Connecting rural schools to quality education: Rural teachers' use of digital educational resources

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Abstract

Maintaining teaching quality at a high level in rural and remote areas in China can be supported by the use of digital educational resources. This study examined which factors explain differences in rural teachers' use of digital educational resources in their teaching practice in Western China. Data were collected from 462 teachers from 25 primary and secondary schools in rural areas via a questionnaire to gather information about teachers' use of digital educational resources, and school- and teacher-level factors that might influence this. Although various digital educational resources were utilized, electronic lesson plans and multimedia courseware played a dominant role in delivery of lessons. Results from a multilevel regression analysis revealed that no school-level factors seem to be associated with the use of digital educational resources. In contrast, at the teacher level, higher levels of attitudes, knowledge and skills, better facilitating conditions, and teachers' age and teaching experience significantly explained teachers' use of digital educational resources. However, other key factors such as the intention to use, self-efficacy, and subjective norm did not explain differences in use in the rural school context. The article concludes with some practical implications and recommendations for further research.

Keywords

Digital educational resources; Integrative model of behavior prediction; Rural teachers

3.1 Introduction

Recenlty, scholars, educational practitioners, and the public have reached a consensus that high-quality knowledge should be freely, openly, and easily available to promote digital equity between regions, areas, and schools (Harley et al., 2006; Hoosen, 2012; Zhang, Fang, & Ma, 2010). Therefore, almost every country has made significant investments in the production of digital educational resources (DERs) for teachers. The potential of technology has been utilized to ensure education for all, i.e., offering compulsory education of good quality to all children (Burnett, 2008). In terms of educational quality for all, however, teachers in rural and remote areas seem to be less qualified than their urban peers (Liu & Onwuegbuzie, 2012). In addition, the general lack of quality resources has been identified as a pressing concern (Robinson, 2008).

In order to realize the premises of digital equity and education for all, one developing country that is currently facing the challenge of implementing DERs is The *People's Republic of China*. Although children in China have equal rights to education, the increasing social and economic disparities between urban and rural areas have led to an educational gap (Qian & Smyth, 2008). Among the factors that are associated with differences in educational quality, resource disparity is the main reason (Zhou, Peverly, & Lin, 2004). Due to "city-oriented" policies, high-quality educational resources have been mainly allocated to urban schools (Shah, 2016), which has resulted in a tremendous gap between urban and rural compulsory education. Distributing public resources fairly has been regarded as one of the most urgent targets of educational policy (Chuanyou, 2006). Since ICT policies make an important impact on promoting the use of technology and improving educational quality in the rural area, integration of DERs into teachers' pedagogical practices is the main aim of the *National Development Plan for ICT in Education* (MOE, 2012). In compulsory education, serious efforts have been made to construct and allocate DERs, giving priority to rural areas. For instance, a resource pool has been developed to provide free DERs with 160 million students in all rural schools (Wu, 2016). Since 2013, teachers have been encouraged to share high-quality DERs via both national and regional education resource public service of platforms which also aimed to reduce the difficulties of rural schools' DERs construction.

Despite an abundance of information regarding the types of DERs available to be used in education and their potential benefits, few empirical data are available about what resources are actually being used by teachers, particularly those in rural areas. Furthermore, investments in technology do not guarantee more use of these tools among practitioners (Yang & Huang, 2008). Nevertheless, earlier research (e.g., Mumtaz, 2000) showed that teachers' responses to ICT were influenced by the support provided by the school, a positive attitude to ICT from the school principal, and teachers' perceptions toward ICT and related skills. In addition, Tondeur, Valcke, and Van Braak (2008), while investigating teacher and school characteristics in concurrence, found that except for school-level factors, structural teacher factors such as gender and experience were significant predictors of the adoptions of ICT for teachers. Furthermore, recent research concludes that not one factor, but a mix of various factors together, influenced teachers' behavior to use DERs (Vermeulen, Kreijns, Van Buuren, & Van Acker, 2017).

In the present study, we aim to elucidate the degree to which certain teacher- and school-level factors explain rural school teachers' use of DERs. The findings may contribute to teacher professional development initiatives and capacity building in schools with regards to the use of DERs in the classroom. Below, we will elaborate on the theoretical framework that guided the current study.

3.2 Theoretical Framework

In order to gain more insights into factors that explain teachers' DERs usage in rural schools, we used the Integrative Model of Behavior Prediction (IMBP; Fishbein & Ajzen, 2011) as a framework on factors that explain teachers' DERs usage in rural schools. In IMBP, three key constructs (Attitude, Self-efficacy, and Subjective norm) are hypothesized to influence behavioral intention, together with knowledge and skills, and facilitating conditions, which all influence actual behavior (see Figure 3.1).

