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Why teachers use digital learning materials: The role of self-efficacy, subjective norm and attitude

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Abstract Although Information and Communication Technology (ICT) seems a promising tool in an educational context, many teachers are reluctant to integrate it in their daily practice. A large scale survey was undertaken amongst primary and secondary school teachers in the Netherlands to explore possible determinants of the educational use of digital learning materials (DLMs) in order to develop interventions to reduce teachers' reluctance to use ICT and more specifically to stimulate the use of DLMs. Basing on the Integrative Model of Behaviour Prediction it was conjectured that self-efficacy, attitude and subjective norm would take a central role in explaining the intention to use DLMs. Several other predictors were added to the conceptual model whose effects were hypothesized to be mediated by the three central variables. All conjectured relationships were found using mediation analysis on survey data from 1,484 teachers. Intention to use DLMs was most strongly determined by attitude, followed by self-efficacy. ICT skills was in its turn the strongest predictor of self-efficacy. Subjective norm played only a limited role in the intention to use DLMs. Basing on the outcome of this study, persuasive communication focusing on positive outcomes and skills based training seem appropriate interventions to promote a positive attitude towards DLM and improve self-efficacy in using DLMs.

Keywords Digital learning materials · Attitude · Self-efficacy · Integrative model of behavior prediction · Determinants of ICT use

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1 Introduction

1.1 Teachers' reluctance to integrate digital learning materials into their classroom practices

Since over two decades, ICT was introduced into classroom practice it has gained much attention and ever growing confidence in its effectiveness. ICT is believed to be more than the core of the Information Society. It is supposed to be paramount to the education of knowledge workers (Pelgrum 2001). Although benefits of ICT use in education have been acknowledged (e.g., Hayes 2005; Vichitvejpaisal et al. 2001; Higgins 2003) teachers do not seem to integrate it into their teaching activities (Cuban 2001; Varank, and Tozoğlu 2006; Yang, and Huang 2008; Becta 2008) and, thus, the use of ICT remains rather limited. Therefore, the question arises why teachers are reluctant to integrate ICT in their pedagogical practices. In this paper, we address the question in the context of teachers' usage of digital learning materials (DLMs). Important determinants of using ICT in education and the lack of ICT in classroom practice will be further investigated in the context of teacher's usage of DLMs. The aim is to get insights in the factors driving teachers to use DLMs in their educational practices. Using these insights may help to design necessary interventions so as to make initiatives to promote DLM usage more successful. Moreover, it could be argued that failure to motivate teachers to use DLMs could make developing or sharing of such materials seem less rewarding or attractive. The lack of newly developed materials could in its turn lead to an increased underuse of DLMs, hereby completing a vicious circle.

In order to get insight into which factors influence teachers' decision to use DLMs in their pedagogical practices, and how, we have adopted the Integrative Model of Behaviour Prediction (IMBP, Fishbein 2000; Fishbein and Yzer 2003; Yzer et al. 2004) as a theoretical framework. Although often applied in the domain of health prevention and education, this model was applied for the first time in the domain for the advancement of the integration of ICT in teachers' pedagogical practices. Therefore a second aim of the current study is to test the appropriateness of the IMBP for the current domain. Before elaborating upon our research hypotheses, we will discuss how IMBP can be applied in the current study. A discussion of the IMBP will be followed by a brief review of literature in support of the appropriateness of this model in the domain of the advancement of the integration of ICT in teachers' pedagogical practices. The IMBP can be of practical assistance in developing interventions basing on the relative importance of the determinants, which will be discussed in the implications section.

1.2 Developing a theoretical model of DLMs usage based on the IMBP

The IMBP constitutes the theoretical framework on which the current study is based. This model integrates the theory of planned behaviour (Ajzen 1991), the social cognitive theory (Bandura 1986), and the health belief model (Janz and Becker 1984) and contains a number of critical factors which possibly determine educational ICT use. In the IMBP, dispositional variables are key determinants with respect to a specific behaviour, here teachers' usage of DLMs in education. Although the model

takes into account organizational variables, the main focus of the IMBP is on individual level characteristics. Attitude, self-efficacy and subjective norm are the most important dispositional variables in the IMBP. When combined, these factors are conjectured to influence behavioural intention which, in turn, is related to the actual behaviour. IMBP posits that a person will perform a particular behaviour (i.e., using DLMs) only if that person has formed the intention to perform that behaviour. Intention to use DLMs, thus, is a proximal measure of actually using DLMs. The benefit then, is that the model enables to assess the effectiveness of interventions for enhancing the usage of DLM, as the target of the behaviour change, even if there are no readily available measures of actual behaviour or when the behaviour has not yet been performed. However, the use of intention as a proximal measure for behaviour is somewhat limited because the relationship between intention and behaviour is moderated by environmental variables that may impede real usage of DLMs (e.g., the non-availability of appropriate DLMs) and by teachers' actual knowledge and skills (e.g., to use DLMs in a pedagogical manner).

In IMBP the three dispositional variables attitude, subjective norm, and self-efficacy towards using DLMs are the immediate antecedents of teachers' intention to use DLMs in their pedagogical practices. Attitude towards using DLMs is the person's overall feeling of sympathy or antipathy towards the consequences or outcomes of using DLMs. The antecedent variables of attitude are the outcome beliefs teachers have and their evaluations should they use DLMs. In the perspective of IMBP, outcome beliefs are formulated in terms of expectancies (i.e., probabilities) about the performance of the behaviour having certain consequences or outcomes, either advantageous (e.g., DLMs give more variations during class) or disadvantageous (e.g., DLMs require more class preparation). The evaluations of those outcome beliefs state how important and desirable (e.g., more variations during class is extremely important) or unimportant and undesirable these outcomes are (e.g., more class preparation is undesirable). Evaluations are therefore expressed in terms of importance or in terms of desirability.

Subjective norm towards using DLMs is the aggregated person's beliefs that most people who are important to that person may think that he or she should use DLMs. In that sense, subjective norm reflects a pressuring form of social influence (Ajzen 1991). The antecedent variables of subjective norm concern the non-aggregated normative beliefs teachers have that important people (e.g., school staff, colleagues, and parents) may think that they should use DLMs. Normative beliefs are expressed in terms of expectancies (i.e., probabilities) about these beliefs to be true (e.g., it is very likely that my direct colleagues think that I should use DLMs; it is unlikely that my pupils think that I should use DLMs). Normative beliefs are weighed by the person's motivation to comply, that is, the extent to which the person wishes to comply with the thinking of these important people (e.g., I do not comply with what my direct colleagues think; I certainly do comply with what my pupils think).

