PEU		
PU	PU	0.30***		EXP(Medium) x SI		
PEU	PEU	N/S		EXP(Medium) x FC	EXP(Medium) x FC	N/S
ATT	ATT	0.34***		EXP(Low) x PEU		
SI				EXP(Low) x SI		
FC	FC	N/S		EXP(Low) x FC		
EFF	EFF	0.25***		GDR(M)	GDR(M)	0.16*
ANX				GDR(F)		
EXP(High)	EXP(High)	1.69**		GDR(M) x PU		
EXP(Medium)	EXP(Medium)	N/S		GDR(M) x PEU		
EXP(Low)				GDR(M) x SI		
EXP(High) x PEU				GDR(M) x PU		
EXP(High) x SI				GDR(M) x PEU		
EXP(High) x FC	EXP(High) x FC	-0.47**		GDR(M) x SI		

The findings are summarized below:

1. Of the seven constructs considered in the model, only perceived usefulness, attitude, and computer self-efficacy have statistically significant impact on behavioral intention. In particular, perceived ease of use is not proven to be statistically significant.
2. Experience is a strong moderator. High experience increases the intention to use the technology in the future.
3. Male students tend to have slightly stronger intension to use the technology.
4. Interestingly, if a student already has at least one semester of experience using educational technology, better facilitating conditions decrease rather than increase the students' intention to use the technology in the future.

4.2 Discussion

The results that perceived usefulness has a direct impact on behavioral intention while the same is not true for perceived ease of use is in contrary to early typical results under TAM showing that both are statistically significant. The reason is yet to be found out in follow-up interviews, but one possibility is that the pre-service teachers are less concerned with the latter as they are not supposed to face the practical difficulties immediately. Indeed, these pre-service teachers are full-time students, and they are mostly facing challenges only up to the level of fulfilling the requirement of homework assignments or final projects, which are more or less the same with their peers in the same course. Their effort put into using any educational technology is under countable circumstances that they should be able to handle, such as presentation, group projects, or even teaching practicum. Since the curriculum is designed to give initial experience of formal teaching to the students, the effort expected from them is relatively small compared to real workplace. Thus, their perception in using educational technology for their work or study should not be comparable to in-service teachers or others who may constantly find new challenges at work. Yet, we think that the curriculum should be designed so that they can feel similar challenges in learning and using educational technology compared to post-graduation work. Our future work should be able to address these questions in depth.

For those already with some experiences using the technology, the negative relation between facilitating conditions and behavioral intention to use may be explained by their uncertainty in their future working environment and their inadequacy feeling in experiencing with educational technology. Our undergraduate students are only offered with one core course in how to use technology in their teaching mathematics. It could give the students a feeling of unimportance in using educational technology for teaching in the future. This could also explain why they believe they only have some experiences using the technology rather than none or high, and it fails to sustain their assurance in using it for professional work. Nevertheless, this uncertainty perception could be further investigated in our future qualitative work with interviewing these students.

It is also possible that some students misinterpret the questions, leading to error in their responses. While our questionnaire follows closely the design in the original paper by the proposers of UTAUT, which is presented in English, the majority of students in our sample are native Chinese speakers who may not be able to fully understand some of the questions in English as a second language. They may even hesitate to ask our assistants when they do not understand the questions in order not to project a bad image. One possible measure to take is to translate the questionnaire into Chinese using a back-translation process (Brislin, 1970). Some authors have shown that the UTAUT is robust enough to be used with translated questionnaire (Oshlyansky, Cairns, & Thimbleby, 2007). However, due to time constraint we have used the original English version instead.

5 Conclusions and Future Works

In this paper, our aim is to study the technology acceptance of our pre-service teachers in primary mathematics education, and investigate the incentives behind their decision of adoption in our local context. To the best of our knowledge, this is the first work undertaken in our Institute to study the perception of our students, who will soon serve as the major group of local teachers in primary mathematics sector. Understanding their perspective in technology-enhanced pedagogy is significant to the design of any advanced learning technology that is suitable for their teaching. Our future work will attempt to further investigate their tendency in using educational technology with a more formal model, and study the reasons behind their choices through qualitative approaches.

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