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Investigation of E-Learning System Acceptance using UTAUT*

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This paper demonstrates the results of our research activities in which we validated state-of-the-art theory of technology acceptance (Unified Theory of Acceptance and Use of Technology—UTAUT) in the context of a specific e-learning system—Moodle. This research was performed because there is little research reported in the area of e-learning acceptance and there are only a few validations of UTAUT in the context of e-learning. Research objectives were achieved with an online survey in which we included Likert-based statements related to UTAUT concepts and concepts specific to e-learning systems. The survey was performed on a random sample of undergraduate students, who were asked about their level of agreement or disagreement related to their acceptance of Moodle. The answers from 235 students were primarily analyzed using structural equation modeling (SEM) which demonstrated the validity of concepts and the level of causal relationships between concepts. We found that performance expectancy, social influence and facilitating conditions have a direct effect on students' attitudes towards using Moodle, where performance expectancy was the strongest determinant of student attitudes. Students' intention for using Moodle is caused by social influence and facilitating conditions. Behavioural intentions were shown to be a strong indicator for the actual use of Moodle. The implications and limitations of the present study are also discussed.

Keywords: e-learning; acceptance; UTAUT; SEM; on-line learning

1. INTRODUCTION

E-LEARNING IS a way of learning that is supported by information communication technologies (ICT) and services, and that makes it possible to deliver education and training to anyone, anytime and anywhere. In other words, e-learning is a term for all types of technology-enhanced learning services and processes, including computer based learning, web-based learning, the virtual classroom, and digital collaboration [1]. With the advent of e-learning technologies in the past decade, the accessibility of training, teaching, and learning has dramatically increased, and e-learning has become an important learning method [2]. In the e-learning approach, individuals access information resources on the web to learn and solve daily tasks by themselves. In the case of web-based learning, the material is delivered through a web browser over the public internet, a private intranet, or the extranet [3]. Lately, the term 'e-learning 2.0' is being used to refer to new ways of thinking about e-learning that is built around collaboration and focuses on social learning and the use of social software such as blogs, wikis, podcasts and virtual worlds such as Second Life [4].

E-learning is not only being used by educational organizations, but is also very important in a variety of other contexts. It is of substantial importance for the business sector, where companies use e-learning technologies and services for providing cost-effective online training courses for employees. According to the Ambient Insight report called 'The Worldwide Market for Self-paced eLearning Products and Services: 2009–2014 Forecast and Analysis', the global market for e-learning products and services has been growing at a five-year compound annual growth rate (CAGR) of 12.8% and revenues will reach $49.6 billion by 2014 [5]. The e-learning market, at least in Europe, is still in an immature and growing phase, and it remains unclear what will survive as a critical segment of the sector. However, one of the segments that appear to be stable and likely to continue in growth, at least in the short to medium term, are e-learning environments that provide access to synchronous and asynchronous learning resources and activities [6].

In higher education especially, the increasing tendency is to implement a virtual learning environment (VLE), sometimes called a learning management system (LMS), or web-based courseware management system (CMS). VLE is a system that provides the necessary services for handling all aspects of a course through a single, intuitive and consistent web interface. In other words, it is a platform that facilitates e-learning [7]. Course content management, communication, the uploading of content, the return of students' work, peer assessment, student administration, the administration of student groups, the collection and organization of students' grades, questionnaires,

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quizzes, and tracking tools are all examples of tools that are usually provided by a VLE. With the advent of new Web 2.0 technologies and services, VLEs are being extended with new interactive features. For the rest of the paper, the term 'e-learning system' will be used to stand for VLE.

When users are presented with a new technology or service, a number of factors influence their decision on how and when they will use it. A new instruction-learning environment forces the need to adapt; new e-learning technologies and services must have a positive impact on learners' capabilities, where learners are expected to deploy different learning styles according to their adaptation processes [8]. Students' perceptions of e-learning during education can be influenced by several individual factors like gender, age, previous experience with computers, level of technology acceptance, and their individual learning style [9]. Therefore, e-learning system stakeholders must carefully consider the needs and values of system users and ensure that the system effectively meets these demands [10]. Although e-learning environments are popular, there is minimal research on instructors' and learners' attitudes towards e-learning environments [11]. Liao and Lu [12] also claim that there is a lack of discussion on the individuals' behaviour in the adoption and continued use of e-learning, despite the continuous growth of the e-learning market. There are different common theories and underlying models available that can be used to discover the primary reasons why users are adopting/not-adopting and subsequently using/not using a specific e-learning system. In our research we used the Unified Theory of Acceptance and Use of Technology (UTAUT) for reasons that will be discussed in the following section. Additionally, we focused on a single e-learning system, which usually improves the precision of responses and validity [13].

