Determinants of the educational use of digital learning materials:

The mediating role of self-efficacy, perceived norm and attitude

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Abstract

Initiatives to stimulate the development and propagation of open educational resources (OER) need a sufficiently large community that can be mobilized to participate in this endeavour. Failure to achieve this could lead to underuse of OER. In the context of the Wikiwijs initiative a large scale survey was undertaken amongst primary and secondary school teachers to explore possible determinants of the educational use of digital learning materials (DLMs).

Basing on the Integrative Model of Behaviour Prediction it was conjectured that self-efficacy, attitude and perceived norm would take a central role in explaining the intention to use DLMs. Several other predictors were added to the model as well whose effects were hypothesized to be mediated by the three central variables.

All conjectured relationships were found using path analysis on survey data from 1484 teachers. Intention to DLMs was most strongly determined by self-efficacy, followed by

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attitude. ICT proficiency was in its turn the strongest predictor of self-efficacy. Perceived norm played only a limited role in the intention to use DLMs.

Concluding, it seems paramount for the success of projects such as Wikiwijs to train teachers in the use of digital learning materials and ICT (e.g. the digital blackboard) and to impact on their attitude.

Keywords
digital learning materials, attitude, self-efficacy, Integrative Model of Behavior Prediction, determinants of ICT use, perceived norm

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Introduction

1. Why are teachers reluctant to integrate digital learning materials into their classroom practices?

Since over two decades ago, 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; Meijer, van Eck, & Felix, 2008) teachers do not seem to integrate it into their teaching activities (Cuban, 2001; Varank, & Tozoğlu, 2006; Yang, & Huang, 2008) and, thus, the use of digital learning materials (DLMs).

Failure to motivate teachers to use DLMs could make the development 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 the Netherlands, the Wikiwijs initiative aims at disclosing *open* DLMs for use in all strata of education. The effectiveness of this initiative depends largely on the actual use of DLMs in education. Therefore, in the current research paper, 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. More precisely, we will test several hypotheses concerning DLM use basing on the Integrative Model of Behavior Prediction (IMBP: Fishbein, 2000; Fishbein & Yzer, 2004; Yzer, Capella, Fishbein, & Hornik, 2004).

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 believe model" (Janz & Becker, 1984) and contains a number of critical factors which determine educational ICT use. A discussion of the IMBP will be followed by a brief review of literature in support of the application of this model in the domain of the advancement of the integration of ICT in teachers' pedagogical practices .

In the IMBP, dispositional variables are key determinants with respect to a specific behaviour, here teacher's 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 perceived 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. According to the model, the intention-behavior relationship may be moderated by

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environmental variables (such as the non-availability of DLMs or the proper ICT infrastructure) and by teacher's actual ICT knowledge and skills.

Furthermore, IMBP considers the positive and negative outcome beliefs teachers have should they use DLMs (e.g., DLMs give more variations during class and DLMs require more class preparation) to be antecedent variables of attitude. The antecedent variables of subjective norm concern teachers' normative beliefs that important people (e.g. colleagues and parents) may think that they should use DLMs. Finally, self-efficacy antecedent variables concern the convictions (i.e. the efficacy beliefs) teachers have that they can use DLMs and that they can 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 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.

3. Empirical studies in support of the application 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 behavior intention and actual behavior), 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 polices. Individual level characteristics found to be of importance were commitment to professional learning and background in formal computer training. 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 empirically tested.

A more recent study by Tondeur, Valcke and van Braak (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, Khambari, & Luan, 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, Lee, & Chai, 2007; Kersaint, Horton,

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Stohl, & Garofalo, 2003; van Braak, 2001) assert that notwithstanding the potential of ICT, effective implementation of technology 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.

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. The cited studies clearly show the importance of several contextual factors, but largely ignore the main dispositional variables of interest in this study.

4. The current study

The aim of the current research is to disentangle the interrelationships between attitude, self-efficacy and perceived norms and to discover which other variables affect their relationship with behaviour. If teachers have explicit knowledge about the advantages ICT offer in educational practice, why does their behaviour point in the other direction? Which variables (contextual or dispositional) inhibit the use of computer related technology in education?

According to IMBP it is conjectured that self-efficacy, attitude and perceived norm will directly impact on the intention to use DLMs. Next, we hypothesize that these dispositional variables will indeed mediate the effect of several other distal factors. This results in three additional hypotheses:

(1) ICT proficiency and entrepreneurship (cfr. commitment to professional learning; Mumtaz, 2000) will be positively related with the intention to use learning materials, mediated by self-efficacy,

(2) (negative) outcome expectations and computer anxiety will be negatively related with intention, mediated by attitude and

(3) received support will be positively related with intention, mediated by perceived norm.

