Influence of Pre-service and In-service Teachers' Gender and Experience on the Acceptance of AR Technology

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Abstract: Augmented reality has received more and more attention by researchers in the field of education. Because of its rich visual presentations and various user interaction, AR leaning environment has great potential for learning activities. This study used mature UTAUT questionnaires to investigate pre-service teachers and in-service teachers' acceptance of AR technology. The effective participants included 70 pre-service and 50 in-service teachers. Through data analysis of effective participants from the perspectives of gender and experience, we found that 1) Pre-service teachers are more sensitive to social influences than in-service teachers are. For all the participants, 2) Male teachers are more sensitive to social influences than females. 3) Effort expectancy has a negative impact on AR behavioral intention of high-experience teachers. Based on the research results, specific discussions and suggestions are proposed for different teacher groups to improve the technical acceptance of AR in teaching.

Keywords: augmented reality, UTAUT, gender, experience

1 Introduction

In recent years, augmented reality (AR) has been paid more attention by researchers in the field of education and recommended to teachers for teaching[1]. AR has great potential for learning activities because of its rich visual presentations and various user interaction[2], and teachers show their interests and willingness in using AR[3]. However, we found that teachers who really brought AR into the classroom were few. According to researches about teachers' technology acceptance, many factors affect teacher's behavioral intentions to technology, such as gender, age, experience and etc [4]. Having a better understanding of these factors' impacts could let us offer assistance to teachers more pertinently [5].

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Therefore, we conducted a questionnaire survey when we gave lecture to teachers about using AR in teaching. We investigated their basic information and behavioral intentions in adopting AR based on the UTAUT model. In this study, we analyze their acceptance of AR technology from the perspective of gender and experience.

2 Lecture Review

2.1 AR in education

Augmented reality (AR) is a technology that supplements the real world with virtual objects and appears to coexist in the real world. A system based on AR is defined to have the following properties:(1) combines real and virtual objectives in a real environment;(2) runs interactively and synchronously; and (3) aligns real and virtual objects with each other.[6, 7] By 2010, AR was seen in advertising, education, navigation and information[8]. At first, AR has been used to provide more information for learning activities, and it was more widely used in sightseeing and museum guidance [9, 10, 11, 12]. Up to now, more and more AR systems have been used in education and the role of AR systems has become richer and clearer [1, 13].

According to the statistics of M Akcayir, G Akcayir [1], AR has been proved to be able to take advantages on interaction, pedagogical contributions, and learner outcomes. By summarizing the results of previous empirical studies, the impacts of AR on learners is mainly reflected in learning achievements and positive attitudes. Learning achievements are the focus of the studies and almost all of the studies have discussions about it. KH Cheng, CC Tsai [14] founded that imaged-based AR worked on students' spatial ability, practical skills, and conceptual understanding, while location-based AR supported students' inquiry activities. MB Ibanez [15] Suggested that AR could be helpful in learning the basic principles of electricity. Aruiz-Ariza [16] concluded that AR game Pokemon Go increased users' amount of daily exercise and affected their cognitive performance.

Positive attitudes, such as motivation, interest, confidence and so on, has been tested and proved that they could be promoted by AR. THC Chiang [17] showed that primary school students learning with AR-based mobile learning approaches would have higher motivations in attention, confidence and related dimensions. SJ Lu and YC Liu [18] thought that students would be more confident in learning activities by using a program integrating AR.

Based on previous studies, it is clear that every AR system is committed to improving students' learning achievements and positive attitudes. Investigating teachers' acceptance of AR technology contributes to acquire its practice information in teaching activities and recommend it to teachers pertinently.

2.2 The UTAUT Model and Research Hypotheses

In terms of technology acceptance, the commonly used models include TAM, TAM2 and the Unified Theory of Acceptance and Use of Technology (UTAUT) [4]. In recent years, the UTAUT model has been used in an educational context, such as desktop video conferencing [5], and mobile learning [19]. The UTAUT is a more complete a technology acceptance model include six main constructs: performance expectancy, effort expectancy, social influence, facilitating condition, behavioral intention and usage behavior, and four moderating factors: age, gender, experience, and voluntariness. It is based on the synthesis of eight well-established theories and models include the Theory of Reasoned Action, the Motivational Model, the Model of PC utilization, the Theory of Planned Behavior, the Combined TAM and TPB, the Technology Acceptance Model, the Innovation Diffusion Theory and the Social Cognitive Theory. It has proven superior to previous models, which explains 70 % of the variance in user intentions to use technologies [4].