Self-efficacy, defined by Bandura (1986) as the belief "in one's capabilities to organize and execute the courses of action required to produce given attainments" (p. 3) is, thus, a person's conviction that he can carry out a behaviour when performance barriers are present. Finally, the antecedent variables of self-efficacy concerns the non-aggregated convictions teachers have that they can use DLMs and that they can or cannot overcome the impediments to use DLMs.

Figure 1 displays an adaptation of the IMBP for the current domain (i.e., the advancement of the integration of ICT in teachers' pedagogical practices). This figure also shows that the variables are grouped into proximal, distal and ultimate variables. Proximal variables include all the dispositional variables and, therefore, the terms dispositional and proximal are interchangeable. The adaptation of the IMBP to the current domain with respect to the proximal variables includes the specification of the attitude object as well as the specific behaviour to which self-efficacy and subjective norm are related. The distal variables encompass all the variables at the level of teachers' characteristics and school organization, and the ultimate variables the determinants at the level of local, regional, and governmental organization. The IMBP has been adapted to include several relevant distal variables at different levels with respect to pedagogical ICT use.

Empirical research based on the IMBP has shown that the relative impact of attitude, self-efficacy and subjective norm depends on the topic under study. When the target behaviour is condom use, self-efficacy may be most important (Fishbein 2000), while marihuana use may be primarily determined by attitude (Yzer et al. 2004). According to Fishbein (2000) the relative importance of specific determinants not only depends on the behaviour itself, but may also vary with the population of interest. Behaviour that is mainly determined by attitude in one population may well be normatively driven in another. The purpose of this study is therefore also to determine the importance of attitude, self-efficacy and subjective norm in predicting teachers' intentions to use DLMs.

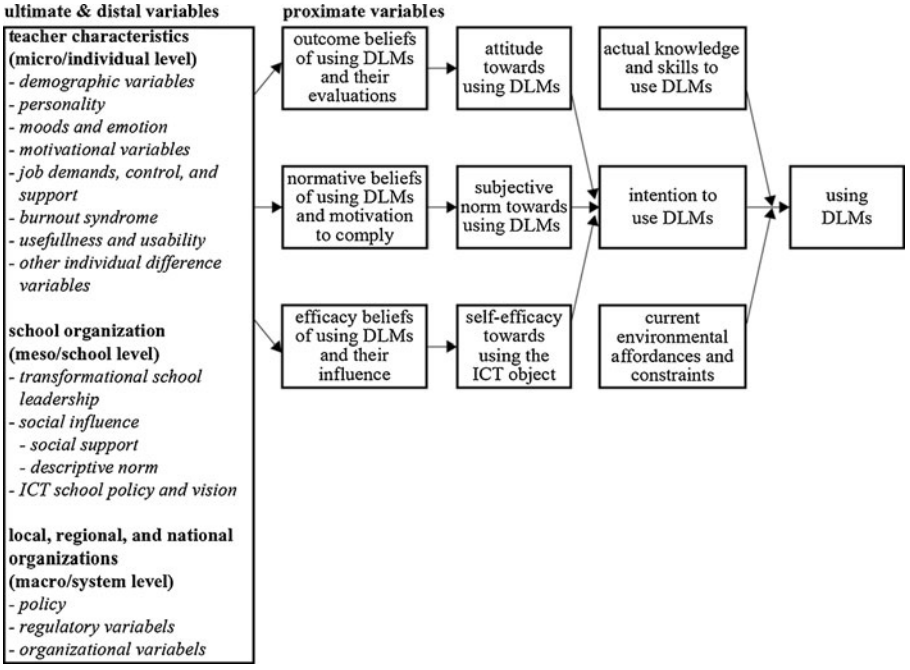

Fig. 1 IMBP adapted to the domain of the advancement of the integration of ICT in teachers' pedagogical practices

1.3 Empirical studies in support of the appropriateness of IMBP in the current domain

A comprehensive review of the literature by Mumtaz (2000) resulted in a number of contextual as well as some dispositional variables influencing teacher's use of ICT. Contextual variables include the environmental variables (in IMBP moderating the relationship between behaviour intention and actual behaviour), the distal, and ultimate variables (in IMBP, the effects of these variables are mediated by the dispositional variables), but exclude the individual level characteristics. The most influential contextual variables according to the Mumtaz study were access to resources, quality of the ICT infrastructure, perceived ease of use, incentives to change, support and collegiality in the school and school and national policies. Individual level characteristics found to be of importance were commitment to professional learning and background in formal computer training. Related to the commitment to professional learning, Pelgrum and Plomp (1993) note that teachers' lack of confidence with regard to ICT usage can in part be explained by poor training. It can be expected that teachers who actively seek out training activities show higher levels of self-efficacy and thus are less reluctant to actually use ICT.

Drent (2005) found that, in addition to the factors that were studied by Mumtaz (2000), entrepreneurship was one of the most determining factors of innovative educational ICT use in teacher training programs. Entrepreneurship was defined as a two dimensional construct. The first dimension was the extent to which teachers make use of their professional network to get support with respect to their ICT use. The second dimension was related to the initiatives teachers take to gather information regarding possible innovative uses of ICT. In addition to its relationship with ICT usage, entrepreneurship was also related to attitude towards ICT and ICT knowledge and skills. These relationships are to be expected when basing on the IMBP.

A more recent study by Tondeur et al. (2008) attempting to integrate both school and teacher level characteristics in an explanatory model of ICT use, found that gender and previous computer use were significant predictors of the adoption of ICT for pedagogical use. Contextual school level characteristics and contextual environmental variables found to be of importance were similar to the previously cited study (Mumtaz 2000) and included availability of ICT (hardware and an Internet connection in the classroom), schools' openness to change, presence of a school ICT policy and availability of ICT support.

In a recent review of antecedents of laptop use among educators (Moses et al. 2008), it was found that gender, lack of time, technology competence as well as administrator and ICT support are important predictors of actual ICT usage. Moreover, this study also acknowledges the impact of attitude. Other authors (Cuban 2001; Teo et al. 2007; Kersaint et al. 2003; van Braak et al. 2004; van Braak 2001a; van Braak 2001b) assert that notwithstanding the potential of ICT, effective implementation of technology (i.e., actual use) is highly dependent on positive attitudes. Attitude is considered to be a key variable in IMBP and will, therefore, take a central role in the current paper.