While many definitions of the six key constructs can be found in the literature, we endorsed the definitions based on Fishbein and Ajzen's IMBP. Attitude is the general feeling of sympathy or antipathy toward behavior.

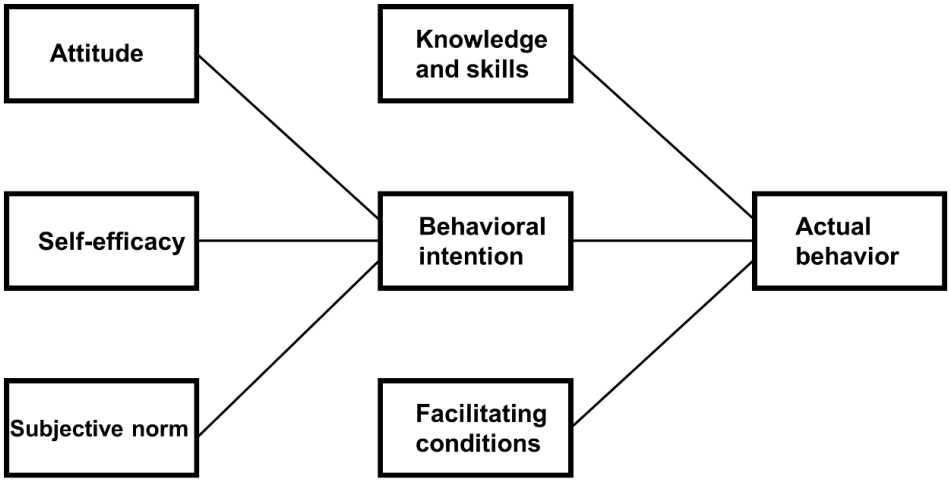

Figure 3.1. The Integrative Model of Behavior Prediction (Fishbein & Ajzen, 2011)

Subjective norm is the perceived peer pressure about whether to perform particular behavior. Self-efficacy refers to the belief in one's capabilities to perform a specific action. Behavioral intention refers to the strength of an individual's willingness to execute particular behavior. Facilitating conditions is defined as external control regarding the environment such that behavior may occur if conditions in the environment promote it. Knowledge and skills reflect the necessary competencies to perform a specific action. Although IMBP was initially conceived of as a theoretical model to predict technology acceptance in the domain of health, it is assumed to identify the factors that determine a particular behavior in any given population (Van Acker, Van Buuren, Kreijns, & Vermeulen, 2013).

Earlier studies show that IMBP is a stable and parsimonious model for explaining teachers' use of different forms of technology in educational contexts (see, e.g., Admiraal, Lockhorst, Smit & Weijers, 2013; Vermeulen et al., 2017). Below, we elaborate on the different elements of IMBP that guided the current study.

3.2.1 Teacher-level factors

3.2.1.1 Behavioral intention to use DERs

Behavioral intention to use technology is one of the proximal measures of actual use of technology. This means that the probability of carrying out a specific behavior increases as an individual's intention to perform that behavior becomes stronger. Previous studies have consistently shown that behavior intention is a suitable proxy for actual behavior (e.g., Ajzen, 1991; Fishbein & Ajzen, 2011; Taylor & Todd, 1995). For example, Armitage and Conner (2001) used a meta-analytic review to analyze the efficacy of the theory of planned behavior (TPB; Ajzen, 1991), which shows a medium correlation between the two constructs. However, Teo (2009) reported doubts about behavior intention as a valid measure of actual behavior. Similarly, Kreijns, Vermeulen, Van Acker, and Van Buuren (2014) indicated that in addition to behavioral intention, environmental variables and teachers' knowledge and skills are supposed to influence actual behavior regarding technology.

3.2.1.2 Facilitating conditions

Facilitating conditions also predict actual behaviors. The study of Groves and Zemel (2000) showed that environmental supports significantly explained differences in teachers' use of technologies in teaching. For instance, ICT training was a significant predictor of technology use; therefore, it is necessary for a school to keep professional development at the center of its ICT policy (Tondeur et al., 2008). Moreover, a recent study indicated that Turkish pre-service teachers' use of ICT is significantly predicted by training programs, especially courses related to ICT (Aslan & Zhu, 2017). Furthermore, Farjon, Smits, and Voogt (2019) discussed that access to different technologies plays a crucial role in successful technology integration. However, research on the level and variety of software and hardware conditions showed that only the level of presence of software applications was significantly related to the use, but no effects were found with other three conditions (Admiraal et al., 2013).

