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Determining factors of the use of e-learning environments by university teachers

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Abstract

E-learning environments increasingly serve as important infrastructural features of universities that enable teachers to provide students with different representations of knowledge and to enhance interaction between teachers and students and amongst students themselves. This study was designed to identify factors that can explain teachers' use of e-learning environments in higher education. A questionnaire was completed by 178 teachers from a wide variety of departments at Wageningen University in the Netherlands. We found that 43% of the total variance in teacher use of e-learning environments could be explained by their opinions about web-based activities and their opinions about computer-assisted learning (predictors) and the perceived added value of e-learning environments (mediating variable). In other words, teachers' use of e-learning environments can be explained to a high extent by their perceptions of the added value of these environments, which in turn are substantially influenced by their opinions about web-based activities and computer-assisted learning.

Keywords: Computer-mediated communication; Cooperative/collaborative learning; Distance education and telelearning; Media in education; Multimedia/hypermedia systems

1. Introduction

Whilst traditional teaching methods, such as face-to-face lectures, tutorials, and mentoring, remain dominant in the educational sector, universities are investing heavily in learning technologies, to facilitate improvements with respect to the quality of learning (Cancannon, Flynn, & Campbell, 2005). The implementation of information and communication technology (ICT) as an advanced flexible technology with its unique characteristics is one of the main new investments. However it should be noticed that "despite their potential, telematics applications are not yet regularly used as instructional tools (e.g., in The Netherlands, with one of the

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world's highest concentrations of Internet users and personal and organisational computer use, a national study has indicated that almost all university students use e-mail and the World Wide Web on a personal basis, but in general computer use in educational programmes is limited to occasional information searches)" (Veen, 1999, cited in Collis, Oscar & Pals, 2001). While the use of ICT in distance learning for off-campus students is already accepted, Cancannon et al. (op. cit.) stated that there is also a trend in higher education to utilise the benefits of e-learning to improve the learning performance of campus-based students. As a result of this trend, many universities around the world are expanding their investment in ICT (Cheung & Huang, 2005). Nevertheless, equipment and connectivity do not guarantee successful or productive ICT use (Granger, Morbey, Lotherington, Owston, & Wideman, 2002). We should consider that implementing technology in education is complex, shaped by pedagogical philosophies, curricular requirements, and the proliferation of ICT in society at large (Granger et al., 2002). Literature on instructional technology shows that the use of the Internet in education has the potential to motivate students and teachers, increase student participation and interaction in the classroom, and provide students with a more active role in their learning, increased motivation, and increased autonomy in the educational process (Claudia, Steil, & Todesco, 2004). While teachers are requested to use the capability of the new high technology to facilitate learning processes, students are encouraged to improve their learning through computer and networked-based activities.

In many cases, however, educational institutions do not pay enough attention to the questions of how, what, and why ICT should be implemented. According to Greenhalgh (cited in Masiello, Ramberge and Kirsti, 2005) ICT implementation often takes place without a theory and many institutions do not spend any resources on trying to understand what kind of changes ICT and computers bring into their system; they just follow the new trend, casting doubt on the success and cost effectiveness of such initiatives.

When universities promote ICT use, they need to understand their teachers' and students' attitudes towards its use. Teachers' attitudes are considered as a major predictor of the use of new technologies in instructional settings (Albirini, 2006). An analysis of cross-cultural studies carried out in the 1990s revealed that sometimes changes in attitudes are more important than changes in skills for teachers' advance in technology integration (Albirini, 2006). Therefore, we agree with Cheung and Huang (2005) that only when parties involved in the process of learning are making use of ICT to really benefit students' learning, is IT investment justified in terms of a university's scarce resources.

Use of ICT in education has been studied by many researchers in terms of factors that influence the likelihood of implementation success for innovative technologies in an educational setting (e.g., Brett & Nagra, 2005; Cheung & Huang, 2005; Collis, Oscar, & Pals, 2001; Dewiyanti, Brand-Gruwel, Jochems, & Broers, 2007; Goodyear, Jones, Asensio, Hodgson, & Steeples, 2005; Granger et al., 2002; Ma, Anderssonw, & Streithw, 2005; Masiello, Ramberg, & Lonka, 2005; Selim, 2003). Some of them (Collis et al., 2001; Selim, 2003) have introduced a model for the use of ICT in education. They used the Technology Acceptance Model (TAM), which was proposed by Davis (1993) and is shown in Fig. 1, as a basis for their research. TAM describes that a person's behavioural intention concerning the use of an application is determined by perceived usefulness (the belief that using an application will increase one's performance) and perceived ease of use (the belief that one's use of an application will be free of effort) (Selim, 2003). Since the introduction by Davis, TAM has been widely used for predicting the use of information technologies (Selim, 2003).