A factor that can be related to attitude is computer anxiety or 'Cyberphobia'. Russell and Bradley (1997) have researched this phenomenon within a group of school teachers and found that computer anxiety hinders teachers' professional development. Teachers fear they lack the necessary skills to implement ICT in their

classes and they feel insufficiently confident that the outcome of their ICT use will be beneficial for their pupils. Although this study was performed about 15 years ago, computer anxiety remains on the research agenda. In two more recent studies (Wilfong 2006; Beckers and Schmidt 2003) the relationship between computer anxiety and several other variables, among which self-efficacy, was studied. Both studies suggest a relationship between computer anxiety and self-efficacy beliefs. According to IMBP we would expect that the effect of computer anxiety on ICT usage is at least explained by a heightened lack of self-efficacy. Computer anxiety should however be considered in its most broad sense, and thus the term ICT anxiety may be more appropriate as the anxiety may not be related to the device or technology per se, but more specifically to the application of ICT in the specific context under study, in this case the use of digital learning materials.

Several studies thus confirm the roles of distal (e.g., support in school, background and training) and environmental variables (e.g., access to and quality of infrastructure), hereby providing support for the applicability of the model to the context of educational ICT use. We have summarized the relevant variables from the reviewed studies in Table 1. The cited studies clearly show the importance of several contextual factors, but largely ignore the main dispositional variables of interest in this study. Contextual environmental variables will not be discussed in this paper as we consider in the current study only the direct and mediating effects of the determinants of behaviour intention. The effects of all other variables on the other hand will be tested empirically. As previously stated, the IMBP posits that relationships between distal variables such as computer skills and entrepreneurship on the one hand and ICT usage on the other hand can be explained by the three proximal variables in the model (i.e., attitude, self-efficacy and subjective norm). This will be tested empirically in the current study for a specific behaviour, being the use of DLMs in class. Previous research has shown that interventions targeted at specific health related behaviour (e.g., walking 20 min per day) are more effective than interventions

Table 1 Summary of the variables derived from previous studies, which support the relevance of the IMBP in the domain of teachers' pedagogical ICT use

Position in the IMBP	Variables	Authors
Proximal	Attitude	Drent (2005); Cuban (2001); Teo et al. (2007); Kersaint et al. (2003); van Braak et al. (2004); van Braak (2001a); van Braak (2001b)
	Self-efficacy	Pelgrum and Plomp (1993)
Distal	Incentives to change, school and national policies, support and collegiality, commitment to professional learning, formal computer training, school's openness to change, ICT support	Mumtaz (2000); Tondeur et al. (2008); Moses et al. (2008)
	Entrepreneurship	Drent (2005)
	Gender, previous computer use	Tondeur et al. (2008); Moses et al. (2008)
	ICT anxiety	Wilfong (2006); Beckers and Schmidt (2003)
Moderator	Access to resources, quality of ICT infrastructure	Mumtaz (2000)

targeting at general health behaviour (e.g., exercising more). Therefore the aim of the current paper is to study a sufficiently specific behaviour in a well determined population.

We believe that studies focusing on general ICT use might miss certain effects because the behaviour lacks sufficient specificity. Teachers may, for example, have a positive attitude towards using e-mail to communicate with their students, but might feel quite anxious when using an electronic blackboard. As a consequence, measures of a general attitude towards ICT or of the intention to use ICT might include a lot of variability due to the different ICT applications teachers consider when completing these instruments. In this study we focus on the use of DLMs as a specific application of ICT. DLMs are defined in the most broad sense as all forms of digitally available materials which can be used for teaching or learning activities, such as electronic text documents, images as well as multimedia fragments and simulations. Moreover, we will study our conjectures within the population of interest, being primary and secondary school teachers as the behavioural intention of using DLMs might differ between teachers and other populations.

1.4 The current study

We have argued that although ICT offers several advantages in educational practice, teachers seem reluctant to use it. Previous research has shown the importance of several variables in the IMBP in explaining ICT usage within a teacher population. IMBP, however, posits that self-efficacy, attitude and subjective norm can help explain the relationship with distal variables and teachers' intentions to use ICT. The first aim of the current study is thus to test this theoretical perspective hereby validating it and providing a framework for the development of interventions. We thus seek to find a theoretical justification for the previously found relationships.

Although researchers have investigated the impact of many possible determinants of ICT usage, the relative importance of attitude, self-efficacy and subjective norm have thus far not been studied combined. In this paper we specifically study the impact of each of these proximal variables in order to determine the focus of future interventions. According to Fishbein (2000), outcome beliefs should be the target of an intervention when attitude is the most important predictor of a behaviour. In contrast, when self-efficacy plays the central role in determining a behaviour, skills based training will be most effective. Finally, when subjective norm is the key determinant, stimulating dialogue regarding expectations of significant others may be a way to increase people's awareness of these expectations.

The role of distal variables, studied in previous works, as well as the proximal variables in explaining teachers' behaviour will now be specifically tested for a specific type of behaviour, namely DLM usage, which is a specific type of innovative ICT usage. The relative impact of attitude, self-efficacy and subjective norm may well be different for other types of ICT usage. In order to be able to develop effective interventions, it is thus important to address a behaviour which is sufficiently specific (Fishbein 2000).

According to IMBP it is conjectured that self-efficacy, attitude and subjective norm will directly impact on the intention to use DLMs (H_1-H_3). Moreover, we expect attitude to be the strongest predictor of intention (H_4). Next, we hypothesize

that these dispositional variables will mediate the effect of several other distal factors. This results in four additional hypotheses:

H_5: ICT skills will be positively related with the intention to use digital learning materials, mediated by self-efficacy,
H_6: Outcome expectations and computer anxiety will be related with intention, mediated by attitude; part of the effect of anxiety on intention will also be mediated by self-efficacy (cfr. Russell and Bradley 1997; Wilfong 2006; Beckers and Schmidt 2003),
H_7: perceived support (cfr. ICT support; Tondeur et al. 2008; Moses et al. 2008) will be positively related with intention, mediated by subjective norm
And H_8: entrepreneurship will predict intention to use DLMs, mediated by self-efficacy and attitude. The definition of entrepreneurship which was used in previous research (Drent 2005) will be extended with the extent to which teachers actively seek out engagement in professionalization activities (cfr., commitment to professional learning activities; Mumtaz 2000).

