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Examining technology acceptance by school teachers: a longitudinal study

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Abstract

The role of information technology (IT) in education has significantly increased, but resistance to technology by public school teachers worldwide remains high. This study examined public school teachers' technology acceptance decision-making by using a research model that is based on key findings from relevant prior research and important characteristics of the targeted user acceptance phenomenon. The model was longitudinally tested using responses from more than 130 teachers attending an intensive 4-week training program on Microsoft PowerPoint, a common but important classroom presentation technology. In addition to identifying key acceptance determinants, we examined plausible changes in acceptance drivers over the course of the training, including their influence patterns and magnitudes. Overall, our model showed a reasonably good fit with the data and exhibited satisfactory explanatory power, based on the responses collected from training commencement and completion. Our findings suggest a highly prominent and significant core influence path from job relevance to perceived usefulness and then technology acceptance. Analysis of data collected at the beginning and the end of the training supports most of our hypotheses and sheds light on plausible changes in their influences over time. Specifically, teachers appear to consider a rich set of factors in initial acceptance but concentrate on fundamental determinants (e.g. perceived usefulness and perceived ease of use) in their continued acceptance.

Keywords: IT adoption; User technology acceptance; Organizational technology management; Structural equation modeling; IT adoption in education

1. Introduction

The role of information technology (IT) in modern education has increased significantly over the past two decades, but resistance to technology remains considerably high [25]. While technology-supported teaching/learning has become increasingly important in education [6,28,36,43], fostering technology acceptance (as defined by Gattiker [24]) among individual educators remains a critical challenge for school administrators, technology advocates, and concerned government agencies. Understandably, pervasive technology acceptance by school teachers is required for realizing the technology-empowered teaching/learning paradigm advocated by visionary educators and IT professionals. As Keen [23] commented, ‘‘it is not the software but the human side of the implementation cycle that will block progress in seeing that the delivered systems are used effectively.’’

Fundamental to teaching activities is the preparation and presentation of the materials that are selected and packaged to disseminate knowledge. Towards this end, use of an adequate technology can enable teachers to become increasingly effective in preparing, presenting, describing and transferring knowledge, thus nourishing, inspiring, and advancing students’ developments. Morrison and Vogel [47] have therefore advocated effective use of technology-supported presentation visuals to enhance students’ comprehension and retention of course materials.

As a group, teachers may subtly differ from endusers in ordinary business settings. For instance, teachers are relatively independent and have considerable autonomy over their teaching activities, including technology choice and use. This suggests a professional orientation [2] that might lead to differences in teachers’ technology acceptance compared to that of business users. Public schools are institutions whose objectives fundamentally differ from those of business organizations: teachers usually have less peer competition for resources or promotion. From a research perspective, such characteristics can affect teachers’ technology acceptance which, as a result, may differ from that of business workers examined in most previous research.

Teachers have lasting impact on students’ intellectual developments, value systems, and attitudinal beliefs, including those concerning technology. Also public school teachers are not particularly technology savvy, partially because the older ones received training when technology was less developed and pervasive. This, together with a demanding workload and stringent time constraints, can severely hinder technology acceptance by individual teachers, which may have been partially responsible for the lack of convincing evidence supporting technology’s impacts on learning in K-12 education [27].

Our research longitudinally examined technology acceptance decisions by public school teachers. In addition to identifying key acceptance drivers, we examined how their decision-making may differ from that of business end-users. Specifically, we developed a model for explaining teachers’ technology acceptance decision-making, taking into account findings from relevant prior research and important characteristics of the targeted education context. We tested this model using the responses from more than 130 teachers in Hong Kong. The particular technology examined was Microsoft PowerPoint, which can greatly facilitate teachers’ organizing, archiving, presenting, updating and sharing class materials [7].

2. Study background

To prepare students for challenges in a knowledge centric economy, school administrators and government leaders in Hong Kong have strongly emphasized proper integration of technology into curriculum design and classroom activities [1]. Accordingly, technology deployment in education has accelerated, fuelled by substantially increased incentives and funding. For instance, US$ 335 million in capital investments and US$ 30 million in annually recurring costs were earmarked for promoting the use of technology in education in 1998–1999. At the time of our study, most public schools were equipped with networked computers and Internet access.

The critical role of IT in education is clearly recognized by the Education Department, which identified technology-enhanced teaching/learning to be an important objective in its education strategy between 1998 and 2003. Individual teachers’ attitudes toward technology and their ability to use and integrate applications in routine classroom activities were specifically targeted in ‘‘Information Technology Learning Targets’’ in 2000. Several technology competency levels were defined for measuring teachers’ capability to use technology and providing a foundation for training program design.