3.2.1.3 Knowledge and skills

Many theoretical models have been used to show the essential qualities of teacher professional knowledge required for technology integration in teaching. The most cited model is the TPACK framework, which has been used to examine the effective use of technology (e.g., Baran, Canbazoglu Bilici, Albayrak Sari, & Tondeur, 2019; Voogt & McKenney, 2017). The TPACK model developed by Mishra and Koehler (2006) includes three basic areas of teacher knowledge (Technology, Pedagogy, and Content), three blended areas illustrating the intersection of the basic areas, and finally the integrated knowledge of the interactions of all three basic areas. Previous research indicates that technology use in classrooms, especially in small and often underfunded rural areas, is dependent on teachers' capacity for maintaining infrastructure (Howley & Howley, 2008). A reason for this is that these areas cannot support teachers by having specific ICT staff who look after the maintenance of equipment and troubleshooting of technical issues in the classroom (Howley, Wood, & Hough, 2011). Moreover, technological pedagogical knowledge (TPK) is a particularly important area of knowledge for rural teachers because these teachers need to teach a wide variety of subjects, and therefore, they often do not have in-depth knowledge of each subject (Heitink, Voogt, Fisser, Verplanken, & Van Braak, 2017). In short, if the teacher lacks the appropriate skills and knowledge, even well-selected technology may not be used effectively for instruction by the teacher in the classroom (Hofer, Grandgenett, Harris, & Swan, 2011).

3.2.1.4 Self-efficacy toward using DERs

Although knowledge and skills are essential, it is not enough to use technology in the classroom, because teachers also need to feel confident (Ertmer & Ottenbreit-Leftwich, 2010). When teachers feel both confident and able to use technology, they are indeed more likely to utilize it. Previous studies showed a positive correlation between the actual behavior and self-efficacy in using technology (Barbeite & Weiss, 2004; Rohatgi, Scherer, & Hatlevik, 2016; Lee & Lee, 2014). Results of a study regarding teachers' sharing behavior in relation to open educational resources indicated that knowledge sharing self-

efficacy is the only predictor of actual sharing behavior in the online and face-to-face context (Van Acker, Vermeulen, Kreijns, Lutgerink, & Van Buuren, 2014). However, a positive relationship between self-efficacy and classroom technology use of elementary and secondary teachers has not been confirmed (Mueller, Wood, Willoughby, Ross, & Specht, 2008).

3.2.1.5 Attitude toward using DERs

A large number of studies in the literature have reported a strong relationship between teachers' attitudes and technology use in education, showing that the more teachers believe using technology is good, the more they are likely to plan and implement technology in the classroom (Bas, Kubiatko, & Sünbül, 2016; Farjon et al., 2019). By comparing four models predicting technology use, Teo and Van Schaik (2012) found that attitude appeared to be the most important predictor. This highlights the critical role of attitude in predicting teachers' integration of technology into their classrooms. In fact, based on IMPB, Admiraal et al. (2013) found that attitudes seemed to be the only explanatory variable concerning the use of hardware facilities by teacher educators. Similarly, Kreijns, Van Acker, Vermeulen, and Van Buuren (2013) found that using digital learning materials was strongly explained by the teacher' attitude toward using digital learning materials. Albirini (2006) concluded that the challenge of integrating technology into education is more human than it is technological. Therefore, he suggested that policy makers promote positive attitudes for teachers toward these tools to better prepare them for integrating technology in their teaching practices, especially in developing countries.

3.2.1.6 Subjective norm toward using DERs

Subjective norm refers to the perceived pressure exerted by one's important people to perform a specific behavior. In other words, as the subjective norm becomes stronger, the more likely the person will show the particular behavior. In a previous study, the positive relationship between teachers' subjective norm and technology use was confirmed (e.g., Marcinkiewicz & Regstad, 1996; Sugar, Crawley, & Fine, 2004). For example, Teo (2010) extended

the technology acceptance model (TAM) by including subjective norm and facilitating conditions, finding that subjective norm significantly predicted the behavioral intention. Research on the relationship between subjective norm and technology use is limited and has yielded mixed results. A study based on IMBP found that experienced teacher educators' subjective norm toward technology was significantly related to their use of software applications (Admiraal et al., 2013). Yet other research showed that subjective norm was an unimportant variable affecting teachers' behavioral intention (Kreijns et al., 2014; Kreijns, Vermeulen, Van Buuren, & Van Acker, 2017).