2 Method

2.1 Participants

A questionnaire was administered electronically in December 2009 to teachers of primary and secondary schools. A representative sample was recruited from an online panel in such a way that it reflected the primary and secondary teacher population well. Basing on recent statistics (CBS 2009), the sample does not differ on any important characteristics (age and gender) from the teacher population in the Netherlands. The latter encompass pre-vocational secondary education (4 years), senior general secondary education (5 years), and pre-university education (6 years). A total of 1,484 teachers completed the questionnaire entirely. Table 2 contains the most important socio-demographic information regarding the sample.

2.2 Measures

Apart from the demographical variables, the questionnaire included the measures for the proximal and distal variables of interest. Most measures were newly constructed

Table 2 description of the sample demographics: gender, age and employment in primary or secondary education

	Primary education (N=742)	Secondary education (N=742)
age	M=41.59; SD=12.01	M=44.31; SD=12.37
gender	men: N=140; women: N=602	men: N=410; women: N=332

taking into account the recommendations of Fishbein (2000) concerning the construction of IMBP instruments. One existing measure was adapted for use in our study. Cronbach's alpha was calculated for each scale as a measure of internal consistency. An overview of the scales (with the exception of ICT skills) and their constituting items can be found in Appendix I.

2.2.1 Proximal variables and intention to use DLMs

Attitude was measured using a 12-item bipolar scale. Respondents rated several aspects of DLM usage on a seven-point rating scale with end anchors such as "boring versus fun" or "useful versus useless" (α=.97). Both the affective as well as the cognitive dimension of attitude were measured. The self-efficacy scale consisted of three items such as "I am convinced I can effectively make use of digital learning materials in my courses". Questions were answered on a seven point rating scale with end anchors being "fully agree" and "fully disagree" (α=.91). Subjective norm was measured using six items gauging injunctive norm (i.e., to what extent teachers think colleagues, school management, parents and students want them to make use of DLMs) and descriptive norm (i.e., to what extent teachers believe other colleagues make use of DLMs). An example item is: "My students want me to make use of DLMs in class". Answers ranged from "fully agree" to "fully disagree" on a seven-point scale (α=.81). Seven items were used to measure the intention to use DLMs. All items were answered on a seven-point rating scale with end anchors being "extremely likely" and "extremely unlikely". An example of an item was: "I have the intention to use digital learning materials frequently in my courses" (α=.97).

2.2.2 Distal variables

A single item measured ICT skills. Respondents could answer how well they could use ICT in their pedagogical practices (perceived ICT skills) on a scale ranging from beginner to guru. The entrepreneurship scale (α=.90) consisted of nine items measuring the extent to which teachers were taking initiative to professionalize themselves in the domain of ICT and DLMs and was adapted from Drent (2005). Outcome expectations was operationalized by two scales related to negative outcomes (α=.86) and positive outcomes (α=.92) which were measured with five and two items respectively. Example items are: "Regularly using digital learning materials will increase my workload" and "By using digital learning materials regularly, my classes will be more interesting". Computer anxiety (α=.96) was measured with five items such as "The use of digital learning materials in my courses makes me anxious". Finally, to measure perceived support, respondents were asked to indicate whether they received support from other teachers, whether school management allowed them to take courses, or whether they take part in support teams (α=.55). Scores ranged from zero when none of the aforementioned activities were performed to three when all of the activities were performed.

For each scale, items were reverse scored if applicable and the average scale score was computed. Due to the use of prompts in the Web-based survey, the data set had no missing values.

2.3 Data analysis

Relationships between the variables under study were analyzed using bivariate correlations. The mediation hypotheses were tested using Preacher and Hayes (2008) method for assessing indirect effects. This method tests four different relationships: (1) whether there is a significant direct relationship between the distal variable of interest and the mediator (attitude, self-efficacy and subjective norm), (2) whether there is a significant direct relationship between the mediator and the outcome variable (i.e., intention to use DLMs), (3) whether the indirect effect of the distal variables on the outcome variable, through the mediators, is significant (using a bias corrected and accelerated bootstrap method) and finally (4) whether there is still a direct effect of the distal variable when controlling for the mediation effect (i.e., whether there is full or partial mediation). To obtain standardized regression coefficients, all variables were standardized prior to the analysis. Age, gender and school type were added as covariates in the analyses. Outliers were detected using multiple linear regression analysis and removed basing on the Mahalanobis distance (Barnett and Lewis 1978).

3 Results

Correlations between the variables in the different models can be observed in Table 3. The same table also includes the mean score and standard deviations for each variable.

Hypotheses 1–3: the influence of attitude, self-efficacy and subjective norm

Figure 2 shows the results of the mediation analysis. In total, 69% of the variance in intention to use DLMs was explained by the variables in the model (R^2=.69; F(10, 1,475)=249.04, p<.001). Gender and age had no significant relationship with the intention to use DLMs. The standardized regression coefficients show that, when considering the proximal variables, attitude is most strongly related to intention, followed by self-efficacy. Subjective norm seems to have only a limited impact on teachers' intention to use DLMs.

Hypotheses 4–7: the mediating role of the proximal variables

All significant relationships of the distal variables with intention are fully mediated by the three proximal variables, except for entrepreneurship and positive outcomes. Entrepreneurship and positive outcomes have an indirect effect on intention through two and three proximal variables respectively, as well as a moderate direct effect (p's<.001). Formal tests for the significance of the indirect effect of each distal variable can be found in Table 4.

3.1 Conclusions and discussion

The analysis revealed the importance of the three proximal variables under study. Together, these variables explained a large proportion of variance in intention to use DLMs. Attitude was found to be the strongest predictor, followed by self-efficacy.