At the time of our investigation, use of PowerPoint by teachers was far from widespread. From a technology management perspective, examining teachers’ acceptance at this particular time was important; e.g. highlighting barriers to individual acceptance and, at the same time, shedding light on adequate management intervention. In cooperation with the Hong Kong Professional Teachers’ Union, the largest teachers’ union in the region, we conducted a longitudinal study to examine individual teachers’ technology acceptance decision-making before and after an intensive training program.

3. Literature review and motivation

User technology acceptance/adoption has been studied considerably in previous IS research [16,34,38, 52,54]. A review of the literature suggested a prevalent anchor of the cognitive/behavioral approach that focuses on behavioral intention. The fundamental synopsis is that an individual is conscious about his or her decision to accept a technology; thus, acceptance can be explained by the underlying intention. In this vein, the research challenge then is to identify important forces that shape or influence behavioral intention. Jointly, findings from relevant prior research suggest that an individual's intention to accept a technology is likely to be affected by attitudinal, cognitive, and/or normative assessments of attributes or factors pertinent to the technology, the social system, the target task, and the implementation context [22,33,57].

Several intention-based theories have been used to explain different user technology acceptance scenarios; e.g. the theory of reasoned actions [5,21], the theory of planned behavior [4], and the technology acceptance model (TAM) [18]. Adapted from the theory of reasoned actions, TAM is specifically designed for explaining individual technology acceptance decisions across a wide range of technologies, user populations and contexts.

By design, TAM is parsimonious and generic to user technology acceptance decision-making. In spite of its popularity and considerable empirical support, it has been criticized for parsimony. Venkatesh and Davis [61] also pointed out the need for a better understanding of key technology acceptance determinants. To address these constraints, several model extension efforts have been attempted. Some incorporated key determinants or antecedents [59]. Others expanded TAM by including constructs from other theories or models [51,55]. At the same time, the analysis of individual technology acceptance has proceeded along several dimensions, including target users [13,41,48], implementation context [31,44], and technology attributes [12,45,46]. The collective results suggest that an individual's decision to accept a technology is likely to be affected by multiple key factors or considerations pertinent to the technology, the user, and the organizational context [14,20].

As Karahanna et al. [37] noted, an individual's beliefs, attitude towards and cognitive assessment of a technology are likely to evolve dynamically over time. Both initial and continued acceptance decisions are significant and deserve attention. Inconsistent findings have been reported by previous research. For instance, Taylor and Todd [56] suggested an individual's tendency to discount the importance of perceived behavioral control considerations when forming acceptance decision or intention. On the other hand, Hu et al. [32] observed that perceived ease of use might be overly emphasized when an individual has limited knowledge about or experience with the technology. From a research perspective, continued investigations are needed to re-examine and reconcile these inconsistent findings, hence strengthening the theoretical underpinning and its empirical applicability [26,40]. Results also can benefit organizational technology management practices; e.g. enabling design of effective management interventions for sustainable user acceptance.

We therefore longitudinally examined technology acceptance decision-making by public school teachers in Hong Kong. Using a questionnaire survey methodology, we tested the model over the course of an intensive 4-week training program.

4. Research model and hypotheses

As shown in Fig. 1, our research model used TAM for a theoretical basis but excluded attitude, primarily because of its limited mediation effects discussed by [19,60]. Specifically, perceived usefulness refers to the extent to which PowerPoint is considered by a teacher to be useful, whereas perceived ease of use refers to the degree to which a teacher views his or her use of it to be free of effort. We measured user acceptance using behavioral intention, congruent with our definition. According to our model, a teacher's decision to accept or not to accept a technology is directly affected by his or her perception of the technology's usefulness and ease of use as well as computer self-efficacy and subjective norm.

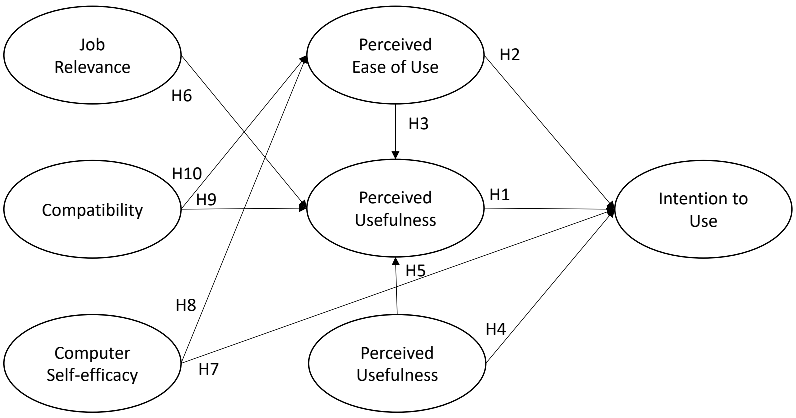

Fig. 1. Research model.

All others being equal, a teacher is likely to consider a technology to be useful when it is easy to use. Hence, we tested the following hypotheses:

H1. The degree to which a teacher considers PowerPoint to be useful has a positive effect on his or her intention to accept the technology.