Selim (2003) studied the effect of usefulness and ease of use of a course website on students' course website use (see Fig. 2). Course Website Usefulness is defined as the student's belief that using the course website will increase his or her learning performance, efficiency, and effectiveness. Course Website Ease of Use refers to the

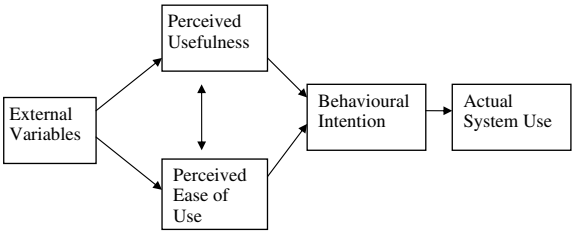

Fig. 1. Technology acceptance model (TAM) (Davis, 1993).

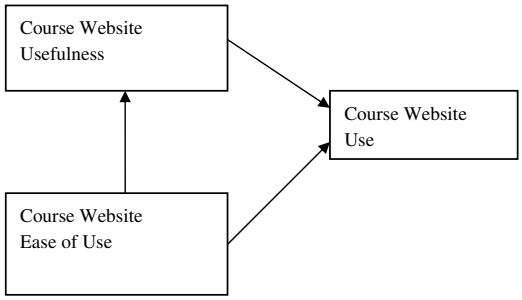

Fig. 2. Course website acceptance model (CWAM) (Selim, 2003).

degree to which the student expects the use of the course website to be free of effort. Course Website Use is the intention to use the course website, which is used as an indicator of the acceptance of course websites.

Atkinson and Kydd (1997) examined the influence of playfulness, ability to use the computer, ease of use, and usefulness on the use of the World Wide Web. They found that all the considered constructs affected World Wide Web use. Collis et al., (op cit) described an attempt to develop and validate a model focussing on the use of ICT (in particular email, the WWW and videoconferencing) in teaching and learning activities. They believed that an individual's acceptance of technological innovations in his or her learning-related activities is based upon four rather simple concepts: environment, effectiveness, ease of use, and engagement. These four "E's" were the basis of a conceptual model for prediction of the acceptance of ICT innovations by an individual in an educational context. Perceived usefulness and ease of use were also studied by Cheung and Huang (2005).

Several studies concentrated on barriers to using technology in education (Muir-Herzig, 2004). Findings have shown that barriers include lack of teacher time, limited access and high cost of equipment, lack of vision or rationale for technology use, lack of teacher training and support, and current assessment practices that may not reflect what is learned with technology. The time needed by a teacher to learn how to use the new technology includes the time the teacher needs to become competent with the computer as a personal tool but also as an instructional tool (Brand, 1998, cited in Muir-Herzig, 2004).

Other researchers have highlighted other factors which they think might be influential in teachers' and students' attitudes toward the use of ICT in education. Educational researchers such as Biggs and Ramsden have identified different approaches to learning that can be used to characterise the ways in which students engage in learning tasks and their learning environment (Brett & Nagra, 2005). Instructional and learning strategies in connection with computer technology use should be examined (Lowerison, Sclater, Schmid, & Abrami, 2006). These authors believe that before assessing the impact of technology on education, one should focus on how teachers teach and how students learn. Race (2003) identified constructivist learning approach and instructional strategy as being important. Lowerison et al. (2006) also considered learning strategy and instructional technique as two effective factors of students' perceived effectiveness of computer technology use. Paris (2004) studied the effect of prior ICT experience on secondary students' attitudes toward online web-based learning.

Based on the literature mentioned above, we assumed that teachers' use of e-learning environments might be related to teachers' perceptions of the added value of e-learning. These perceptions are in turn assumed to be influenced by the teachers' learning and teaching approach, their general interest in and opinion about computer-assisted learning, their tendency toward web-based education, the time needed to launch, update and maintain a course website, ease of use, and teaching experience. Reviewing well-known scientific journals in the field has shown that the literature lacks investigations of real teacher use of e-learning environments.

Previous research concentrated on teachers' intentions to use e-learning environments or their use of several specific functions of e-learning environments like e-mail or PowerPoint presentations (e.g., Collis et al., 2001; Ong & Lai, 2006). In this study, however, we focussed on teachers' use of a wide variety of e-learning environment functions and their opinions about the added value for learning processes. We assessed teachers' use of 25 different e-learning capabilities and features that were available for them (see paragraph Section 2.2 for details). In this respect, we believe that our study provides a more informative and precise picture regarding teachers' use of e-learning environments than previous studies in this field.

Therefore, in the present study we examined the real use of different functions of e-learning environments as indicators of teachers' use of e-learning environments. In the study the following research questions were formulated:

1. Which functions of e-learning environments do teachers often use?
2. What added value do teachers perceive of e-learning environments?
3. Which factors influence teachers' use of different functions and capabilities of e-learning environments?
4. What are the barriers for implementing e-learning environments in the learning process?