3.2.2 School-level factors

The model of the structure of concentric circles developed by Veenstra (1999) classified school-level factors that may be of influence on technology use into two categories: 1) contextual characteristics (e.g., ICT infrastructure, software) and 2) cultural characteristics (e.g., school leadership, school ICT policy). Studies indicated that both cultural characteristics such as openness to change and school ICT policy (Tondeur et al., 2008; Vanderlinde, Van Braak, & Dexter, 2012), and contextual variables such as ICT-equipment availability (Akbulut, Kesim, & Odabasi, 2007; K. T. Lee, 2002; Tallent-Runnels et al., 2006) and presence of ICT in the curriculum (Akbulut, 2009) are related to ICT use. For the current study on the usage of DERs in rural schools in China, two school-level variables might be relevant. The first school contextual factor is school location, defined as the remoteness of rural schools (e.g., town, village). Researchers indicate that school location is a very important context variable in China because there are large differences in education between areas (Liu & Teddlie, 2009). The empirical evidence on the relationship between the remoteness of school and technology use is mixed. Although many studies have indicated that the remoteness of schools seem to decrease technology integration (e.g., Page & Hill, 2008; Subramony, 2007), another study found that the remoteness of a rural school had little influence on teachers' technology use (Howley et al., 2011). Yet one could also expect that there is more need in rural schools to use DERs.

The second school factor is school type. In the present study, school type is defined as a primary school (six years) and junior secondary school (three years), which are both compulsory for all children in China. Based on a review of studies regarding the impact of ICT on European schools, the findings showed that teachers from primary schools perceived that ICT had a greater impact on teaching than their peers from secondary schools (Balanskat, Blamire, & Kefala, 2006). Likewise, Wong and Li (2011) indicated that compared to primary school teachers in Hong Kong, secondary school teachers believed that the paradigm shift in learning toward a constructivist paradigm was less efficient.

The present study aims to provide more insights into rural teachers' use of DERs, and teacher- and school-level factors that explain differences in teachers' use of DERs. Therefore, the specific research questions are:

(1) What types of DERs do rural teachers use for their teaching?
(2) Which school-level variables explain differences between rural teachers' in their use of DERs in teaching?
(3) Which teacher-level variables explain differences between rural teachers in their use of DERs in teaching?

3.3 Methods

3.3.1 Research context

China's ICT strategies seem to achieve quality standardization throughout the whole country (Yang, Zhu, & MacLeod, 2018), without specification to the regional contexts. However, different regional plans have been reformulated in order to promote the exchange of experiences and lessons from failures (Duan, Warren, Lang, Lu, & Yang, 2008). According to Meng & Li (2002), the rural areas in China are divided into three categories: 1) eastern developed regions, 2) middle medium-developed regions, and 3) western less-developed regions. In western rural areas, there are 375 poor counties that account for more than 60% of all counties in China.

In the current study, three areas in Western China were selected where significant investments and supportive projects had been carried out. Schools were purposefully selected from about 150 rural schools with about 10,000 rural

teachers in these areas based on that they have already integrated DERs into the classroom. The target population in this study was rural teachers in the three areas during the school year of 2018-2019. In this selection, all school types are represented, i.e., teaching sites and primary schools in villages with a small number of teachers, and primary or secondary schools in towns with a larger number of teachers. In addition, class size seems one factor to consider when explaining Chinese rural teachers' use of DERs. There is a national class size standard that the students' number per class should not exceed 45 in primary schools and should not exceed 50 in secondary schools. However, the class size in rural schools varies from small sizes (<30) in villages to large sizes (>55) in towns.

3.3.2 Participants

First, personal visits were made to the department of ICT in education in each area. Then, before the school visit, the rural school principals were contacted and informed about the study by phone. During each school visit, the school principal selected teachers who were available and willing to participate. A total of 462 teachers from 25 rural schools in three different areas throughout Western China completed the voluntarily survey during the period from September 2018 to November 2018. Table 3.1 shows the demographic information of the teachers and school characteristics.

3.3.3 Measures

Based on previous analysis of both teachers' age and teaching years and use of DERs, we recoded age (0 = lower than 55, 1 = higher than 55) and years of teaching with DERs (0 = less than 3 years, 1 = more than 3 years).

Apart from the demographical variables, the questionnaire included the constructs proposed in IMBP. For the actual behavior, we focused on the self-reported pedagogical DERs usage of teachers rather than their general ICT usage. According to McGorry's (2000) back-translation procedures, the initial English version of items was translated into Chinese and then back into English by the first author and an English teacher. Subsequently, eleven teachers

Table 3.1. Demographic information of the teachers and school characteristics *(N = 462)*.