H2. The degree to which a teacher considers PowerPoint to be easy to use has a positive effect on his or her intention to accept the technology.

H3. The degree to which a teacher considers PowerPoint to be easy to use has a positive effect on his or her perception of the technology's usefulness.

Within a social system, an individual's technology acceptance decision may be influenced by opinions/suggestions to varying degrees. By and large, public school teachers appear to have strong psychological attachments to the school community and exhibit relatively close bonds with their colleagues. Several factors may contribute to the attachments or bonds, including the non-profit nature of schools, less direct competition among peers, personal commit to education, long-term career pursuit and the relatively closed-loop community. As a result, a teacher may be motivated to accept a technology in order to comply with important referents' opinions or a community norm. Such effects are encompassed in the Theory of Planned Behavior. In our case, teachers may decide to accept PowerPoint partially because their colleagues and school administrators are in favor of the decision. In addition, a teacher may also consider PowerPoint to be useful when most of his or her significant colleagues suggest acceptance of the technology. We therefore tested the following hypotheses:

H4. A teacher's perceived subject norm concerning acceptance of PowerPoint has a positive effect on his or her intention to accept the technology.

H5. A teacher's perceived subject norm concerning acceptance of PowerPoint has a positive effect on his or her perception of the technology's usefulness.

Job relevance may influence a technology's usefulness as perceived by individuals and, in this study, refers to the extent to which a teacher considers PowerPoint to be relevant to his or her job. In general, teachers have considerable autonomy in teaching, including choice of teaching material, delivery methods, and technology use. In this vein, the assessment of a technology's relevance to routine classroom activities is important. The effect of job relevance on perceived technology usefulness has also been examined [29]. Therefore, we tested the following hypotheses:

H6. The degree to which PowerPoint is perceived to be relevant to a teacher's job has a positive effect on his or her perception of the technology's usefulness.

Computer self-efficacy (or perceived computer self efficacy, to be more specific) refers to an individual's judgement of his or her ability to use a computer [15]. This may influence an individual's perception of a technology's ease of use and acceptance. Such effects draw theoretical support from the self-efficacy theory [9], which has been applied to explain various individual behaviors or performance. Bandura [10] advocated the use of measures specific to the underlying psychological functioning under examination rather than relying on vicarious experience. Accordingly, we concentrated on measuring individual teachers' general capability of using a computer. Our teachers are not technologically sophisticated and, in most cases, have limited prior computer training or experience. We postulate a positive effect of computer self-efficacy on perceived ease of use. In addition, we also posit that computer self-efficacy has a direct positive effect on technology acceptance. The discussed effects have been empirically examined by previous studies [3,35]. Accordingly, we tested the following hypotheses:

H7. A teacher's (perceived) computer self-efficacy has a positive effect on his or her intention to accept PowerPoint.

H8. A teacher's (perceived) computer self-efficacy has a positive effect on his or her perception of PowerPoint's ease of use.

Compatibility can affect a teacher's acceptance decision indirectly as well; e.g. via perceived usefulness and perceived ease of use [58]. From a system perspective, hardware and software compatibility is important and may affect teachers' decisions to accept a technology, especially when taking account their limited technology training or experience. Therefore, we focused on the hardware and software aspect of compatibility and hypothesized a positive effect of compatibility on perceived usefulness as well as on perceived ease of use. That is, such compatibility may contribute to greater technology usefulness as perceived by individual teachers. Prior research has examined compatibility from different aspects [50], generating support for its effects on perceived usefulness and/or perceived ease of use or usefulness. Similarly, we tested the following hypotheses:

H9. The degree to which PowerPoint is considered by a teacher to be compatible to the computer hardware and software of routine use at school or at home has a positive effect on his or her perception of PowerPoint's usefulness.

H10. The degree to which PowerPoint is considered by a teacher to be compatible to the computer hardware and software of routine use at school or at home has a positive effect on his or her perception of PowerPoint's ease of use.

5. Research design

5.1. Dependent variable

We measured user acceptance using behavioral intention, a dependent variable choice that is theoretically justifiable and empirically supported. As Mathieson [42] concluded, ‘‘given the strong causal link between intention and actual behavior, the fact that behavior was not directly assessed is not a serious limitation.’’ In our case, use of intention to measure user acceptance was also practical, because our targeted subjects had had limited or no prior experiences with PowerPoint before the training; they attended the training program in summer and had few teaching responsibilities. These facts made actual technology usage a less attractive measure for user acceptance. From a management perspective, anchoring user acceptance analysis in intention is desirable when target users have just acquired the necessary training or knowledge. We examined technology acceptance at the beginning as well as at the completion of training.

5.2. Subjects

We targeted teachers from public schools and recruited subjects from those attending a PowerPoint training program designed for partial fulfillment of the technology competency certification. Offered at a training center commissioned by the Hong Kong Professional Teachers’ Union, this program consisted of four 2 hour sessions of hands-on laboratory sessions over a 4-week period. As a group, subjects had received limited computer training during or after post-secondary studies and reported having no previous experience in using PowerPoint.