The research presented in this article concerns the use of e-learning at Wageningen University in The Netherlands. Wageningen University and Research Centre (Wageningen UR) is a leading international knowledge institute in the fields of nutrition and health, sustainable agricultural systems, environmental quality and processes of social change. Wageningen UR with its more than 6.000 staff and more than 9.000 students provides education in 18 BSc programmes and 30 MSc programmes. Wageningen University's students come from 98 different countries which results in a very diverse and rich environment for discussion and collaboration. The university does research and generates knowledge in the field of life sciences and natural resources. The university specialises in food and food production, plants and animals, environment and climate, economics and society. In May 2005, based on essential science indicators, the university was in the list of top universities and research centres in the world in terms of publications and citations in the domain of agronomic sciences, plant and animal sciences, and environmental sciences. Developing the use of new technology and ICT in the university was one of the main priorities of the university in the last decade.

2. Methodology

2.1. Participants

A sample of teachers in MSc programmes at Wageningen University participated in this study. First, we identified the MSc courses in the university study guide of about 80 educational units and groups of Wageningen University. Internships, theses, and capita selecta courses were excluded. In sum, 517 MSc courses were identified. A questionnaire was sent to the contact person or the main teacher of each course. Teachers who were involved in more than one course were asked to fill out the questionnaire for the main course for which they were responsible. The questionnaire was piloted to measure the reliability and to determine whether it was understandable for the target group. Moreover, the validity was improved by consulting and discussing with seven experts in the field and 10 university teachers. The final version of the questionnaire was sent to all identified university teachers. It was distributed to 404 teachers of many different chair groups and departments of the university. Useable responses were received from 178 teachers, indicating a 44% response rate. From the teachers who did not send back the questionnaire, 87 teachers replied that they did not have enough time to fill out the questionnaire and 37 persons mentioned that they did not use e-learning environments in their work. A few teachers refused to participate in the study and stated that they used computers solely for calculation and as a tool which was necessary to do the course. Finally, 26 teachers reported that they were not working for the university anymore. In sum, we think that lack of time needed to fill out the questionnaire and lack of familiarity with e-learning environments were the main reasons for the non-response.

2.2. Instrument

In order to develop a valid and reliable questionnaire, the following steps were undertaken. First, for each variable several items and indicators were formulated based on literature study of previous research in this domain (Chou & Liu, 2005; Goodyear et al., 2005; Madden, Ford, Miller, & Levy, 2005; Paris, 2004; Race, 2003; Williams & Pury, 2002; Wu & Hiltz, 2004; Young & Norgard, 2006), consultations with experts in the field, and in-depth interviews with teachers at Wageningen University and colleagues in the chair group of Education and Competence Studies (ECS). Then, we asked a sample of experts in the field to judge the relevancy of those items for the related constructs and their validity. Furthermore, we piloted the first version of

the instrument and asked teachers to report on the clarity of the items and the time needed to complete the questionnaire. Second, exploratory factor analysis was conducted to identify factors and latent variables. In the third and final step, a series of confirmatory factor analyses, using LISREL 8.72, was carried out to see whether each set of items could accurately capture the relevant construct.

The first part of the final questionnaire concentrated on general information about the teachers, their workload and their teaching experience. The second part consisted of items for all factors in this study. The last part consisted of 25 questions about teachers' use and perceived added value of 25 different features and capabilities of e-learning environments. With most questions, teachers were asked to indicate the level of their agreement or disagreement with the statements in the questionnaire on a five point scale (1: strongly disagree; 5: strongly agree). Moreover, they were asked to specify to what extent they used different features of e-learning environments in performing their teaching tasks and to what extent they believed in the added value of each feature.

2.3. Data analysis

Because of the exploratory nature of this research, exploratory factor analysis using principal components factor extraction and VARIMAX rotation was conducted to identify the factors in our research model. The following four commonly used decision rules were applied to identify the factors (Hair, Anderson, Tatham, & Black, 1995): (1) minimum Eigenvalue of 1; (2) minimum factor loading of 0.4 for each indicator item; (3) simplicity of factor structure; and (4) exclusion of single item factors. Items that did not fulfil these rules were trimmed. Subsequently, the reliability of each factor was evaluated by determining the internal consistency of the indicator items of each construct by using Cronbach's alpha. Moreover, using LISREL 8.72, a series of confirmatory factor analyses was performed to further examine the items for each factor and construct. A joint domain factor analysis was performed, including all the items used to develop the research constructs. The result provided significant support for factorial and discriminant validity of the measurement scales. Furthermore, the data were analyzed using the bivariate correlation test. The bivariate correlation test computes Pearson's correlation coefficient, and measures how all measured constructs and extracted factors are related. Finally, structural equation modelling was carried out to see how identified factors can explain teachers' use of e-learning environments. Kelloway has suggested that the use of the chi-square test is reasonable when the study involves a large sample (Wen, Tsai, Lin, & Chuang, 2004). Therefore, we decided not to use chi-square in this study because of the number of participating teachers ($N = 178$). However, according to Joreskog and Sorbom (cited in Wen et al., 2004), as the chi-square is very sensitive to sample size, the degree of freedom can be used as an adjusting standard by which to judge whether chi-square is large or small. Therefore, the chi-square per degree of freedom and other types of goodness-of-fit measures including Root Mean Square Error of Approximation (RMSEA), Normed Fit Index (NFI), Non-Normed Fit Index (NNFI), Comparative Fit Index (CFI), Root Mean Square Residual (RMR), Goodness of Fit Index (GFI), and Adjusted Goodness of Fit Index (AGFI) were used to evaluate the properness of the solution and goodness-of-fit of the model.