Method

A questionnaire was administered electronically in December 2009 to teachers of primary and secondary schools. The latter encompass pre-vocational secondary education (four years), senior general secondary education (five years), and pre-university education (six years). A total of 1484 teachers completed the questionnaire entirely. Table 1 contains the most important socio-demographic information about the sample.

Apart from the demographical variables, the questionnaire included the measures for the proximal and distal variables of interest. The measures were either adapted from existing measures or newly constructed. Cronbach's alpha was calculated for each scale as a measure of internal consistency.

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Attitude towards the use of DLMs

Attitude was measured using a 12-item bipolar scale. Respondents rated several aspects of DLM usage on a 7-point rating scale with end anchors such as boring versus fun or useful versus useless ($\alpha = .97$).

Self-efficacy

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" ($\alpha = .91$).

Perceived norm

Perceived norm was measured using three items gauging to what extent teacher thought that colleagues in the own section, other sections and other schools were making use of DLMs. Answers ranged from "not at all" to "very frequently" on a seven-point scale ($\alpha = .80$).

Intention to use DLMs

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" ($\alpha = .97$).

Distal variables

A single item measured ICT proficiency. Respondents could answer how well they could use ICT in their pedagogical practices on a scale ranging from beginner to guru. The entrepreneurship scale ($\alpha = .90$) consisted of 10 items measuring the extent to which teachers were taking initiative to school themselves in the domain of ICT and DLMs. Outcome expectations ($\alpha = .86$) and anxiety ($\alpha = .96$) were measured with 7 and 5 items respectively such as "Regularly using digital learning materials will increase my workload" and "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, could take courses, take part in support teams or none of the above ($\alpha = .55$). Scores ranged from 0 to 3.

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.

Analysis

The first hypothesis regarding the importance of the proximal variables, was tested using multiple linear regression analysis. Structural equation modelling (with the AMOS 8.0 software) was used to test hypotheses 2 to 4 and to assess model fit. Model fit was evaluated using (1) the χ^2 statistic, which becomes lower as model fit improves; (2) the comparative fit index (CFI), for which values between .90 and .94 indicate good fit, whereas values of .95 and higher indicate very good fit; (3) the Tucker Lewis index (TLI), for which values of above .95 indicate good model fit and (4) the

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root mean square error of approximation (RMSEA), for which values of .06-.08 indicate a good fit and values of .05 and less indicate a very close fit (Hu & Bentler, 1999).

Results

Correlations between the variables in the different models can be observed in Table 2. The same table also includes the mean score and standard deviations for each variable.

Hypothesis 1: the influence of attitude, self-efficacy and perceived norm
A regression analysis was performed using intention to use DLMs as the dependent variable. Results can be found in Table 3. All predictors have a significant effect on the intention to use DLMs. The standardized regression coefficients show that, when controlling for attitude and perceived norm, self-efficacy is the strongest predictor.

Hypothesis 2: Self-efficacy mediates the influence of entrepreneurship and ICT proficiency
SEM was used to assess the adequacy of a fully mediated model. Model fit was poor and modification indices suggested to add a direct path between entrepreneurship and intention. The resulting model and its estimated parameters can be found in Figure 2. The resulting model showed very good fit ($\chi^2(1, N = 1484) = .20$, $p = .64$, CFI = 1.00, TLI = 1.00 and RMSEA = .00).

Hypothesis 3: Attitude mediates the relationship between outcome expectations and computer anxiety
Here as well, SEM was used to assess the adequacy of a fully mediated model. The model showed very good fit ($\chi^2(2, N = 1484) = 4.59$, $p = .10$, CFI = .99, TLI = .99 and RMSEA = .03). Figure 3 contains the conjectured paths as well as the estimated coefficients.

Hypothesis 4: Perceived norm mediates the effect of perceived support
The SEM analysis indicated that the fully mediated model showed poor fit and therefore the saturated model was adopted. Figure 4 shows the resulting model and the associated path coefficients.

Discussion

Analyses revealed the importance of the three proximal variables under study. Together, these variables explained 65 percent of variance in intention to use DLMs. Self-efficacy was found to be the strongest predictor, closely followed by attitude. Compared to those two variables, perceived norm played only a limited role in predicting teachers' intention to use DLMs. Attitude, which was the second most important predictor of DLM use, seems to impact more on intention than self-efficacy, when basing on the direct paths between (see Figures 2 and 3 respectively). The strong

relationship between attitude and self-efficacy (see Table 2) tempers this effect however. When considering the unique impact of both variables in the multiple regression, self-efficacy remains the important predictor.