5.3. Measures

We operationalized the constructs in our model by using measurements validated by previous research, with wording changes necessary for the targeted technology and education context. The particular items for each construct are listed in Appendix A, together with their sources. All question items were measured using a seven-point Likert scale ranging from ‘‘strongly agree’’ to ‘‘strongly disagree’’. All items were randomly arranged and half of them were negated to reduce a potential ceiling or floor effect that may induce monotonous responses from subjects.

5.4. Data collection

We collected responses to technology acceptance evaluation upon the completion of the first and the last laboratory session. Examining user acceptance in this particular manner allowed the intended investigation of probable changes in key acceptance drivers and their influence patterns and magnitudes over the course of training. The same instrument was used throughout the study and was administered by the same investigator. Prior to each data collection, the subjects were explicitly informed of the study’s purpose and intended use, together with an assurance of confidentiality of their response.

6. Data analysis results

6.1. Analysis of respondents

Of the 201 participants attending the training program, 170 were our targeted teachers and most agreed to participate in our study. After removing partially completed responses, we received 138 effective replies in our first data collection and 134 effective responses in the second. A total of 107 teachers participated in both data collections. On average, our respondents were 39 years of age and had 14 or more years of teaching experience. School distribution was largely balanced, though there were slightly more from elementary than from secondary schools. Gender distribution showed an approximate 4:1 ratio in favor of female teachers. Most subjects (71%) primarily taught in the arts and humanities area and few participating teachers (5%) exclusively taught science-related subjects. Most respondents had a university degree or equivalent (62%). Computer access was available to most respondents at work as well as at home (90%). The subjects who took part in the data collections were highly comparable in these demographic dimensions. Table 1 summarizes important characteristics of our respondents.

Table 1

Summary of respondents' characteristics

Demographic dimension	Training commencement (N = 138)	Training completion (N = 134)
Gender		
Male	28 (20.3)	25 (18.6)
Female	110 (79.7)	119 (81.4)
Average age (years)	38.6	38.8
Average teaching experience (years)	14.2	15.0
Affiliated institution		
Elementary school	57 (41.3)	54 (40.3)
Secondary school	55 (39.8)	57 (42.5)
Others	26 (18.9)	23 (17.2)
Primary teaching area(s)		
Science only	7 (5.1)	6 (4.5)
Arts and humanities	98 (71.0)	96 (71.6)
Science and arts–humanities	20 (14.5)	23 (17.2)
Others	13 (9.4)	9 (6.7)

Education level		
University degree or equivalent	87 (63.0)	83 (61.9)
Associate degree	36 (26.1)	33 (24.6)
High school	13 (9.4)	16 (11.9)
Others	2 (1.5)	2 (1.6)
Computer access		
At work	123 (89.1)	120 (89.6)
At home	125 (90.5)	121 (90.3)
Prior computer-related training (received after secondary school)		
0–4 hours	69 (50)	72 (53.7)
5–8 hours	8 (5.8)	8 (6)
9–12 hours	12 (8.7)	10 (7.5)
13 hours or more	49 (35.5)	44 (32.8)

The values given in parentheses are percentages.

6.2. Instrument validity

We evaluated the instrument's validity in terms of internal consistency (i.e. reliability), and convergent and discriminant validity [53]. Internal consistency was examined using Cronbach's a-value. As shown in Table 2, based on both data collections, nearly all constructs exhibited an a-value greater than 0.7, a common threshold for exploratory research [49].

Table 2

Measurement reliability analysis—Cronbach's a-values

Construct	Training commencement			Training completion		
	Mean	S.D.	Construct reliability	Mean	S.D.	Construct reliability
Perceived usefulness (PU)						
PU-1	4.15	1.50	0.77	4.53	1.56	0.77
PU-2	4.49	1.43		4.69	1.54	
PU-3	4.03	1.43		4.36	1.60	
Perceived ease of use (PEOU)						
PEOU-1	4.09	1.67	0.82	4.63	1.64	0.83
PEOU-2	3.76	1.64		4.25	1.76	
PEOU-3	4.04	1.45		4.63	1.51	
PEOU-4	4.46	1.61		4.90	1.51	
Intention to use (ITU)						