Table 3 Correlations between the measured variables; the second column contains the descriptive statistics for each measure

	M (*SD*)	Attitude	Self-efficacy	Intention	Subjective norm	ICT skills	Computer anxiety	Negative outcomes	Positive outcomes	Perceived support
attitude	5.62 (1.03)									
self-efficacy	5.28 (1.60)	.57								
intention	5.04 (1.57)	.70	.66							
subjective norm	2.62 (1.51)	.27	.26	.32						
ICT skills	4.53 (1.04)	.37	.43	.38	.05**					
computer anxiety	1.71 (1.13)	−.48	−.44	−.36	−.08	−.42				
negative outcomes	3.79 (1.62)	−.26	−.22	−.16	−.08	−.24	.37			
positive outcomes	5.19 (1.51)	.71	.77	.76	.26	.36	−.34	−.15		
perceived support	1.42 (1.06)	.22	.19	.24	.29	.11	−.07	−.04**	.18	
entrepreneurship	3.79 (1.32)	.53	.56	.65	.27	.42	−.24	−.10	.55	.33

All correlations are significant at the .001 level, except those marked by **. All scores ranged from 1 to 7, except for perceived support where the highest possible score was 3

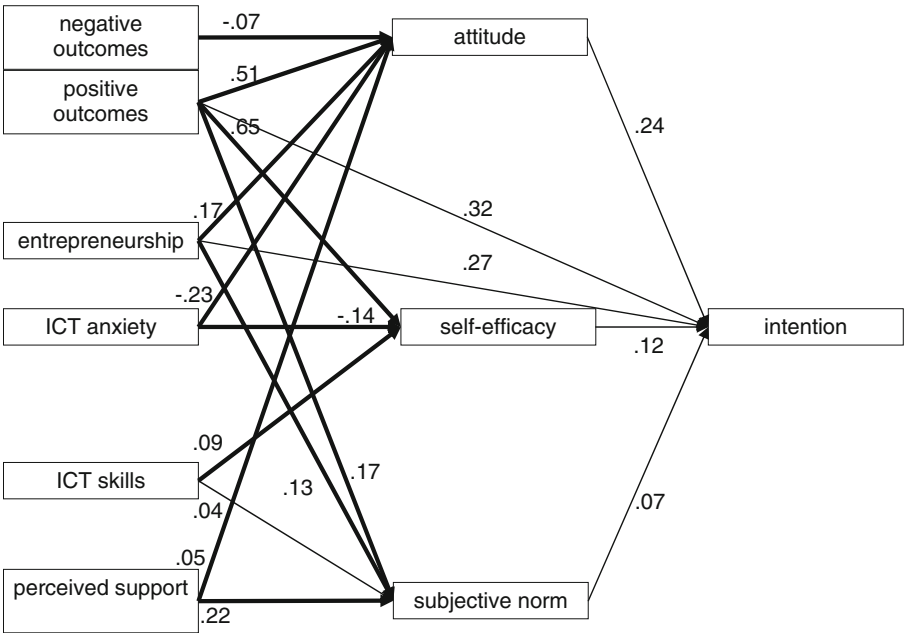

Fig. 2 Results of the mediation analysis assessing the hypothesized impact of proximal and distal variables on teachers intention to use DLMs. Nonsignificant relationships (i.e., coefficients) were omitted from the figure. Broader lines indicate that the indirect effect of the distal variable, through the mediator it is connected with, is significant

Compared to those two variables, subjective norm played only a limited role in predicting teachers' intention to use DLMs. When inspecting bivariate relationships between the proximal variables and intention, it is clear that attitude, self-efficacy and intention are strongly related (correlations of .57 and above). Although the unique contribution of both attitude and self-efficacy in predicting teachers intention to use DLMs is lower, they both still explain the largest proportion of variance. This finding regarding attitude is in accordance with previous studies (Cuban 2001; Teo et al. 2007; Kersaint et al. 2003; van Braak et al. 2004; van Braak 2001a; van Braak 2001b) that have acknowledged the importance of a positive attitude towards ICT for a successful adoption of ICT in classroom practices. As DLM usage requires teachers to use ICT as well, these findings are little surprising. The acceptance of hypotheses one to four confirm the importance of attitude, self-efficacy and subjective norm as important determinants of the intention to use DLMs. The hierarchy of importance confirms that attitude has the highest impact on teachers' intention to use DLMs.

Our main research question, however, was whether the impact of distal variables (e.g., computer anxiety or outcome expectations) can be explained by the relationship between the proximal variables and intention. Our analysis suggests that the relationships of four out of six variables which were measured in the survey are mediated by one or more of the distal variables. We will discuss the indirect effect of each distal variable in order of its total impact on teachers' intentions to use DLMs.

Negative outcome expectations were negatively related with the intention to use DLMs. This relationship was fully mediated by attitude. Teachers who believe that

Table 4 Significance tests of the indirect (bias corrected and accelerated bootstrap) effects of the distal variables. Intervals which do not include 0 indicate a significant indirect effect of the distal variable through the proposed mediator

Distal variable	Mediator	Effect	Lower limit	Upper limit
ICT skills				
	self-efficacy	.011	.005	.020
	attitude	.002	−.009	.015
	subjective norm	−.005	−.012	.001
perceived support				
	self-efficacy	.004	−.012	.026
	attitude	.011	.002	.022
	subjective norm	.016	.007	.026
negative outcomes				
	self-efficacy	−.004	−.011	.001
	attitude	−.017	−.029	−.008
	subjective norm	.003	−.009	.001
positive outcomes				
	self-efficacy	.076	.035	.117
	attitude	.123	.092	.157
	subjective norm	.012	.005	.022
entrepreneurship				
	self-efficacy	.005	−.001	.014
	attitude	.040	.025	.060
	subjective norm	.009	.004	.018
ICT anxiety				
	self-efficacy	−.017	−.030	−.008
	attitude	−.056	−.079	−.038
	subjective norm	.001	−.005	.004

*Significant indirect effects are indicated in bold

the use of DLMs comes with a higher workload have a more negative attitude towards DLMs which leads them to be less inclined to use DLMs. Of all currently measured distal variables, positive outcome expectations were most strongly related to teachers' intentions to use DLMs both directly and indirectly. On top of an indirect effect through attitude, self-efficacy and subjective norm, there was a moderate direct effect of this distal variable as well.

Positive outcome expectations are strongly related to attitude and self-efficacy and weakly to subjective norm. As expected, when teachers clearly perceive the advantages of using DLMs, they have a more positive attitude towards using them in their courses and as a consequence they intend to make more use of them. Contrary to our predictions, positive outcome expectations had an indirect effect on intention through self-efficacy and subjective norm as well. Teachers who perceive the advantages of using DLMs thus feel more confident using them and experience a higher external pressure to use them.