Entrepreneurship was strongly related to self-efficacy. Teachers who take training initiatives and who actively seek support from peers or experts experience higher levels of self-efficacy. The conjectured mediation of self-efficacy on the relationship between entrepreneurship and intention was only partially confirmed. There was a moderate direct effect of entrepreneurship as well. The effect of ICT proficiency, which comes down to more general ICT skills, on the other hand was fully mediated by self-efficacy. Moreover this effect was clearly less pronounced than the impact of entrepreneurship.

Negative outcome expectations as well as computer anxiety were negatively related to intention to use DLMs. As expected, these relationships were fully mediated by attitude. Although levels of computer anxiety were reasonably low, computer anxiety still plays an important role in the extent to which teachers use DLMs.

In the final model, the impact of perceived support and perceived norm was tested and a partial mediation effect was found. Although the relationship between perceived norm and intention was fairly weak, a direct effect as well as an indirect effect of perceived support were found. It must be noted that when controlling for both other proximal variables, the explanatory power of perceived norm is even smaller. The influence of perceived norm could be underestimated due to the consistently low scores. Anecdotally, in several interviews concerning the Wikiwijs project, teachers indicated that they experienced little to no pressure to use ICT or DLMs. Most of them explained this by the lack of a clear policy concerning DLM use on school and governmental level. If government and school management would communicate a clear strategy concerning the use of open educational resources in education, the effect of perceived norm could possibly be discerned more prominently.

Conclusion

The Integrative Model of Behaviour Prediction was found to be a useful 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 direct paths) can be justified. Future research should focus on self-efficacy and attitude as determinants of DLM use and policy makers should mainly develop strategies to impact on those variables by providing sufficient training and support for teachers in using DLM's and ICT in general. The importance of entrepreneurship should be further studied in combination with new distal variables. The IMBP can provide directions for this future research.

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Figures and tables

	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

Table 1 - Socio-demographic information about the sample

	M (SD)	attitude	self-efficacy	intention	perceived norm	ICT proficiency	computer anxiety	outcome expectations	perceived support
attitude	5.62 (1.03)								
self-efficacy	5.22 (1.46)	.70							
intention	5.04 (1.57)	.70	.76						
perceived norm	3.94 (1.13)	.23	.26	.32					
ICT proficiency	4.53 (1.04)	.37	.41	.38	.04**				
computer anxiety	1.71 (1.13)	-.48	-.40	-.36	.00**	-.42			
outcome expectations	3.79 (1.62)	-.26	-.18	-.16	.03**	-.24	.37		
perceived support	1.42 (1.06)	.22	.19	.24	.33	.11	-.07	-.04**	
entrepreneur-ship	3.79 (1.32)	.53	.56	.65	.29	.42	-.24	-.10	.33

Table 2 - Correlations between the measured variables; the second column contains the descriptives for each measure

Note: 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 maximum score was 4.

Variable	B	SE B	ß	p
Attitude	.49	.04	.32	< . 001
Self-efficacy	.55	.03	.51	< . 001
Perceived norm	.16	.02	.12	< . 001

Table 3 - Regression results for the three proximal variables predicting intention to use DLMs (N = 1484)
Note. R2 = .65 (F(3, 1480) = 818.52, p < .001).