ITU-1	5.00	1.25	0.65	5.25	1.19	0.72
ITU-2	4.67	1.38		5.10	1.30	
Computer self-efficacy (SE)						
SE-1	5.89	2.29	0.86	6.63	2.41	0.90
SE-2	6.39	2.42		7.42	2.17	
SE-3	6.69	2.20		7.34	2.02	
SE-4	6.17	2.40		7.21	2.13	
SE-5	6.57	2.31		7.29	2.17	
SE-6	5.79	2.32		6.66	2.13	
Subjective norm (SN)						
SN-1	4.09	1.40	0.79	4.26	1.39	0.88
SN-2	4.23	1.40		4.31	1.40	
SN-3	3.90	1.44		4.09	1.49	
SN-4	4.24	1.41		4.54	1.40	
Compatibility (COMP)						
COMP-1	4.33	1.47	0.64	4.14	1.64	0.91
COMP-2	4.12	1.52		3.96	1.63	
Job relevance (JOB)						
JOB-1	4.70	1.45	0.86	5.14	1.22	0.86
JOB-2	4.81	1.43		5.20	1.21	
JOB-3	4.43	1.32		4.90	1.30	
JOB-4	4.72	1.32		5.22	1.11	
JOB-5	4.74	1.27		5.03	1.26	

Analysis of data from training commencement for behavioral intention and compatibility showed a-values lower than but close to 0.7. This might suggest potential limitations of these measures in the education context. We assessed the instrument's convergent and discriminant validity by using a principal components factor analysis of Varimax with Kaiser normalization rotation. By and large, an instrument is considered to exhibit satisfactory convergent and discriminant validity when measurement items load highly on the respective constructs than on others. Using the responses from the first data collection, a total of seven constructs were extracted with eigenvalues exceeding 1.0; i.e. exactly equal to the number of constructs specified in the model. As shown in Table 3, the question items' loadings were significantly higher on the respective construct (e.g. exceeding 0.6) than on others, thus suggesting our instrument exhibited satisfactory convergent and discriminant validity. Similar factor extraction and loadings were observed in the responses collected upon training completion. In addition, we evaluated the convergent and discriminant validity by examining the correlation coefficient matrix. Results from showed that question items for the same construct exhibited noticeably higher correlation than those for other constructs. Together, results suggested that our instrument had encompassed satisfactory convergent and discriminant validity.

Table 3

Evaluation of convergent/discriminant validity—using factor analysis

Item	Completion of first laboratory session						
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7
PU-1	-0.01	0.24	0.21	-0.08	**0.76**	0.04	-0.10
PU-2	0.03	0.40	0.08	0.05	**0.73**	0.01	0.06
PU-3	0.03	0.09	0.11	0.11	**0.76**	0.23	0.05
PEOU-1	0.23	0.09	**0.85**	0.02	0.13	0.13	0.10
PEOU-2	0.08	0.19	**0.76**	-0.02	-0.07	-0.20	0.15
PEOU-3	0.25	-0.04	**0.76**	0.07	0.15	0.07	0.06
PEOU-4	0.11	0.08	**0.67**	0.08	0.32	0.16	0.06
ITU-1	0.16	0.48	0.00	0.13	0.12	**0.65**	0.16
ITU-2	0.26	0.15	0.16	-0.01	0.23	**0.74**	-0.14
SE-1	**0.78**	-0.02	0.06	0.02	0.29	-0.10	0.14
SE-2	**0.61**	-0.01	0.20	0.00	-0.11	0.09	-0.08
SE-3	**0.79**	0.18	0.03	0.08	0.07	0.30	0.05
SE-4	**0.73**	0.13	0.22	-0.09	-0.18	0.03	-0.03
SE-5	**0.78**	0.17	0.02	0.06	-0.05	0.19	0.01
SE-6	**0.78**	0.10	0.22	0.07	0.23	-0.10	0.12
SN-1	-0.01	0.00	0.15	**0.83**	0.08	0.03	0.08
SN-2	0.10	0.34	-0.03	**0.63**	0.04	0.07	0.12
SN-3	-0.01	0.15	0.06	**0.80**	-0.07	-0.16	-0.15
SN-4	0.02	0.21	-0.08	**0.77**	0.07	0.17	0.02
COMP-1	0.03	0.03	0.18	0.04	0.03	0.17	**0.84**
COMP-2	0.07	0.20	0.12	-0.01	-0.02	-0.19	**0.79**
JOB-1	0.21	**0.64**	0.16	0.22	0.31	-0.03	0.01
JOB-2	0.08	**0.81**	0.09	0.15	0.12	0.25	0.08
JOB-3	0.15	**0.75**	0.05	0.07	0.19	-0.01	-0.01
JOB-4	0.17	**0.71**	0.18	0.19	0.30	0.02	0.09
JOB-5	-0.07	**0.72**	-0.05	0.23	-0.05	0.35	0.20
Eigenvalues	6.84	3.21	2.22	1.92	1.56	1.14	1.04
Percent of variance	26.29	12.34	8.54	7.38	6.01	4.38	4.00