Variables	Category	Frequency	Percent
Teacher level			
Gender	Female	300	64.9
	Male	162	35.1
Age	<26	33	7.1
	26-30	35	7.6
	31-35	84	18.2
	36-40	109	23.6
	41-45	83	18
	46-50	54	11.7
	51-55	57	12.3
	>55	7	1.5
Class size	<16	8	1.7
	16-30	38	8.2
	31-45	166	35.9
	46-55	219	47.4
	56-65	28	6.1
	>65	3	0.6
Number of subjects	1	259	56.1
	2	96	20.8
	3	51	11.0
	>3	56	12.1
Years of teaching with DERs	<1	21	4.5
	1-3	65	14.1
	4-5	90	19.5
	6-10	163	35.3
	>10	123	26.6
School level			
School type	Primary school	296	64.1
	Junior high school	166	35.9
School location	Village	47	10.2
	Town	415	89.8

who were not involved in developing measurement participated in a pilot test. Items were further improved using the feedback from the teachers in the pilot with regard to item wording, missing answer options, and the time needed to complete the questionnaire.

Attitude toward using DERs, self-efficacy toward using DERs, and subjective norm toward using DERs were measured by 19 items that were based on the work of Admiraal et al. (2017). Knowledge and skills were measured by the five TPK items of the TPACK questionnaire (Schmidt et al., 2009). Some of these items were modified because they did not match the context of the research. For example, the item "My teacher education program has caused me to think more deeply about how DERs influence the teaching approaches I use in my classroom" was changed to "I think deeply about how digital educational resources influence the teaching approaches I use in my classroom."

After Principal Component Analysis with Oblimin rotation on these 24 items, the measurement of four concepts was extracted: attitude toward using DERs (10 items, Cronbach's $\alpha = 0.934$ with, for example, "I like to use digital educational resources in my teaching"), self-efficacy toward using DERs (2 items, Cronbach's $\alpha = 0.723$ with, for example, "I doubt my ability to use digital educational resources in teaching"), subjective norm toward using DERs (6 items, Cronbach's $\alpha = 0.882$ with, for example, "My colleagues think teaching with digital educational resources is important"), and knowledge and skills (5 items, Cronbach's $\alpha = 0.893$ with, for example, "I can choose digital educational resources that enhance the teaching approaches for a lesson").

Facilitating conditions ($\alpha = 0.907$) was measured by five items based on the work of Teo and Van Schaik (2012). A sample item was "Guidance is available to me in selecting digital educational resources to use." Intention to use DERs ($\alpha = 0.848$) was measured by four items such as "I will use digital educational resources in class" that were based on the work of Kreijns et al. (2014).

For measuring the actual behavior ($\alpha = 0.871$), participants rated their use frequency of a list of 10 types of DERs. The teacher's actual behavior was created using the mean scores of 10 questions. DERs included, for example, multimedia courseware, multimedia material, electronic lesson plans, teaching cases, and videos of famous teachers.

All measures used items with 7-point Likert type rating scales. Answers for actual behavior were ranging from 1 = never to 7 = always, while for other measures were ranging from 1 = absolutely inapplicable) to 7 = absolutely applicable). An overview of the scales and their constituting items can be found in Appendix C.

3.3.4 Analysis

To answer research question 1, we used descriptive statistics. To answer research question 2 and 3, we employed multilevel analysis with IBM SPSS 25 to build a two-level model. Teachers represented level 1 and schools represented level 2. The teacher-level variables provided information about teachers' perceptions (attitude, self-efficacy, subjective norm, intention, knowledge and skills, and facilitating conditions) toward using DERs and demographic characteristics (gender, age, class size, number of subjects, year of teaching with DERs). The school-level variables provided information about the schools' types and locations.

The data analysis consisted of two different models:

Model 0: The initial model was the unconditional baseline model to determine whether there was a statistically significant variation in using DERs among the schools we sampled.

Model 1: Both teacher variables (perceptions and demographic variables) and school variables were added to the initial model to explain variance in teachers' use of DERs.

The method of Snijders and Bosker (2012) was used to calculate the proportion of variance explained by the model (R^2).

3.4 Results

This section reports the findings of the study dealing with each research question. The first section presents descriptive statistics about rural teachers' use of DERs. The second section uses multilevel analysis to explore both school- and teacher-level factors explaining teachers' use of DERs in teaching practice.

3.4.1 DERs use in rural schools

Table 3.2 summarizes the teachers' responses with regards to how often they use particular DERs.

One of the most frequent uses of DERs in teaching was "electronic lesson plans," demonstrating that teachers were making significant use of resources to prepare for their lessons (26.4% always use). In their use of DERs for implementing lessons, not surprisingly, multimedia courseware was frequently used (34.0% always use). Subject-specific software and tools are seldom used (18% never use, and 20.6% hardly use) and e-books/ periodicals (which enables a lesson to be played back), also were not used regularly (9.1% never use it; 19.3% hardly use it).