These indirect relationships are hard to explain as there seems no theoretical basis to clarify them. Other variables may be intervening in this causal chain which mediate the relationship between positive outcome expectations and self-efficacy on the one hand and subjective norm on the other hand. Another explanation for this finding is a possible feedback effect: teachers who feel more confident in using DLMs make more of use them and thus perceive more uses for them and also perceive their advantages. In relation to subjective norm, the same feedback effect could cause the current results as teachers who frequently use DLMs possibly seek more assistance from colleagues hereby leading to an increased descriptive norm (i.e., the perception of DLMs use by peers) as part of the subjective norm construct.

As conjectured, entrepreneurship was related to attitude. Teachers who take training initiatives and who actively seek support from peers or experts experience a more positive attitude towards using DLMs. The indirect effect of entrepreneurship on intention was only partially confirmed: there was also a moderate direct effect of entrepreneurship after controlling for the three proximal variables. Moreover, the effect of entrepreneurship seemed to be partly mediated by subjective norm as well. This finding could be due to the fact that teachers who frequently discuss DLM usage with colleagues, may perceive a higher frequency use among peers (i.e., a higher descriptive norm). Therefore the subjective norm may have a higher impact for this group of teachers. In general, entrepreneurship was found to be the second most important (indirect) distal predictor of intention to use DLMs.

Several explanations can be given for the effect of entrepreneurship on intention to use DLMs. Teachers who take initiatives to skill themselves in DLM usage, without any external pressure, might be more intrinsically motivated to use DLMs or ICT in general. A finding in support of this hypothesis is the relationship between entrepreneurship and attitude. Entrepreneurial teachers seem to like DLMs more than other teachers which could be an indication of an intrinsic drive to make use of DLMs. Moreover, as the definition of entrepreneurship suggests, this behaviour is not externally driven and thus teachers which score high on entrepreneurship might experience more autonomy in DLM usage. According to self-determination theory, autonomy is in turn related to intrinsic motivation (Ryan and Deci 2000). Given the importance of entrepreneurship as a determinant of intention, further research could look into the impact of intrinsic motivation on DLM use or ICT use in general in an attempt to explain the precise role of entrepreneurship.

Our hypothesis that ICT anxiety would be negatively related to intention, mediated by both attitude and self-efficacy, was confirmed by the data. ICT anxiety was operationalized as a general uncomfortableness towards ICT. We expected that ICT anxiety in general would discourage teachers to use applications of ICT such as DLMs. The current study suggests that the effect of ICT anxiety leads to a more negative attitude towards DLMs and a decreased confidence in being able to apply DLMs in a classroom setting (i.e., self-efficacy). Combined, the relationships with self-efficacy, attitude and subjective norm seem to fully explain the impact of ICT anxiety on intention to use DLMs. Moreover, although levels of ICT anxiety were reasonably low, computer anxiety still plays an important role in the extent to which teachers use DLMs. These findings are in accordance with previous research on the relationship between computer anxiety and self-efficacy beliefs (Wilfong 2006; Beckers and Schmidt 2003).

It was expected that teachers who perceive themselves as skilled in using ICT, would show higher levels of self-efficacy which would in turn lead to an increased intention to use DLMs. The analysis revealed that the effect of ICT skills, which comes down to general ICT competencies, was fully mediated by self-efficacy. Teachers who are more skilled in using ICT seem to feel confident in being able to use DLMs. Knowing how to operate a computer is a direct prerequisite for successful DLM usage and therefore it seems evident that teachers who feel they lack the necessary skills to use ICT will be less inclined to make use of DLMs. This finding is in line with the hypothesis of Pelgrum and Plomp (1993) that teachers' limited self-confidence regarding ICT use might be related to a lack of ICT related skills. In order to stimulate the use of applications of ICT, such as DLMs, it is thus necessary to train teachers in basic ICT skills as well.

Although this relationship was not explicitly tested, correlations between the studied variables show that the variable ICT skills has a moderate positive relationship with entrepreneurship. Teachers who are more entrepreneurial seem to feel they possess more general ICT skills. This finding adds to the complex relationship of entrepreneurship with teachers' intention to use DLMs.

The impact of perceived support through subjective norm was tested and a fully mediated relationship was found, although contrary to our expectations, attitude was involved in this relationship as well. The perception that more colleagues (are able to) provide support for using DLMs, that fact that school management explicitly allows them to engage in professionalization activities all adds to feeling some pressure to use DLMs hereby also increasing teachers' intention to use DLMs. The effect of perceived support on intention, although significant, was very weak. A possible explanation for the support-attitude relationship could be that teachers who work in a DLMs supportive school also perceive more advantages of DLMs, either through the training activities they are encouraged to take or through the support of colleagues or work groups. It must be noted that the influence of subjective norm and perceived support could be underestimated due to the relatively low scores on these variables. This could indicate that many teachers do not perceive using DLMs as a standard and feel little pressure from school management or other teachers.

In this study only perceived support was studied in relation to teachers' intention to use DLMs. In the context of general ICT usage, Tondeur et al. (2008) conclude that a clear ICT policy impacts on teachers actual ICT usage. Similarly, a explicit school and even a national policy concerning DLM usage could change teachers' subjective norm of DLM usage. If government and school management would communicate a clear strategy concerning the use of open educational resources in education, the effect of subjective norm could possibly be discerned more prominently.

3.2 Practical implications

The results of this study suggest that interventions that are developed to increase the use of DLMs in teachers' pedagogical practices should mainly pay attention to improve teachers attitude towards using DLMs. An important determinant of attitude are outcome expectations. Our study revealed that, although negative outcome expectations play a role as well, teachers' attitude towards using DLMs is mainly determined by their positive outcome expectations (e.g., whether DLMs will make

their classes more interesting or exciting). Teachers should thus be made aware of the possible positive outcomes DLMs can have for their teaching activities and they should be supported in alleviating the negative outcomes (e.g., increased workload). Moreover, positive outcome expectations have a direct effect on intention as well, which cannot be explained by any of the proximal variables. As argued earlier, this may be due to the fact that earlier experiences with DLMs actually elicit a positive shift it outcome expectations. Teachers should thus be encouraged to use DLMs, with support of colleagues or DLM professionals, in order to experience the positive impact DLMs can have. Initiatives should thus aim at promoting a positive attitude towards DLMs, for example, by means of campaigns that are based on the persuasion communication model (McGuire 1985) and that elaborate the added value of DLMs in education.