6.3. Model testing results

We examined our model using LISREL 8. The model's overall fit with the data was evaluated using common model goodness-of-fit measures. Overall, our model exhibited a reasonable fit with the longitudinal responses collected. Based on the responses from the first data collection, our model resulted in 2.11 in the w2 to d.f. ratio, which is satisfactory with respect to the commonly recommended value of 3.0. We assessed the model fit using other common fit indexes: adjusted goodness-of-fit index, non-norm fit index, comparative fit index, and standardized root mean square residual (SRMSR) [30]. Our model exhibited a fit value exceeding or close to the commonly recommended threshold for the respective indexes; e.g. a value of 0.08 for the SRMSR index, satisfactory with respect to the commonly recommended value of less than or equal to 0.1. We evaluated the model's explanatory power by examining the portion of the variances explained. Overall, our model was able to account for a significant portion of variances in subjects' acceptance decisions; 47% at the beginning and 72% at completion of the training. Based on the responses from the first data collection, our model explained 48% of the variances for perceived usefulness and 30% for perceived ease of use. At training completion, our model accounted for 58% of the variances for perceived usefulness and 34% for perceived ease of use. Judged by the variances explained, our model's overall explanatory power was satisfactory and appeared to increase over the course of the training. We also tested our hypotheses by examining the corresponding causal paths in the model. Each causal path was evaluated in terms of statistical significance and strength using standardized path coefficient that range between -1 and +1. As summarized in Table 4, responses from both data collections supported most of the hypotheses. Following the suggestion by Bollen [11], we assessed the strength of each causal path by examining its direct and total effect.

Table 4
Summary of causal path testing results—statistical significance and strength

Hypothesis	Causal path	Path coefficient	
		Training commencement	Training completion
H1	PU → ITU	0.44***	0.85***
H2	PEOU → ITU	-0.09	-0.17
H3	PEOU → PU	0.24*	0.57***
H4	SN → ITU	0.27**	0.01
H5	SN → PU	-0.23*	-0.32**
H6	JOB → PU	0.77***	0.69***

H7	SE → ITU	0.40***	0.33***
H8	SE → PEOU	0.40***	0.53***
H9	COMP → PU	-0.18	-0.19**
H10	COMP → PEOU	0.29**	0.20*

* $p < .05$ ** $p < .01$ *** $p < .001$

As shown in Fig. 2, perceived usefulness was the most important determinant of teachers' acceptance throughout our investigation. Based on the responses from both data collections, perceived usefulness had a significant positive effect on intention and the effect appeared to have strengthened with user experience; e.g. showing a path coefficient increase from 0.41 to 0.85. On the other hand, the direct effect of perceived ease of use on intention was not supported by either data collection. The hypothesized effect of perceived ease of use on perceived usefulness was supported by responses from both data collections and appeared to have increased with user experience as well. Based on our analysis, perceived ease of use can affect teachers' acceptance decisions significantly but indirectly (i.e. via perceived usefulness) and its influence magnitude may become increasingly prominent upon their acquiring basic technology training. The effect of subject norm on technology acceptance was supported at the completion of the first laboratory session but, interestingly, was not supported by those from training completion. In addition, responses from both data collections supported subject norm's effect on perceived usefulness but at a direction opposite to that anticipated. The observed effects deserve further analysis. Based on responses from both data collections, job relevance consistently was the most important determinant of perceived usefulness, showing a path coefficient of 0.78 and 0.69, respectively. Computer self-efficacy also affected technology acceptance. Responses from both data collections supported computer self-efficacy's effect on user acceptance and perceived ease of use. Judged by the path coefficient, the effect on perceived ease of use noticeably had intensified over the course of the training, whereas its direct effect remained largely unchanged. The effect of compatibility on perceived ease of use was also supported by the responses from both data collections, showing a path coefficient of 0.29 and 0.20, respectively. On the other hand, the effect of compatibility on perceived usefulness was statistically insignificant at training commencement and subsequently became significant at training completion, but at a direction opposite to that previously hypothesized. Judged by the respective statistical significance levels and path coefficients, the responses collected at training commencement and completion supported most of our hypotheses. Overall, several noticeable changes in key acceptance drivers and their influence patterns or magnitudes were observed over the course of the training. Findings from our analysis have several implications for user acceptance research in education and technology management practice.