3.4.2 School- and teacher-level factors explaining teachers' use of DERs

Bivariate Pearson Correlations were used to indicate the relationships between the teacher-level variables included in IMBP. Table 3.3 contains the bivariate correlations between the teacher-level variables in the present study. The same table also includes the means, standard deviations, and the Cronbach's alpha for the seven scales.

Table 3.2. Descriptive statistics of teachers' use of varied types of DERs in teaching practices *(N = 462)*.

Scale	Frequency (%)							Mean	SD
	never	hardly	rarely	sometimes	often	almost always	always		
Multimedia Courseware	0(0.0%)	7(1.5%)	13(2.8%)	53(11.5%)	163(35.3%)	69(14.9%)	157(34.0%)	5.61	1.23
Multimedia material (text, pictures, animation, video, audio, etc.)	0(0.0%)	6(1.3%)	27(5.8%)	96(20.8%)	181(39.2%)	53(11.5%)	99(21.4%)	5.18	1.23
Electronic lesson plans	1(0.2%)	13(2.8%)	35(7.6%)	86(18.6%)	143(31.0%)	62(13.4%)	122(26.4%)	5.23	1.39
Teaching cases and videos of famous teachers	5(1.1%)	23(5.0%)	72(15.6%)	190(41.1%)	122(26.4%)	24(5.2%)	26(5.6%)	4.25	1.17
Question bank/ test papers	14(3.0%)	17(3.7%)	59(12.8%)	145(31.4%)	143(31.0%)	37(8.0%)	47(10.2%)	4.48	1.37
Microlecture/ microvideo	14(3.0%)	49(10.6%)	128(27.7%)	167(36.1%)	78(16.9%)	13(2.8%)	13(2.8%)	3.73	1.20
Subject software and tools (Geometry, virtual lab, etc.)	83(18.0%)	95(20.6%)	109(23.6%)	99(21.4%)	48(10.4%)	11(2.4%)	17(3.7%)	3.08	1.54
Online course	37(8.0%)	68(14.7%)	113(24.5%)	145(31.4%)	73(15.8%)	16(3.5%)	10(2.2%)	3.51	1.35
Thematic page/website	38(8.2%)	52(11.3%)	101(21.9%)	148(32.0%)	82(17.7%)	24(5.2%)	17(3.7%)	3.70	1.43
E-books/periodicals	42(9.1%)	89(19.3%)	122(26.4%)	119(25.8%)	60(13.0%)	17(3.7%)	13(2.8%)	3.37	1.41

Table 3.3. Correlations between measured variables; the third and fourth column contains the descriptive statistics for each measure *(N = 462)*.

Variable		Number of items	*M*	*SD*	α	*Pearson's r*					
					1	2	3	4	5	6	
1	Actual behavior	10	4.214	0.907	0.871						
2	Behavioral intention	4	6.137	0.878	0.848	0.443**					
3	Facilitating conditions	5	5.149	1.326	0.907	0.447**	0.414**				
4	Knowledge and skills	5	5.703	0.988	0.893	0.558**	0.636**	0.686**			
5	Attitude	10	6.021	0.814	0.934	0.538**	0.857**	0.510**	0.771**		
6	Self-efficacy	2	5.193	1.538	0.723	0.300**	0.366**	0.254**	0.406**	0.475**	
7	Subjective norm	6	5.965	0.891	0.882	0.466**	0.669**	0.532**	0.603**	0.735**	0.346**

** Correlation is significant at the 0.01 level (2-tailed).

Table 3.4 shows the results from the multilevel analyses with DERs usage as the dependent variable. The results from the fully unconditional model indicated that the teacher-level variance accounted for 87.5% (0.724/0.827 = 87.5%) of the total variance in the outcome variable, whereas 12.5% (0.103/0.827 = 12.5%) of the total variance was at the school level.

As mentioned in the analyses section, in the second stage of the analysis, level 1 (teacher) variables and level 2 (school) variables were integrated into the fixed part of the model. Table 3.4 shows that the variables are centered around their grand mean. In Model 0, the intercept of 4.47 represents the overall mean of actual using DERs.