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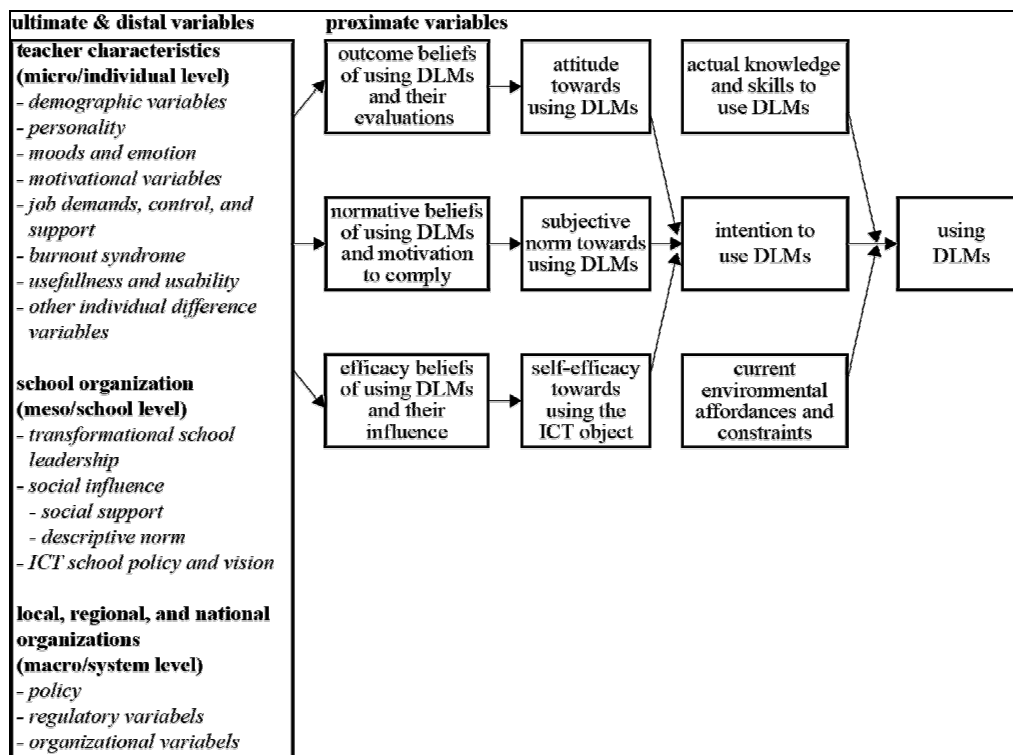Universitat Oberta de Catalunya | Open Universiteit Nederland | Brigham Young University
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Figure 1- IMBP adapted to the domain of the advancement of the integration of ICT in teachers' pedagogical practices
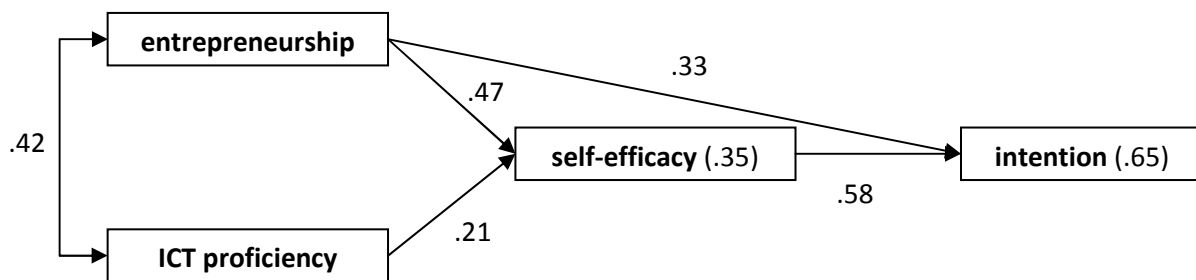

Figure 2 - Path analysis testing the mediating role of self-efficacy in the relationship between entrepreneurship, ICT proficiency and intention (all p's < .001).
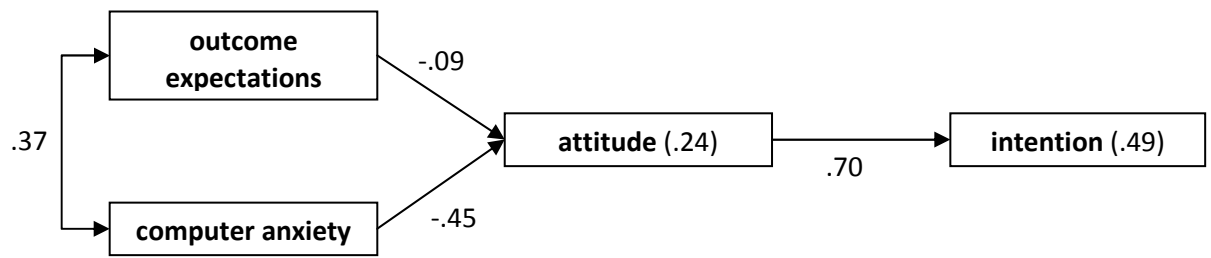**Values between brackets indicate the explained variance (R2).**

Figure 3 - Path analysis testing the mediating role of attitude in the relationship between outcome expectations, computer anxiety and intention (all p's < .001).
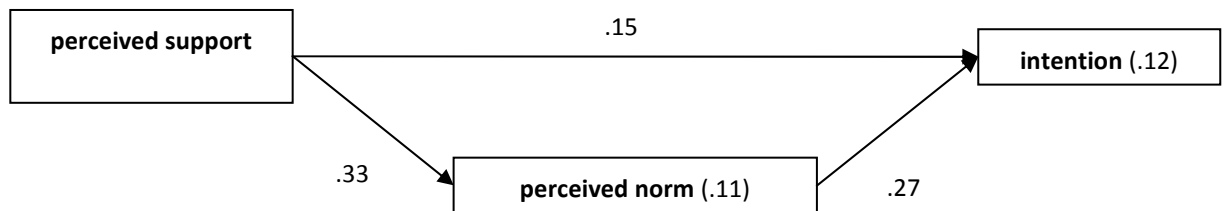**Values between brackets indicate the explained variance (R2).**

Figure 4 - Path analysis testing the mediating role of perceived norm in the relationship between perceived support and intention (all p's < .001). Values between brackets indicate the explained variance (R2).

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