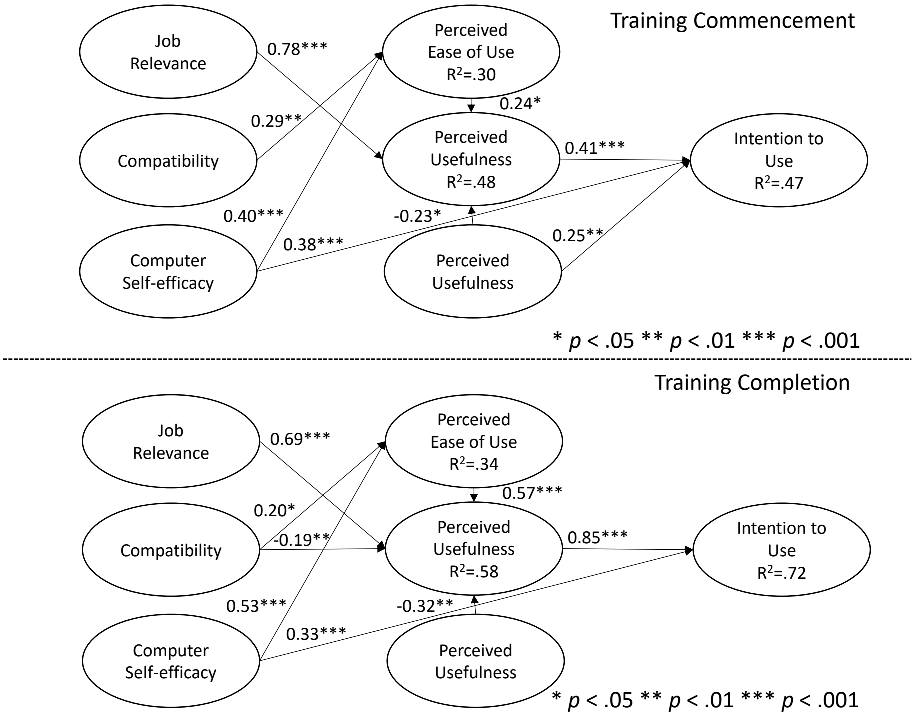

Fig. 2. Model testing results—training commencement vis-a-vis completion.

7. Discussion

Results suggest a significant and prominent core influence path from job relevance to perceived usefulness and then user acceptance. A teacher is likely to consider a technology to be useful when it is relevant to his or her job. Perceived usefulness is a critical determinant of user acceptance and its influence appears to increase as individuals become more experienced. Our analysis suggests a task-centered orientation in teachers' technology evaluation and a pragmatic anchor in their acceptance. These findings may be partially explained by individual teachers' autonomy. From a management perspective, administrators and technology professionals must highlight, demonstrate and communicate convincing evidence that conveys a technology's relevance to teachers' routine teaching activities in order to foster user acceptance. Similar considerations may also be relevant to technology acceptance by individual professionals who have considerable autonomy at work.

One prominent change observed over the course of the intervention was the shift in subjective norm which appears to be a significant driver for initial acceptance but then diminishes in importance as individuals become experienced with the technology. This implies that teachers subconsciously may align their initial acceptance decisions with colleague's opinions or suggestions. In our case, subjects might have exhibited an intention to accept PowerPoint at training commencement partially because of (perceived) assessments of colleagues or administrators. However, teachers became increasingly independent in subsequent acceptance decision-making as they gained additional knowledge and experiences. Administrators should consider means for cultivating a positive community norm which, in turn, creates and reinforces initial technology acceptance. At the same time, they should leverage from such norms by requiring or helping teachers to acquire more knowledge of and experience with a technology.

Judged by the statistical significance, strength of path coefficient and explanatory power, several causal links are important for teachers' technology acceptance decision-making. These paths may become more prominent and significant as individuals acquire additional experience. In turn, this suggests increasing explanatory power of fundamental acceptance determinants beyond teachers' initial encounter with a new technology. Judged by effect magnitude, key antecedents of fundamental acceptance determinants appear to become less important over the course of a training intervention; e.g. job relevance on perceived usefulness and compatibility on perceived ease of use. Jointly, our findings suggest that teachers consider a richer set of factors when making initial acceptance decisions but concentrate on fundamental acceptance drivers in their continued acceptance decision-making. This tendency is inconsistent with Cooper and Zmud [17], who suggested that individuals tend to rely on rational assessment in initial acceptance decisions but incorporate factors of social-political consideration when making continued acceptance decisions using a larger set of decision factors.

Perceived ease of use appears to have limited direct effects on user acceptance at training start or end. This implies that teachers are unlikely to accept a technology simply because it is easy to use. As commented by Keil et al. [39], no amount of perceived ease of use will compensate for low usefulness. However, the effect of perceived ease of use should not be underestimated. According to our analysis, perceived ease of use is an important determinant of perceived usefulness. Judged by its total effect, perceived ease of use does influence teachers' technology acceptance decisions; i.e. via perceived usefulness. In turn, the significant, but indirect, effect of perceived ease of use on user technology acceptance highlights the importance of continued user support beyond initial training. Hence, the relevance and impacts of perceived ease of use should not be discounted as users become experienced with the technology; instead, user training and support should be provided on an ongoing basis to ensure continued acceptance.

According to our findings, subject norm has an adverse effect on perceived usefulness. This surprising influence pattern might be partially attributed to a teacher's entrenched pedagogical views or beliefs; e.g. accepting a technology (to comply with the community norm) but not necessarily convinced of its value. The observed effect of compatibility on perceived ease of use also suggests an important characteristic of teachers. Hardware and software compatibility consistently affects a teacher's perception of a technology's ease of use. This finding also may be attributed to targeted teachers' limited experience with or exposure to technology. This suggests that administrators or government agencies need to consider and evaluate system compatibility when acquiring or promoting new technologies, particularly with respect to those already in routine use.