Research on the role of moderating factors can improve the acceptance of certain technologies in certain groups, such as age and experience. For females, the most important drivers of the behavioral intentions to use desktop video conferencing in a distance course were facilitating conditions. For males, general social influence was the most important variable explaining the behavioral intentions to use desktop video conferencing in a distance course. Therefore, males are more sensitive to social influence than females [5]. It is the same with mobile learning [19], but is not in line with other studies [4], [20]. Wong, Teo, and Russo found that a user's experience has a moderating effect on the relationship between effort expectancy and behavioral intention such that effort expectancy affected behavioral intention to use whiteboards more markedly for the limited-experience group than for the some-experience group. This means that ease of use is an important consideration by student teachers in the early stages of their IWB experience [21]. Other researchers extend the UTAUT with a new moderator variable, such as user type. For pre-adopters, social influence has a bigger impact on behavioral intentions. For post-adopters, the facilitating conditions have a bigger impact on the actual use of interactive whiteboards [22]. In different studies, the moderating factors have different effects, which may be relevant to the specific technical environment and research participants. Therefore, we analyze pre-service and in-service teachers' acceptance of AR technology from the perspective of gender and experience as shown in fig.1. According to this model, the hypotheses put forward are as follows.

H1: The pre-service teachers and in-service teachers affect the acceptance of AR technology through social influence (H1a), facilitating condition (H1b), performance expectation (H1c) and effort expectation (H1d).

H2: The teacher's gender affects the acceptance of AR technology through social influence (H2a), facilitating condition (H2b), performance expectation (H2c) and effort expectation (H2d).

H3: The teacher's experience affects the acceptance of AR technology through social influence (H3a), facilitating condition (H3b), performance expectation (H3c) and effort expectation (H3d).

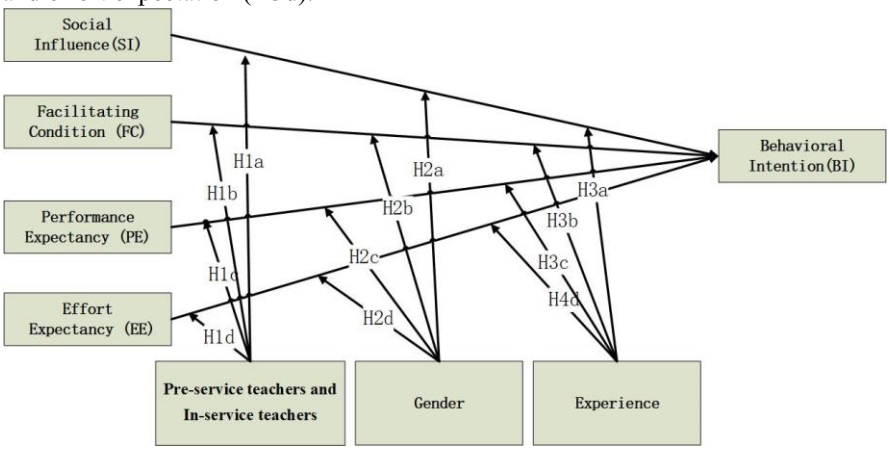

Fig. 1. Model in our study based on UTAUT

3 Method

3.1 Participants and Process

The participants of this study were 71 pre-service teachers (include one invalid questionnaire) and 50 in-service teachers. All the pre-service teachers are graduate students with teacher professional development training or got teacher certifications from the government. The in-service teachers came from different area in China. All the participant attended a two-hour lecture about AR and its role in education first, then filled a questionnaire.

3.2 Instrument

A questionnaire survey was used to investigate the pre-service and in-service teachers' acceptance of AR systems, which was adapted from reliable questionnaires shown in table 1. All the variables in the study were measured using a scale of 1 to 7 (1 = very strongly disagree to 7 = very strongly agree). In addition, the basic information of the participants was collected, such as gender and experience. For experience, the 7-point scale was used to investigate the teachers' experience in using AR systems.

Table 1. The Questionnaire of Technology Acceptance.

Dimension	Item	Reference
Social Influence	People who influence my behavior think that I should use AR in the teaching.	Workman, Michael. 2014[23]
	People who are important to me think that I should use AR in the teaching.	
Facilitating Conditions	I have the resources necessary to use AR in the teaching.	Workman, Michael. 2014[23]
	Instruction is available to help me use AR in the teaching.	
	I have control over using AR in the teaching.	
Performance Expectancy	Using AR technology is secure in the teaching.	Workman, Michael. 2014[23]
	Using the AR technology would make it easier to do my tasks in the teaching.	
	Using the AR technology is a bad/good idea in the teaching.	
	Using AR technology would enable me to accomplish my tasks more quickly in the teaching.	
Effort Expectancy	I have the skills to AR information technology.	Workman, Michael. 2014[23]
	Learning to use AR technology would be easy for me.	
	I would find it easy to get AR technology to do what I want it to do.	
Behavioral intention	I recognize this kind of AR	Venkatesh et.al2003[4]
	I would like to use this kind of AR in my teaching.	
	I would like to recommend this kind of AR to other colleagues.	