3. Results

The results of this study are explained in several sections. First, teachers' use of different capabilities and functions of e-learning environments and teachers' perceptions of their added value are explained. Next, teachers' general opinions about e-learning environments and factors which might prevent them from utilizing these learning environments are discussed. Then, the factor structure of all constructs and their relationships with Teachers' Perceived Added Value of E-learning Environments (AV) and Teachers' Use of E-learning Environments (USE) is described. Finally, the results of structural equation modelling are explained.

3.1. Teachers' use of e-learning environments (USE)

As mentioned before, 25 different functions and capabilities of e-learning environments in universities had been identified. Teachers were asked to specify to what extent they used these functions and capabilities as part

of their teaching tasks on a five-point scale (1: Not at all; 5: Usually). Their answers to these questions in combination (factor score) led to the dependent variable of this study, USE.

Table 1 presents the descriptive statistics of the use of several selected functions and capabilities of e-learning environments. "Presenting course material and literature" ($M = 4.31$), "PowerPoint presentation" ($M = 4.11$) and "E-mail and mailing list" ($M = 4.07$) were used most frequently, while "Voice conferencing" ($M = 1.13$) and "Shared whiteboard" ($M = 1.16$) were used least frequently. "Online discussion" ($M = 1.36$) and "Online collaboration" ($M = 1.46$) were used not very frequently as well.

3.2. Teachers' perceived added value of e-learning environments (AV)

The same procedure was followed to determine AV. Teachers were asked to indicate on a five-point scale (1: Not at all; 5: Very High) to what extent each function and capability of e-learning environments had added value for students' learning. Again, the factor score of this construct was determined. As shown in Table 2, "Presenting course materials and literature" ($M = 3.97$) was believed to have the most added-value, followed by "Course information" ($M = 3.77$) and "PowerPoint presentation" ($M = 3.74$). According to the teachers, "Voice conferencing" ($M = 1.19$), "Shared whiteboard" ($M = 1.28$) and "Videoconferencing and net-meet-

Table 1
Descriptive statistics (percentages, *M*, SD) of teachers' use of selected features and capabilities of e-learning environments (USE)

	Feature	1	2	3	4	5	*M*	SD
1	Presenting course material and literature	5.1	1.1	11.9	20.5	60.8	4.31	0.08
2	Powerpoint presentation	8.0	5.1	9.1	22.2	53.4	4.11	0.10
3	E-mail and mailing list	5.1	2.8	19.9	23.9	47.7	4.07	0.09
4	Course information	5.1	4.0	18.2	33.0	39.2	3.98	0.08
5	Course calendar and schedule	13.6	6.3	14.2	30.1	35.2	3.67	0.10
6	Course announcement and news	10.8	8.0	30.7	21.0	28.4	3.49	0.10
7	Online collaboration	73.3	9.7	14.2	1.1	1.1	1.46	0.07
8	Online discussion	75.0	13.6	10.2	0.6	0	1.36	0.05
9	Application sharing	79.5	5.1	5.7	2.8	1.1	1.31	0.06
10	Online test	85.8	4.5	4.5	1.1	2.8	1.29	0.06
11	Videoconferencing and net-meeting	80.7	9.7	7.4	1.1	0	1.28	0.05
12	Shared whiteboard	85.8	2.8	2.8	0.6	1.1	1.16	0.05
13	Voice conferencing	89.2	7.4	2.8	0	0	1.13	0.03

1 = Not at all; 2 = Rarely; 3 = Sometimes; 4 = Often; 5 = Usually.