The second proximal variable, teachers' self-efficacy, must be targeted as well, for example by providing them with skills based training programs. General ICT skills are one of many competencies that influence teachers intention to use DLMs. Other training related to didactics and specific skills regarding electronic media use (e.g., image or video editing) will probably improve teachers' self-efficacy as well. This is in accordance with Wilfong (2006) who suggested general skill training as a suitable method for improving self-efficacy beliefs. Such skills training could take place in professional learning communities which foster mutual support between teachers. Moreover, such communities can play a key role in the development of a subjective norm towards using DLMs by showing that many teachers are actually using DLMs and that it is thus common in the teaching practice. Furthermore it must be noted that self-efficacy refers to the feeling of competence teachers experience when using DLMs. Although related, this does not reflect the actual skills teachers possess in using DLMs. Therefore it seems necessary to provide (positive) feedback to teachers regarding their ICT skills and DLM usage hereby increasing their self-efficacy.

Although entrepreneurship needs further attention in future research, it seems to have an important impact on teachers' intention to use DLMs through each of the proximal variables in the IMBP. Teachers who are very entrepreneurial with regard to the use of DLMs, and probably educational ICT use in general, should be stimulated to do so. These teachers can be regarded as early adopters of new ideas and technologies and can play an important role in the further adoption of DLMs by other teachers through the subjective norm. A school policy supporting DLM use could possibly foster a digital culture in schools which could in its turn be carried by a group of entrepreneurs or early adopters.

3.3 Theoretical implications

The current study provides support for the Integrative Model of Behaviour Prediction as a paradigm to research teachers' intentions to use DLMs. Although some predictions made by the model do not fully comply with the empirically found relationships, the alterations (i.e., addition of a direct path between entrepreneurship, outcome expectations and intention) can be justified. According to the developers of the IMBP, the strength of the relationship between each proximal variable and intention depends strongly on the topic that is studied (e.g., cannabis use versus ICT use) (Yzer et al. 2004). Similarly some of the relationships between intention and specific distal

variables might not be explained by one or more of the proximal variables. Therefore future studies should attempt to replicate these findings and try to pinpoint possible moderators of the proposed relationships.

The IMBP can thus be considered as a fitting framework to study different forms of educational ICT use, such as DLM usage. Although many of the relationships which were found between the distal variables, were already tested in previous studies, these relationships had never been explained from a broader theoretical perspective. IMBP proves further explanation for the impact certain variables have, through attitude, self-efficacy and subjective norm. In this way a causal chain is established between the variables under study explaining how a specific determinant affects one or more of the proximal variables, hereby influencing teachers' behaviour.

3.4 Limitations and future research

Results from this study are based on responses of a sample of teachers from primary and secondary education in the Netherlands. As government policies regarding ICT usage may impact on the variables under study, results may not be generalizable to other countries. Replications in other countries might not only provide further support for the proposed theory, but also provide insight into how school and government policies regarding ICT and DLM usage impact on how teachers integrate DLMs into the curriculum.

A second limitation is related to the use of intention as the outcome measure. Teachers' intention to use DLMs might differ greatly from their actual behaviour. Although theoretically a strong relationship between intention and actual behaviour can be expected, IMBP itself suggests that several factors may impede teachers' use of DLMs, such as their actual ICT and DLM related knowledge and skills or the environmental constraints such as the absence of an up to date ICT infrastructure. These factors should be taken into account in future studies.

An important issue that was insufficiently addressed in the current study, is the causality of several relationships. The relationship between self-efficacy and anxiety for example, is supported by IMBP, which clearly posits that anxiety is an antecedent of self-efficacy. Previous studies, however, have shown mixed results with regard to the direction of this effect (Wilfong 2006). Future research could look into the interaction between ICT anxiety, attitude and self-efficacy in order to further explore determinants of future ICT use. In the same line of thought, we have argued that several variables might be influenced by the behaviour that is actually performed (e.g., positive experiences with ICT might decrease teachers' anxiety). A longitudinal approach based on the IMBP could help identifying possible feedback mechanisms hereby providing insight into the causality of certain relationships.

Future research should also focus on other antecedent variables of attitude and self-efficacy regarding the use of DLMs. That is, on teachers' positive and negative outcome beliefs and their evaluations should they use DLMs, and on teachers' efficacy beliefs regarding how they think to cope with the impeding factors that are associated with DLMs use. Future studies could consider other distal variables than the ones used in this study (see Fig. 1 to get an impression). Past research suggests that a clear ICT policy on school level might be an important predictor as well as the

school management's vision with regard to ICT might play a key role in teacher's actual ICT usage. Finally, it would be interesting to augment IMBP with elements of motivation theories such as the self-determination theory (Ryan and Deci 2000).

Appendix I: Overview of the measurements and their constituting items and instructions

Variable	Instruction/Item
Intention	Please indicate to what extent the following statements apply to you:
	I plan to use digital learning materials regularly in my courses
	I intend to use digital learning materials regularly in my courses
	I will try to use digital learning materials regularly in my courses
	I am motivated to use digital learning materials regularly in my courses
	I think I should use digital learning materials regularly in my courses
	I will use digital learning materials regularly in my courses
	I expect to use digital learning materials regularly in my courses
Attitude	I consider using digital learning regularly (i.e., a few times a week during the academic year):
	Valuable – worthless
	Disadvantageous – advantageous
	Useless – useful
	Wise – senseless
	Meaningful – meaningless
	Productive – unproductive
	Pleasant – unpleasant
	Fun – dull
	Annoying – pleasing
	Boring – fascinating
	Interesting – uninteresting
	Fantastic – horrible
Self-efficacy	Please indicate to what extent the following statements apply to you:
	I am convinced I can effectively make use of digital learning materials in my courses.
	I am convinced I am successful in using digital learning materials in my courses.
	I am quite confident to use digital learning materials in my courses.
Subjective norm	Please indicate to what extent the following statements apply to you:
	Teachers from other sections of my school use digital learning materials regularly.
	Teachers from my own section use digital learning materials regularly.
	Teachers from other schools use digital learning materials regularly.
	My students want me to use digital learning materials regularly.
	Other teachers want me to use digital learning materials regularly.
	The school management wants me to use digital learning materials regularly.
Entrepreneurship	Please indicate to what extent the following statements apply to you:
	I take initiatives to participate in courses or workshops related to digital learning materials.