4 Results

There were 120 valid questionnaires in this study. They are 70 pre-service teachers (58%) and 50 in-service teachers (43%). There were 11 male and 59 female in the pre-service teacher, and 23 male and 27 female in the in-service teacher. In total, there are 34 male (28%) and 86 female (72%). There are 33 primary school and below teachers, 25 junior high school teachers, 40 senior high school teachers and 22 college teachers. They come from 38 information technology courses, 18 language courses, 15 STEM courses,11 math courses, 11 physics courses, 5 geography courses, 22 other courses (e.g. music, biology, chemistry, ideology and morality course and so on).SPSS 22.0 is used for data analysis. The Cronbach's Alpha system value of all the items is 0.956. Overall, the dimensions associated with behavioral intentions are social influence, facilitating conditions, performance expectancy and effort expectancy as shown in table 2.

Table 2. Correlation analysis of UTAUT's dimensions.

Spearman's rho	dimension			
	Social Influence	Facilitating Conditions	Performance Expectancy	Effort Expectancy
Behavioral Intention	0.401**	0.214*	0.832**	0.320**

*p<0.05, **p<0.01.

4.1 Pre-service teacher and in-service teacher

Differences Analysis of Pre-service teachers' and In-service Teachers' AR Technology Acceptance

Pre-service teachers and in-service teachers have significant differences on Social Influence (t=-2.60, p<0.05), Performance Expectation (t=-2.62, p<0.01), Behavioral Intention (t=-2.32, p<0.05). In-service teachers are superior to pre-service teachers in these respects as shown in table 3.

Table 3. Differences analysis of Pre-service and In-service teachers' AR acceptance.

	Social Influence		Facilitating Conditions		Performance Expectancy		Effort Expectancy		Behavioral intention	
	M	t	M	t	M	t	M	t	M	t
Pre-service teacher	5.04	-2.60*	4.62	-0.93	5.30	-2.62**	4.47	-1.20	5.55	-2.32*
In-service teacher	5.64		4.82		5.73		4.76		5.94	

*p<0.05, **p<0.01.

The Correlation of Pre-service Teachers' and In-service Teachers' Behavioral Intention and Influencing Factors to AR Technology

For pre-service teachers, social influence, performance expectation, effort expectation are related to behavioral intention. Based on this, an effective regression model of pre-service teachers' technical acceptance (F=32.827, p<0.001) was constructed. The value of adjusted R^2 reached 0.58, indicating that 58% of the data was fitted to the model. Therefore, the regression equation is behavioral intention =0.709* performance expectation +0.153* social influence +1.287.

For in-service teachers, social influence, performance expectation, effort expectation and facilitating conditions are related to behavioral intention. Based on this, an effective regression model of in-service teachers' technical acceptance (F=44.616, p<0.001) was constructed. The value of adjusted R^2 reached 0.78, indicating that 78% of the data was fitted to the model. Therefore, the regression equation is behavioral intention =0.925* performance expectation.

4.2 Gender

Differences Analysis of Pre-service and In-service teachers' AR Technology Acceptance with different gender

Gender has significant on Social Influence (t=2.67, p<0.01) as shown in table 4. Male teachers are superior to female teachers in the social factor that influence the intention to use AR, who receive more support and encouragement from others.

Table 4. Differences analysis with different gender.

Pre-service and In-service teacher	Social Influence		Facilitating Conditions		Performance Expectancy		Effort Expectancy		Behavioral intention	
	M	t	M	t	M	t	M	t	M	t
Male	5.75	2.67**	5.02	1.94	5.27	-1.62	4.80	1.11	5.55	-1.2
Female	5.11		4.57		5.56		4.51		5.77	

*p<0.05, **p<0.01.

The Correlation of Pre-service and In-service Teachers' Behavioral Intention and Influencing Factors with Different Gender

For male pre-service and in-service teachers, social influence, performance expectation and effort expectation are related to behavioral intention. Based on this, an effective regression model of male teachers' technical acceptance (F=32.428, p<0.001) was constructed. The results showed that the effect of the predictive variable on behavioral intention was highly explanatory, while the value of adjusted R2 reached 0.741, indicating that 74.1% of the data was fitted to the model. Therefore, the regression equation is behavioral intention =0.665*performance expectation +0.308*social influence.