Table 2
Descriptive statistics (percentages, *M*, SD) of teachers' perceived added value (AV) of selected features and capabilities of e-learning environments

	Feature	1	2	3	4	5	*M*	SD
1	Presenting course materials and literature	7.4	4.5	16.5	26.7	44.9	3.97	1.21
2	Course information	6.8	5.7	19.3	39.8	28.4	3.77	1.13
3	Powerpoint presentation	10.2	5.7	17.6	33.0	33.5	3.74	1.27
4	E-mail and mailing list	13.6	11.4	17.0	24.4	33.5	3.53	1.41
5	Course calendar and schedule	13.1	7.4	17.0	38.6	23.9	3.53	1.29
6	Announcements (news)	11.9	10.2	19.9	30.7	27.3	3.51	1.31
7	Online simulation programs and software	46.6	12.5	16.5	13.1	11.4	2.30	1.45
8	Online collaboration	53.4	31.3	5.7	9.7	0	1.72	0.95
9	Computer-based test	60.8	18.8	10.2	8.5	1.7	1.72	1.06
10	Online discussion	56.3	26.7	9.1	7.4	.6	1.69	0.95
11	Online test	65.3	19.3	6.3	8.0	1.1	1.60	0.99
12	Videoconferencing and net-meeting	81.3	9.7	6.3	2.8	0	1.31	0.71
13	Shared whiteboard	85.2	6.8	4.0	2.3	1.7	1.28	0.79
14	Voice conferencing	85.8	9.1	9.0	0	0	1.19	0.51

1 = Not at all, 2 = A little, 3 = Moderately, 4 = High, 5 = Very high.

ing" ($M = 1.31$) had the least added value. The reported added value of "Online discussion" ($M = 1.69$) and "Online collaboration" ($M = 1.72$) was low as well.

3.3. Teachers' general opinions about e-learning environments and impeding factors

We also asked participants to give their opinions about e-learning in general and about impeding factors that might prevent them from using ICT in their teaching. As can be seen in Table 3, 43.1% of the teachers believed that the quality of students' learning in their course was improved by using computers ($M = 3.10$) and 28.5% of them had the same opinion about the internet ($M = 2.64$). In sum, 73.3% of the teachers reported that they were not able to find useful and relevant computer software to support their teaching tasks ($M = 3.74$) and 65.9% reported a lack of useful and relevant websites in this respect ($M = 3.60$). Although 59.1% of the teachers disagreed with the statement that e-learning environments had no added value for their course ($M = 2.26$), 52.9% of them preferred face-to-face teaching ($M = 3.28$). Some teachers mentioned technical infrastructure ($M = 1.88$), difficulty of working with e-learning environments ($M = 1.78$) and (lack of) time ($M = 2.79$) as impeding factors.

3.4. Factor structure of constructs

As mentioned before, a three-step procedure was followed to identify factors which might contribute to teachers' use of e-learning environments. First, based on literature study, a pilot study and in-depth interviews with teachers and experts, statements and items were formulated to gain information about the teachers' teaching and learning approach and their attitude toward and opinion about e-learning environments. They were asked to indicate to what extent they agreed or disagreed with the statements and items of the questionnaire on a five-point scale (1: strongly disagree; 5: strongly agree). After that, an exploratory factor analysis and a confirmatory factor analysis were carried out (see Section 2).

Running exploratory factor analysis, we were able to extract five factors in all 38 items of the instrument, accounting for 61.54% of the total variance. Cronbach's alpha reliability index indicated that all identified factors were reliable. Table 4 shows all factors with their eigenvalue, explained variance, and Cronbach's alpha.

Except for the fifth factor "time", the factor structure derived from the exploratory factor analysis was confirmed with some minor changes by the confirmatory factor analysis (see Table 5).

3.5. Bivariate correlations

To examine to what extent all measured constructs in this study were related to USE and AV, we used bivariate correlation tests. As can be seen in Table 6, teachers' teaching and learning approach aimed at knowledge construction (KC) is positively correlated with USE and AV. The same holds for their opinion about computer-assisted learning (CAL): the more teachers were positive about computer-assisted learning, the more they used e-learning environments and perceived the added value of these environments. Although

Table 3
Descriptive statistics (percentages, *M*, SD) of teachers' opinions about selected statements

	Abbreviated items	1	2	3	4	5	*M*	SD
1	Quality of students' learning in my course is improved by using computers	14.8	18.8	23.3	27.8	15.3	3.10	1.29
2	Quality of students' learning in my course is improved by using internet	21.0	30.1	20.5	20.5	8.0	2.64	1.24
3	Lack of useful and relevant computer software to support my teaching tasks	8.5	9.1	9.1	46.6	26.7	3.74	1.20
4	Lack of useful and relevant websites to support my teaching tasks	9.7	12.5	11.9	40.3	25.6	3.60	1.26
5	I think e-learning environments have no added value for my course	45.5	13.6	18.2	15.3	7.4	2.26	1.36
6	Time	22.7	22.2	19.9	23.9	11.4	2.79	1.34
7	Difficulty of working with e-learning environments	58.0	19.3	11.9	8.0	2.8	1.78	1.11
8	I prefer face-to-face teaching	19.9	8.5	18.8	29.0	23.9	3.28	1.43
9	Technical infrastructure	55.1	18.8	15.9	4.0	6.3	1.88	1.19

1 = Strongly disagree, 2 = Disagree, 3 = Neither agree nor disagree, 4 = Agree, 5 = Strongly agree.