Variable	Instruction/Item
	I seek out colleagues and teachers from other schools to discuss the use of digital learning materials.
	I personally take initiatives to use digital learning materials in my courses.
	I discuss the fact that I want to make use of digital learning materials with the school management.
	I ask the school management for funds enabling the use of digital learning materials.
	I consult experts in the field of digital learning materials.
	I take part in user groups related to digital learning materials.
	I consult internet sources and other sources to obtain digital learning materials.
	I make use of existing incentive measures in order to obtain digital learning materials.
Outcome expectations	Because I use digital learning materials in my classes regularly (i.e., a few times a week during the academic year)…
	I will have to spend more time on course preparation.
	I will have to increase my work tempo in order to finish things.
	I will have to work harder.
	I will have to increase my mental efforts.
	I will have less time to do other things.
	I will have more variety in my work.
	I will learn new things.
ICT anxiety	Please indicate to what extent the following statements apply to you:
	The use of digital learning materials in my courses makes me anxious.
	I feel nervous when I think about using digital learning materials in my courses.
	I feel discouraged when I have to make use of digital learning materials in my courses.
	I try to avoid using digital learning materials in my courses because it feels intimidating.
	I feel cramped when I use digital learning materials in my courses.
Perceived support	Please indicate which support you receive from colleagues and the school management with respect to the use of digital learning materials.
	Personal support from colleagues.
	Support to participate in workgroups.
	Support to take courses.

References

Ajzen, I. (1991). The theory of planned behaviour. *Organizational Behaviour and Human Decision Processes, 50*, 179–211.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs: Prentice Hall.

Barnett, V., & Lewis, T. (1978). *Outliers in statistical data*. New York: Wiley.

Beckers, J. J., & Schmidt, H. G. (2003). Computer experience and computer anxiety. *Computers in Human Behaviour, 19*, 785–797.

Becta (2008). *Harnessing technology review 2008: The role of technology and its impact on education*. Coventry: Becta.

CBS (2009). *Statline*. Retreived from the Centraal Bureau voor de Statistiek website at http://statline.cbs.nl/StatWeb/publication/?VW=T&DM=SLNL&PA=71814ned&D1=a&D2=803-826&D3=1,3,5-6&HD=110523-1422&HDR=G2,T&STB=G1.

Cuban, L. (2001). *Oversold and underused: Computers in the classroom*. Cambridge: Harvard University Press.

Drent, M. (2005). *In Transitie: Op Weg naar Innovatief ICT-gebruik op de PABO* [In Transition: On the Road to Innovative ICT-use in Teacher Education]. Universiteit Twente: unpublished doctoral dissertation.

Fishbein, M. (2000). The role of theory in HIV prevention. *AIDS Care, 12*, 273–278.

Fishbein, M., & Yzer, M. C. (2003). Using theory to design effective health behaviour interventions. *Communication Theory, 13*, 164–183.

Hayes, D. N. A. (2005). ICT and Learning: Lessons from Australian classrooms. *Computers in Education, 49*, 385–395.

Higgins, S. (2003). *Does ICT improve learning and teaching in schools? A professional user review of the UK research undertaken for the British educational research association*. Southwell: British Educational Research Association.

Janz, N. K., & Becker, M. H. (1984). The health belief model: A decade later. *Health Education Quarterly, 5*, 34–41.

Kersaint, G., Horton, B., Stohl, H., & Garofalo, J. (2003). Technology beliefs and practices of mathematics education faculty. *Journal of Technology and Teacher Education, 11*, 549–577.

McGuire, W. J. (1985). Attitudes and attitude change. In G. Lindzey & E. Aronson (Eds.), *Handbook of social psychology* (3rd Ed., Vol. 2, pp. 233–346). New York: Random House.

Moses, P., Khambari, M. N. M., & Luan, W. S. (2008). Laptop use and its antecedents among educators: A review of the literature. *European Journal of Social Sciences, 7*, 104–114.

Mumtaz, S. (2000). Factors affecting teacher's use of information and communications technology: A review of the literature. *Journal of Information Technology for Teacher Education, 9*, 319–342.

Pelgrum, W. J. (2001). Obstacles to the integration of ICT in education: Results from a worldwide educational assessment. *Computers in Education, 37*, 163–178.

Pelgrum, W. J., & Plomp, T. (1993). The worldwide use of computers: A description of main trends. *Computers in Education, 20*(4), 232–332.

Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behaviour Research Methods, 40*, 879–891.

Russell, G., & Bradley, G. (1997). Teachers' computer anxiety: Implications for professional development. *Education and Information Technologies, 2*(1), 17–30.

Ryan, R., & Deci, E. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist, 55*, 68–78.

Teo, T., Lee, C. B., & Chai, C. S. (2007). Understanding pre-service teachers' computer attitudes: Applying and extending the technology acceptance model. *Journal of Computer Assisted Learning, 24*, 128–143.

Tondeur, J., Van Keer, H., van Braak, J., & Valcke, M. (2008). ICT integration in the classroom: Challenging the potential of a school policy. *Computers in Education, 51*, 212–223.

van Braak, J. (2001a). Factors influencing the use of computer mediated communication by teachers in secondary schools. *Computers in Education, 36*, 41–57.

van Braak, J. (2001b). Individual characteristics influencing teacher's class use of computers. *Journal of Educational Computing Research, 25*(2), 141–157.

van Braak, J., Tondeur, J., & Valcke, M. (2004). Explaining different types of computer use among primary school teachers. *European Journal of Psychology of Education, 19*(4), 407–422.

Varank, I., & Tozoğlu, D. (2006). Why are teachers resistant to change? Key issues and challenges in technology integration. *Afyon Kocetepe Universitesi Sosyal Bilimler Dergisi, 8*, 193–207.

Vichitvejpaisal, P., Sitthikongsak, S., Preechakoon, B., Kraiprasit, K., Parakkamodom, S., Manon, C., & Petcharatana, S. (2001). Does computer-assisted instruction really help to improve the learning process? *Medical Education, 35*, 983–989.

Wilfong, J. (2006). Computer anxiety and anger: The impact of computer use, computer experience, and self-efficacy beliefs. *Computers in Human Behaviour, 22*, 1001–1011.

Yang, S. C., & Huang, Y.-F. (2008). A study of high school English teachers' behaviour, concerns and beliefs in integrating information technology into English instruction. *Computers in Human Behaviour, 24*, 1085–1103.

Yzer, M. C., Capella, J. N., Fishbein, M., Hornik, R., Sayeed, S., & Ahern, R. K. (2004). The role of distal variables in behaviour change: Effects of adolescent's risk for marijuana use on intention to use marijuana. *Journal of Applied Social Psychology, 34*, 1229–1250.