Computer self-efficacy is an important determinant of perceived ease of use and user acceptance and its effect on perceived ease of use increases with user experience. On the other hand, the net influence of computer self-efficacy on individuals' acceptance decisions decreases with user experience. From a management perspective, our findings suggest that computer literacy matters and teachers must overcome some baseline learning curve beyond which their technology acceptance can be facilitated by training on more sophisticated technologies. In essence, this suggests that there may be some efficacy threshold affecting teachers' willingness to adopt new technologies, particularly the advanced ones. This insight is interesting for technology acceptance research that targets acceptance decisions by individuals who do not feel comfortable about the technology. Hence, early efforts for encouraging adoption of common or basic technologies are critical.

8. Limitations

This study has several limitations. First, our research results were obtained from a single study. Thus, caution must be taken when generalizing our findings. Our subject sample also consisted of teachers attending a training program designed for partial fulfillment of technology competency certification. Our subjects were late recipients of this particular training and conceivably might differ from peers who had completed the training at an earlier time. Measurement is another plausible limitation, since most constructs exhibited satisfactory reliability, but intention and, to a lesser extent, compatibility showed a Cronbach's a-value lower than (but close to) the commonly recommended threshold. This may suggest potential limitations of these measurements in an education context.

9. Conclusion

Overall, our model showed a reasonably good fit with the data collected; it exhibited satisfactory power for explaining technology acceptance decisions by teachers. Specifically, our findings suggest a prominent and significant influence pattern from job relevance to technology usefulness and then user acceptance. In addition, our analysis sheds light on several interesting changes in key acceptance drivers and their influence patterns and magnitudes over time. Furthermore, teachers are likely to consider a rich set of factors when making initial acceptance decisions, but concentrate on fundamental acceptance determinants in their continued acceptance decision-making. The responses collected at the training commencement and completion support most of our hypotheses.

Understanding key acceptance drivers and probable changes in influence patterns and magnitudes over time can help school administrators and technology professionals to identify areas that hinder user acceptance and to address underlying barriers to adoption [8]. Given the importance of the influence pattern from job relevance to perceived usefulness and then user acceptance over time, technology professionals should anchor technology introduction in routine teaching support and enhancement rather than using examples not highly related to classroom activities. User support needs to be provided beyond initial training, and user training should aim at ‘‘signaling and conveying’’ the relevance and value of a technology, followed by conveniently accessible user support to facilitate teachers’ continued usage. School administrators also should consider creating user communities or interest groups to support and encourage experience sharing and technical knowledge transfers among teachers.

Appendix. Measurement items used in the study

Construct	Question item	Source
Perceived usefulness (PU)	PU-1: PowerPoint enables me to accomplish tasks more quickly	[19]
	PU-2: Using PowerPoint increases my productivity	
	PU-3: Using PowerPoint makes it easier to do my teaching job	
Perceived ease of use (PEOU)	PEOU-1: Learning to operate PowerPoint is easy for me	[19]
	PEOU-2: It is easy for me to become skillful in using PowerPoint	
	PEOU-3: I find it easy to get PowerPoint to do what I want it to do	
	PEOU-4: Overall, I find PowerPoint easy to use	
Intention to use (ITU)	ITU-1: Whenever possible, I intend to use PowerPoint in my teaching	[31]
	ITU-2: To the extent possible, I would use PowerPoint to do different teaching tasks	
Computer self-efficacy (SE)	SE-1: I could complete a job using a computer if I had seen someone else using it before trying it myself	[16]
	SE-2: I could complete a job using a computer if I could call someone for help if I got stuck	
	SE-3: I could complete a job using a computer if someone else had	

	helped me get started	
	SE-4: I could complete a job using a computer if I had a lot of time to complete the job for which the PowerPoint was provided	
	SE-5: I could complete a job using a computer if someone showed me how to do it first	
	SE-6: I could complete a job using a computer if I had used similar package before to do the same job	
Subjective norm (SN)	SN-1: My friends would think that I should use PowerPoint	[55]
	SN-2: My colleagues would think that I should use PowerPoint	
	SN-3: People who influence my behavior would think that I should use PowerPoint	
	SN-4: People who are important to me would think that I should use PowerPoint	
Compatibility (COMP)	COMP-1: PowerPoint is compatible to the computer I use at school and/or at home	
	COMP-2: PowerPoint is compatible to the software I use at school and/or at home	
Job relevance (JOB)	JOB-1: I consider PowerPoint to be important to my job	[26]
	JOB-2: I consider PowerPoint to be needed to my job	
	JOB-3: I consider PowerPoint to be fundamental to my job	
	JOB-4: I consider PowerPoint to be of concern to my job	
	JOB-5: I consider PowerPoint matters to my job	

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