Table 4
Identified factors in exploratory factor analysis with number of items, Cronbach alpha, eigenvalue, and percentage of explained variance

Factor	Label	Number of items	Cronbach alpha	Eigenvalue	Explained variance (%)
1	Knowledge construction teaching and learning approach (KC)	4	0.73	3.76	19.78
2	Teachers' opinion about computer-assisted learning (CAL)	4	0.72	2.23	11.74
3	Teachers' opinion about web-based activities (WA)	4	0.70	2.48	13.03
4	Ease of use (difficulty)	4	0.70	1.71	9.01
5	Time	3	0.86	1.52	7.98

Table 5
Structure of the factors identified in confirmatory factor analysis

	Item	Factor loading	*T*-value
Factor 1: Knowledge construction teaching and learning approach (KC)			
1	Learning should involve social negotiation and mediation	0.51	5.41
2	Students should construct their own knowledge through their activities in the course	0.62	6.58
3	Teachers primarily are guides and facilitators of learning, not instructors	0.73	8.53
Factor 2: Teachers' opinion about computer-assisted learning (CAL)			
4	Quality of students' learning in my course is improved by using computers	0.74	11.21
5	I really enjoy using computers to support my teaching practice	0.79	15.12
6	Using computers for learning costs students important learning time	−0.52	−5.88
7	I prefer not to use computers to support my teaching practice	−0.72	−12.76
Factor 3: Teachers' opinion about web-based activities (WA)			
8	Students learn more doing web-based activities than activities on paper	0.51	4.41
9	Finding the way on a website is easier than finding the way in a book	0.53	6.03
10	I prefer web-based activities to activities on paper	0.76	7.46
Factor 4: Ease of use (difficulty)			
11	Designing, updating, managing, and maintaining a website is difficult	0.72	10.07
12	Using e-learning environments is difficult for students	0.64	8.73
13	Using e-learning environments is complicated for teachers	0.75	11.61
14	E-learning environments are not clear and understandable	0.43	6.08

no significant correlation was found between teachers' opinion about web-based activities (WA) and their actual use of e-learning environments, results indicated a fairly high correlation between WA and AV. Ease of use (perceived difficulty) appeared to be negatively correlated with both USE and AV. Teachers' previous experience with e-learning environments (E-Experience) had a rather high positive relationship with the actual us e and the perception of the added value of e-learning environments. No significant relations were found for Time and Teaching Experience (T-Experience).

3.6. Structural model

As mentioned in the previous section, the results of the bivariate correlation tests revealed that, except for Time and Teaching Experience, all other variables somehow were related to AV and USE. However, to gain an in-depth insight, we were more interested in exploring a model that could explain the effect of all mentioned factors on AV and USE. Therefore, based on the conceptual framework of the study (see Fig. 1) and the extracted factors, a model was developed (see Fig. 3). This section describes the results of structural equation modelling (SEM).

In conducting structural equation modelling, the four extracted factors in the confirmatory factor analysis (see Table 5) were used as predictor variables, AV as the intermediate and USE as the outcome variable to

Table 6
Correlations between all identified factors and TU-EE and TP-AVEE

	Teachers' use of e-learning environments (TU-EE)	Teachers' perceived added value of e-learning environments (TP-AVEE)
Knowledge construction teaching and learning approach (KC-TLA)	0.141(*)	0.237(**)
Teachers' opinion about computer-assisted learning (TO-CAL)	0.416(**)	0.430(**)
Teachers' opinion about web-based activities (TO-WA)	0.074	0.406(**)
Ease of use (difficulty)	−0.236(**)	−0.147(*)
Time	−0.101	−0.069
Teachers' use of e-learning environments (TU-EE)	1.000(**)	0.593(**)
Teachers' perceived added value of e-learning environments (TP-AVEE)	0.593(**)	1.000(**)
Previous experience with e-learning environments	0.499(**)	0.310(**)
Teaching experience	0.009	0.074

* $p < 0.05$.
** $p < 0.01$.

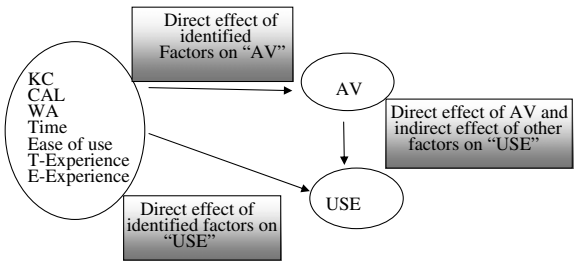

Fig. 3. Final conceptual model of factors which might contribute to teachers' perceived added value of e-learning environments (AV) and teachers' use of e-learning environments (USE).

examine the proposed structural relationships between variables. The final proper solution and structural model of this study is presented in Fig. 4.