For female pre-service and in-service teachers, social influence, performance expectation, effort expectation and facilitating condition are related to behavioral intention. Based on this, an effective regression model of female teachers' technical acceptance (F=46.843, p<0.001) was constructed. The value of adjusted R2 reached 0.683, indicating that 68.3% of the data was fitted to the model. Therefore, the regression equation is behavioral intention =0.862* performance expectation + 0.842.

4.3 Experience in using AR

Differences Analysis of Pre-service and In-service Teachers' AR Technology Acceptance with different experience

According to the 7-point scale of experience item in using AR, the top 27% of teachers (33 people) were in the high experience group and the bottom 27% (33 people) were in the low experience group. Experience has significant on Facilitating

Condition (t=-7.33, p<0.001), and Effort Expectancy (t=-6.422, p<0.001). High-experience teachers are superior to Low-experience teachers in these respects as shown in table 5.

Table 5. Differences analysis with different experience.

Pre-service and In-service teacher	Social Influence		Facilitating Conditions		Performance Expectancy		Effort Expectancy		Behavioral intention	
	M	t	M	t	M	t	M	t	M	t
Low-experience	5.13	-1.860	3.70	-7.33***	5.43	-1.089	3.61	-6.422***	5.75	-0.265
High- experience	5.71		5.53		5.71		5.46		5.81	

*p<0.05, **p<0.01,***p<0.001.

The Correlation of Pre-service and In-service Teachers' Behavioral Intentions and Influencing Factors with Different Experience

For low-experience teachers, social influence and performance expectation are related to behavioral intention. Based on this, an effective regression model of low-experience teachers' technical acceptance (F=82.46, p<0.001) was constructed. The value of adjusted R^2 reached 0.836, indicating that 83.6% of the data was fitted to the model. Therefore, the regression equation is behavioral intention =0.849* performance expectation.

For high-experience teachers, social influence, facilitating condition, performance expectation, and effort expectation are related to behavioral intention. Based on this, an effective regression model of high-experience teachers' technical acceptance (F=31.527, p<0.001) was constructed. The value of adjusted R^2 reached 0.792, indicating that 79.2% of the data was fitted to the model. Therefore, the regression equation is behavioral intention =0.264*performance expectation-0.427*effort expectancy.

5 Discussion and conclusion

In this study, we analyzed 70 pre-service teachers' and 50 in-service teachers' basic information and acceptance of AR technology. According to results, there are interesting findings that teachers of different gender and experience present different responses to behavioral intentions of AR and its determinants (performance expectation, effort expectation, social influence and facilitating conditions).

Pre-service teachers and in-service teachers had a significant influence on the relationship between the behavioral intention of AR and its determinants (H1a). For pre-service teachers, social influence and performance expectancy had statistically positive effects on behavioral intentions to use AR. For in-service teachers, performance expectancy had statistically positive effects behavioral intentions to

use AR. This may because pre-service teachers are under pressure to find jobs. Therefore, they are willing to use AR, if the AR recognized by society. This verified Venkatesh's hypothesis [4], which were not found in the previous survey of ICT acceptance of preservice teachers [24].

For all the participants, gender has a significant effect on the relationship between social influence and behavioral intentions of AR (H2a). For the male teacher, social influence and performance expectancy had statistically positive effects on behavioral intentions to use AR. For the female teacher, performance expectation is the only significant factor influencing behavioral intentions to use AR in the regression equation. Therefore, for pre-service teachers and in-service teachers, male are more sensitive to social influences than female, which is consistent with two other studies [5], [19]. Therefore, if the teacher using AR is male, school leaders or teaching and research personnel should give them more support and encouragement.

For all the participants, experience has a significant effect on the relationship between Effort expectancy and behavioral intentions of AR (H3d). For low-experience teachers, performance expectancy had statistically positive effects on the intention to use AR. For high-experience teachers, effort expectancy also has a significant impact on behavioral intentions to use AR, but it is a negative impact, which is an interesting finding. This may because high-experience pre-service and in-service teachers prefer AR with certain difficulty. For them, the ease of use is inversely proportional to behavioral intentions in a way.

The limitations of the present study need to be noted. As the sample size of the experiment was not large, it might be imprecise to infer the findings to other cases. We did not research the influence of teachers' knowledge and skills in designing learning activities with AR on their acceptance. Consequently, several follow-up studies can be considered, such as how to improve different teachers' acceptance of AR. In the future, we plan to use different strategies in present AR to different teachers and not only improve their behavioral intention but also inspire them to use AR in instructional practice.

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