Next, when all the teacher and school variables were integrated into Model 2, we found that no school-level variables significantly explained variance in teachers' actual use of DERs. The results indicate that Model 1 explains 39.06% of the variance at the teacher level. The relative importance of the coefficients can be compared by standardizing regression coefficients (β). Age seems to have the strongest association with actual behavior (β = 0.559), which means that teachers over the age of 55 have a lower use of DERs. Similarly, attitude toward using DERs has a relatively strong positive association with actual behavior (β = 0.203), and knowledge and skills also make a significant positive contribution (β = 0.196), whereas facilitating conditions are significantly related to actual behavior, but explain little (β = 0.094). The latter means that the actual behavior of using DERs is not substantially more for teachers with a better perception of support from the school. Teachers with a low number of teaching years in general use DERs less compared to teachers with a high number of teaching years (β = -0.259).

Table 3.4. Results from multilevel analysis with DERs usage as dependent variables (*N* = 462 teachers in 25 schools).

	Model 0 (null)	Model 1	
	B (SE)	*B* (SE)	β
Fixed			
Intercept (cons)	4.200 (0.077) ***	4.473 (0.465) ***	
Teacher-level characteristics			
Attitude toward using DERs		0.249 (0.105) *	0.203
Self-efficacy toward using DERs		n.s	
Subjective norm toward using DERs		n.s	
Behavioral intention to use DERs		n.s	
Facilitating conditions		0.071 (0.036) *	0.094
Knowledge and skills		0.199 (0.062) **	0.196
AGE: 0 = ≤55		0.559 (0.277) *	0.559
Gender: 0 = female		n.s	
Class size		n.s	
Number of teaching subjects		n.s	
Years of teaching with DERs: 0 = ≤3		-0.259 (0.092) * *	-0.259
School type		n.s	
School location		n.s	
Random			
School level (between)	0.103 (0.042) *	0.035 (0.018)	
	12.5%		
Teacher level (within)	0.724 (0.049) ***	0.469 (0.032) ***	
	87.5%		
Model fit (Deviance (2-log)	1192.696	982.017	
χ^2		210.679	
df		19	
p		< 0.001	
Reference		Model 0 (null)	

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

3.5 Discussion and conclusion

The aim of this study was to explain the degree to which certain teacher- and school-level factors are related to rural school teachers' use of DERs. For this purpose, we used IMBP, which categorizes these factors into DERs-related teacher characteristics (teacher level) and DERs-related school characteristics (school level). In order to allow the nested structure of teachers within schools, multilevel analyses were conducted.

3.5.1 Teachers' DERs use

Regarding the first research question, the descriptive statistics indicate that although a diversity of DERs were being used, the general view of the use of DERs in Chinese rural schools was quite traditional. Traditional DERs, such as electronic lesson plans/ instruction design, and multimedia courseware, were being used frequently, but the more recent and innovative resources, such as micro-teaching videos, subject-specific software, and tools seemed under-utilized. These results are in line with the findings of another study, in which word processors and presentation software are commonly used in primary schools in regional and metropolitan areas (Maher, Phelps, Urane, & Lee, 2012).

3.5.2 School-level variables

The results of the multilevel analysis indicate that rural school teachers' use of DERs should be considered as a teacher-level phenomenon. The unconditional random intercepts model revealed that 87.5% of the variance in rural school teachers' use of DERs was attributed to differences between teachers, whereas only 12.5% was due to differences between schools. Although the difference between schools was small, the results of this study support the use of multilevel analyses to verify the influence of school-level characteristics on teachers' DERs usage in the Chinese context (e.g., Sang, Valcke, Van Braak, Tondeur, & Zhu, 2011).

Using the second research question in this study as a reference, we can affirm similarity to another study (Mumtaz, 2000), which shows that school factors play a very limited role in explaining the teachers' use of DERs. For example,

the remoteness of a rural school was not significantly related to teachers' use of DERs. This result is in accordance with the findings of a previous study in which no significant differences with regard to technology integration were found between elementary teachers in more and less remote locations (Howley et al., 2011). Similarly, the current study does not concur with earlier findings (Balanskat et al., 2006; Wong, & Li, 2011) in Europe and Hong Kong, indicating the different impact of ICT on primary and secondary schools.

3.5.3 Teacher-level variables

Regarding the third research question, the effect size (standardized coefficients) indicate that teachers' age, attitude toward using DERs, and knowledge and skills are more strongly related to their use of DERs, compared to facilitating conditions and teaching year with DERs-though they are still significantly related. The finding that rural teachers over the age of 55 are not using DERs as often as their peers, corroborates the previous findings of Scherer, Siddiq, & Teo (2015), who found a negative relationship between perceived usefulness of ICT and teachers' age. The finding that DERs are more intensively used by teachers who have more years of experience in using DERs, is in agreement with the finding of Tondeur et al., (2012), indicating the importance of technological learning experience in technology integration. A remarkable finding in this study was that new teachers also use DERs less than other teachers. An explanation may be found in an earlier study, in which new teachers were found to experience so many challenges in their first few years of teaching that they developed a preference to spend most of their time in familiarizing themselves with school curriculum and classroom management skills (Russell, O'Dwyer, Bebell, & Tao, 2007).