To evaluate the final model, the modification indices suggested by LISREL were taken into consideration. The ratio (K^2/DF) is 3.33, which is acceptable. The RMSEA and RMR values are 0.062 and 0.084, indicating a good fit. Furthermore, NFI (0.90), NNFI (0.94), GFI (0.89), AGFI (0.82), and CFI (0.96) are all within acceptable levels. The estimated parameters and the corresponding *t*-values of the final research model are shown in Table 7 and Fig. 4. As illustrated in Table 7, the results indicate that the explained variance of

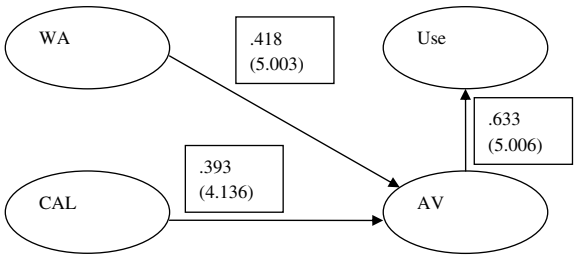

Fig. 4. Teachers' use of e-learning environments model (USE model).

Table 7
Path coefficients and percentages of variance explained by the final model

Path	Path coefficient	*T*-value	R^2	Result
WA → AV	0.418	5.003	0.416	Accepted
CAL → AV	0.393	4.136		Accepted
AV → USE	0.633	5.006	0.427	Accepted
WA → USE	0.264	3.742	0.178	Accepted
CAL → USE	0.249	2.594		Accepted

USE is 0.427. Teachers' Opinion about Web-based Activities (WA) and Teachers' Opinion about Computer-Assisted Learning (CAL) explained 0.178 of it. Also WA and CAL explain 0.416 of variance in AV. As illustrated in Fig. 4 and Table 7, the direct paths from WA and CAL to AV and from AV to USE are significant. Furthermore, the indirect effects of WA and CAL on USE are significant.

4. Discussion

The purpose of this study was to investigate teachers' use of e-learning environments as teaching and learning tools in higher education and to explore factors which explain teachers' use of those e-learning environments. In the previous paragraph, we introduced the Teachers' Use of E-learning Environments Model (USE Model) which consists of Teachers' Opinions about Web-based Activities (WA) and Teachers' Opinions about Computer-Assisted Learning (CAL) as predictors, and Teachers' Perceived Added Value of E-learning Environments (AV) as the mediating variable. Using structural equation modelling techniques, the USE Model was validated and the results indicated a good fit to the data. The relationships between the constructs from the USE Model were supported, accounting for 43% of the total variance in teacher use of e-learning environments. In the following paragraphs, the findings of our study are discussed in relation to the research questions formulated in the introduction paragraph.

4.1. Which functions of e-learning environments do teachers often use?

In line with Lowerison et al. (2006) findings, the results of our research have shown that ICT was used more frequently for communication (e.g., e-mail), presentation (e.g., PowerPoint) and information (e.g., putting the reader and related literature on the website of the course) purposes. To be more specific, we found that general course information functions (like course calendar and schedule and course announcement and news), content management functions (like presenting course material and literature and PowerPoint presentations) and communicating functions (like mail and mailing list) are used most frequently. Other communication functions (like video conferencing, chatting, and voice conferencing) and collaboration functions (like online discussion, online collaboration, shared whiteboard, and application sharing) are the least used features of e-learning environments. Although some very advanced functions of e-learning (e.g., interactive course modules, interactive online simulation programs) are reported, we can claim, based on the results mentioned above, that e-learning is still at an early stage of its use in the university. It can be concluded that e-leaning is not well-integrated in the higher level learning processes and that teachers just use the superficial capabilities of the e-learning tools.

4.2. What added value do teachers perceive of e-learning environments?

Comparable to the pattern of the actual use of e-learning environments mentioned above, our results indicate that teachers believe that presentation of course materials and literature, presentation of information about the courses, PowerPoint presentations, and E-mail have the most added value for teaching and learning processes. Voice conferencing, shared whiteboard, and videoconferencing and net-meeting are believed to have the least added value for teaching and learning processes. The assumed added value of online discussion and online collaboration is low as well.

4.3. What are the barriers for implementing e-learning environments in the learning process?

Our results reveal that teachers believe that they do not face serious technical problems and they are able to work with ICT tools and e-learning environments. Probably, at this university, more attention has been paid to the technological aspects of e-learning than to the pedagogical aspects. Teachers are satisfied with the facilities and connectivity but they feel that they do not have access to relevant software, websites and content. Most teachers believe that computers and the internet have added value to teaching and learning processes but they themselves need to learn (and want support) how they can use the different functions of e-learning in their own courses.