With regard to IMBP-core variables, we only found attitude, knowledge and skills, and facilitating conditions to be significantly related to the use of DERs. Among these, attitude is the variable that most strongly explained the use of DERs. This result is compatible with the findings by Kreijns et al. (2013), who have noted strong links between positive attitudes toward using DERs and a higher probability of frequent DERs use. The finding that an increase in the

probability of frequent DER becomes more likely when teachers have a higher level of knowledge and skills regarding DERs is in line with a recent study conducted by Taimalu and Luik (2019), which highlights the important role of knowledge and skills, including how to integrate technology with pedagogy and subject-specific content. The outcome that facilitating conditions exhibited a significant effect, although with explanatory power, is in line with the results of Mei, Brown, and Teo (2018), who showed that timely technical support and administration policy support were found to be important for supporting technology usage and to avoid chaos in the classroom, especially in rural areas of China. However, in contrast to the findings of Kreijns et al. (2013), the current results did not support the crucial role of both self-efficacy and subjective norm for the use of DERs. These findings might be less surprising considering the specific research context. In the process of urbanization, urban schools have a stricter bureaucratic management, more flexible professional title system, and better performance incentives, whereas rural schools are more loose organizations. In rural schools, it is difficult for principals to motivate the teachers, because no matter how hard rural teachers work, there seems no hope for them to get promoted or to transfer to urban schools. Thus, very few rural teachers feel pressures from colleagues or administrators to develop confidence in using DERs. Surprisingly, intention to use did not explain differences in DERs use, although the intention is understood to be a good proxy for actual use. In this regard, this study confirms Van Acker et al. (2014)'s statement that many teachers with reasonably high intentions never conduct the behavior.

3.5.4 Limitations and directions for future research

Although the current study has yielded important insights into factors influencing rural teachers' use of DERs in Western China, some limitations need to be mentioned. First, because a small sample of teachers three different areas in Western China were involved in the study, the results cannot be simply generalized to other educational regions and other countries. Therefore, we suggest conducting similar studies with a larger sample, and to replicate the analysis using multilevel structural equation modeling to test patterns and

interrelationships among variables in IMBP. Secondly, the data in this study were obtained via survey instruments gathering self-reported data. In order to gain a broader picture of rural teachers' use of DERs and prevent a common-method bias, other qualitative methods could be used. For instance, observations could be used to obtain information about the actual use of DERs in classrooms. Thirdly, both the intention and actual behavior measures were based on self-perceived measures, which may cause the problem of self-reported bias. As such, future research should explore the stability of the construct of actual behavior for teachers by classroom observations and/or interviews with students. Furthermore, since variation at the school level was small, as was found earlier, future research should predominantly focus on other teacher variables affecting their use of DERs, such as motivation for technology and constructivist beliefs about teaching and learning. Finally, the adoption of a longitudinal approach could be recommended to track changes in teachers' deliberations and related DERs integration levels in their daily practices.

3.5.5 Concluding remarks

The current study contributes to the literature regarding DER usage in many ways. Firstly, from a theoretical perspective, more insights have been gained in the complex interplay of teacher variables affecting their use of DERs. To our knowledge, almost no research has examined teachers' use of DERs through inclusion of all the six key constructs of IMBP. Another contribution regarding the use of DERs is that this paper maps rural teachers' judgment of their own behaviors. In explaining DERs use in Chinese rural schools, teacher characteristics are more significant factors than school characteristics. These findings might indicate an increase in the use of DERs when teacher characteristics are taking into account. From the perspective of ICT policy planning, these characteristics may be more receptive to interventions centered on promoting DERs use in classrooms. This means that policymakers need to realize that teachers should be involved in the ICT policy planning process when considering future ICT policy planning to encourage the use of DERs in rural schools. The findings imply that developing a more positive attitude toward using DERs is a fruitful

way to stimulate technology in rural schools. For example, teachers' perceptions of the benefits of using DERs and changes of students are likely to influence their attitudes toward using DERs. Lastly, considering the influence of the knowledge and skills on classroom use of DERs, it seems crucial that teacher training, especially for the new teachers, should focus more on having teachers master technological pedagogical content knowledge.

Hence, we recommend policymakers, school leaders, and developers of teacher training programs to support teachers' use of DERs by helping them developing a more positive attitude toward technology and by increasing their knowledge and skills, so as to see rural teachers' use of DERs grow.