4.4. Which factors influence teachers' use of different functions and capabilities of e-learning environments?

As discussed in detail in the results section, while conducting exploratory and confirmatory factor analysis, we were able to extract different factors like Knowledge Construction Teaching and Learning Approach (KC), Teachers' Opinion about Computer-Assisted Learning (CAL), Teachers' Opinion about Web-based Activities (WA), Ease of Use (perceived difficulty), and Time which might contribute to the explanation of teachers' actual use of e-learning environments (USE). Consistent with previous studies (Collis et al., 2001; Selim, 2003), we found that perceived usefulness and added value of e-learning environments play a critical role in this respect. We can conclude that teachers' perceptions of e-learning environments directly influence the actual use of e-learning environments and account for a substantial part of the variance in actual use. Moreover, our results have shown that teachers' previous e-learning environment experience is also correlated with their use of e-learning environments. In contrast with our expectations, we cannot conclude that the time needed for working with e-learning environments has an effect on, nor even has any relation to, both teachers' perceptions of the added value and their actual use of e-learning environments. Furthermore, our study indicates that teachers' attitudes and opinions about computer-assisted learning and web-based activities are effective in shaping their attitude toward e-learning environments. In other words, teachers' attitudes toward e-learning environments are intertwined with their general feelings about computers and the web. Although the teacher's learning and teaching approach is not included in the final model, bivariate correlation does disclose its positive relations with both the actual use and the perceived added value of e-learning environments. In addition, in contrast to our expectation and Madden et al.'s findings (2005), we cannot conclude that less experienced teachers use more or less e-learning environments than teachers with more general teaching experience.

5. Conclusion

In sum, we were able to identify five different factors shaping teachers' opinions about e-learning environments. We labelled them as Knowledge Construction Teaching and Learning Approach (KC), Teachers' Opinion about Computer-Assisted Learning (CAL), Teachers' Opinion about Web-based activities (WA), Ease of Use (perceived difficulty), and Time. Studying all those factors together with teachers' general teaching experience and their previous experience with e-learning environments, we found that teachers' previous experience with e-learning environments, WA, CAL, and ease of use can help us to explain teachers' perception of the added value and usefulness of e-learning environments and their actual use of these environments.

Results of our study have shown that, in line with Davis' Technology Acceptance Model (TAM) (Fig. 1) and similar to Selim's Course Website Acceptance Model (CWAM) (Fig. 2), ease of use and usefulness (we prefer to label this as perceived added value) can be used to predict teachers' actual use of e-learning environments. However, those parts of our results indicate that teachers' previous experience with e-learning environments and their opinion about web-based activities can also help us to explain the use of e-learning environments.

Results of our LISREL analysis (Fig. 4) enable us to say that teachers' perceived added value of e-learning environments is part of their general attitude and opinion about computers and the web. In other words, the actual use of these environments is to a high extent – almost two thirds of the variance – influenced by their opinion about computers and the web. At first glance, these results seem obvious because e-learning, as one of

the main ICT applications, is affected by the general feelings of teachers regarding ICT. Though the question remains that while computers and the web as technological aspects of e-learning environments have a direct impact on the perceived added value of e-learning environments, how can we explain the impact of instructional and pedagogical aspects of those learning environments? Why do technological aspects still play the main role? Do we need more activities to integrate the e-learning environments in education? Do we need to develop new approaches which see e-learning as a new learning paradigm and not just as a tool which facilitates the traditional way of learning? Does this mean that we can claim that teachers' attitudes toward computers, and the web – technological aspects – are more important than their learning approach and other instructional and pedagogical aspects? Apparently, further studies are needed to shed light on the unexplained part of the variance of teachers' use of e-learning environments.

At this moment, two limitations of this study need to be acknowledged. One limitation is that we focused on courses at MSc level and, thus, we cannot generalize our findings for the whole university. Also, some courses were taught by more than one teacher and we sent the instrument to just one of them. This might have affected the results to some extent.

Nevertheless, in our opinion, the results of this study have several important implications for educational practice. First, we should notice that although well-arranged technical support and reliable infrastructure are important, they are not enough. In the current study, the Teachers' Use of E-learning Environments Model (USE Model) was identified. Based on this model, teachers' perceptions of the added value of e-learning environments account for around half of the variance in the actual use of these environments. This indicates that any program for enhancing the actual use of e-learning environments should focus on teachers' attitudes. Second, a teacher's first-hand experience has a positive effect on his or her use of e-learning environments. Therefore, teachers should be encouraged to try e-learning in their own courses. For example, they could be assisted in preparing useful content for their courses. In this way, the use of e-learning environments in higher education could be fostered.

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