We decided to use Moodle, a very popular open source e-learning system. For example, Moodle has been adopted by the Open University (the largest university in the United Kingdom) which has embarked on a €7.5m programme to build an integrated online learning environment [14]. Moodle has been deployed and used at the Institute of Informatics at the Faculty of Electrical Engineering and Computer Science, Maribor for the last five years. A brief explanation of functionalities provided by Moodle being deployed at the University of Maribor can also be found in [15]. Through the unified web environment implemented using Moodle [16], students enrol in courses, download learning materials, communicate with other participants using forums and live chats, write blogs, contribute using wikis, communicate with professors and teaching assistants through the built-in synchronous and asynchronous messaging services, finish their activities and upload files, check grades, etc. Professors and teaching assistants use Moodle to manage learning content materials, manage students and their grades, check the uploaded students' work, prepare quizzes, etc. Although Moodle provides several features, not all of them are used by the professors and teaching assistants, therefore the set of functionalities that are being used varies from course to course. Students enrol in courses at the beginning of the semester and a course normally lasts for 15 weeks. At the end of the semester, access to the online courses students enrolled in remains open to the students so that they can get online learning materials and their work after they have completed the course whenever they want. At the end of each year, all the online courses are archived in order to preserve the work and grades.

To understand students' perceptions about using Moodle, the UTAUT-based research model was empirically tested using the structural equation modelling (SEM) approach. In the next section, theoretical backgrounds about acceptance theories are given. Examples of e-learning acceptance and use studies found in existing literature are provided in the same section. The following section reveals the research model and provides a list of research hypotheses. In section four, the research methodology is described, where the development of a measurement instrument is explained and the data collection and statistical analysis processes are described. In section five, data analysis and results are given in the following order: First, the characteristics of the sample are given and then a two-stage model-building process is presented, which was used when applying the SEM. Next, the validity and reliability of the measurement model are discussed, which have been examined via confirmatory factor analysis (CFA). After the CFA, appropriate fit tests are measured to assess the overall model fit of the measurement model and structural model. At the end of section five, the statistical analysis is given with the list of supported and unsupported hypotheses. The following section discusses the results and the last section concludes the paper with the implications and limitations of the study.

2. THEORETICAL BACKGROUNDS

The most common theory in the field of IT/IS (information technology/information system) adoption is the Technology Acceptance Model—TAM. Davis [17] proposed TAM to explain the potential user's behavioural intentions when using a technological innovation, because it explains the causal links between beliefs (the usefulness of a system and ease of use of a system) and users' attitudes, intentions, and the actual usage of the system. TAM has become one of the most widely used models in IS research because of its understandability and simplicity [18]. The focal TAM concepts are the following (see Fig. 1):

- *perceived ease of use (PEOU)*—the degree to which a person believes that using a particular system would be free of effort,

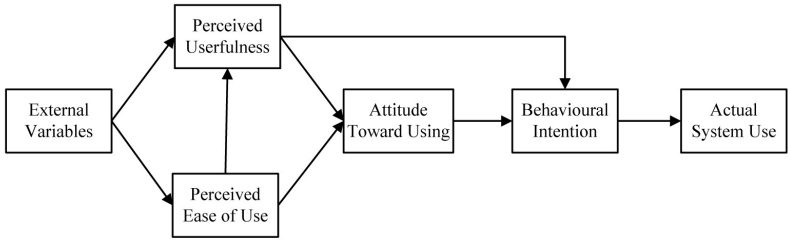

Fig. 1. Technology Acceptance Model (TAM) [17].

- *perceived usefulness (PU)*—the degree to which a person believes that using a particular system would enhance his or her job performance, and
- the dependent variable *behavioural intention (BI)* —the degree to which a person has formulated conscious plans to perform or not perform a specified future behaviour.

TAM has a flexibility that can be extended; therefore it has progressed through a rigorous development process. In existing literature we can find several studies that have revealed several antecedent factors to PU and PEOU. In TAM2 [19] subjective norms, image, job relevance, and result demonstrability were found to be significant determinants of PU. The TAM2 model was further extended with the determinants of PEOU in TAM3, where the Venkatesh and Bala [20] identified the following determinants of PEOU: computer self-efficacy, perceptions of external control, computer anxiety, computer playfulness, perceived enjoyment and objective usability. Because of TAM's demonstrated adaptability [21], it can also be used as a model for investigating user requirements and factors important for e-learning usefulness and simplicity. In the literature, there are mixed results for the importance of TAM determinants in the field of e-learning [22]. For example, in [23] the PEOU was not a significant predictor of attitudes toward the use and intention of using an e-learning system. Van Raaij and Schepers [24] also did not find a significant connection between PEOU and intention of using the e-learning system. On the other hand, in the study performed by Ngai, Poon and Chan [7], PEOU was demonstrated to be a dominant determinant of the attitude of students using an e-learning system. The statistical significance of the path between the PEOU and attitude towards using an e-learning system was also found by Liu, Liao and Pratt [22], where the authors studied a user's acceptance of streaming media for e-learning. Because of the mixed results (see also: Appendix A), TAM remains an area for future research in the field of e-learning technologies and services.

Venkatesh et al. [25] reviewed user acceptance literature and empirically compared eight user acceptance models: the theory of reasoned action (TRA), the technology acceptance model (TAM), the motivational model (MM), the theory of planned behaviour (TPB), the model of PC utilization (PCU), the innovation diffusion theory (IDT), and the social cognitive theory (SCT). Based on those models, Venkatesh et al. [25] formulated a unified model, called the Unified Theory of Acceptance and Use of Technology—UTAUT. According to the authors' results, the UTAUT outperformed the eight individual models, thus providing a better tool for understanding the drivers of acceptance [25]. The UTAUT model contains the following direct determinants of behavioural intention and use behaviour (see Fig. 2):

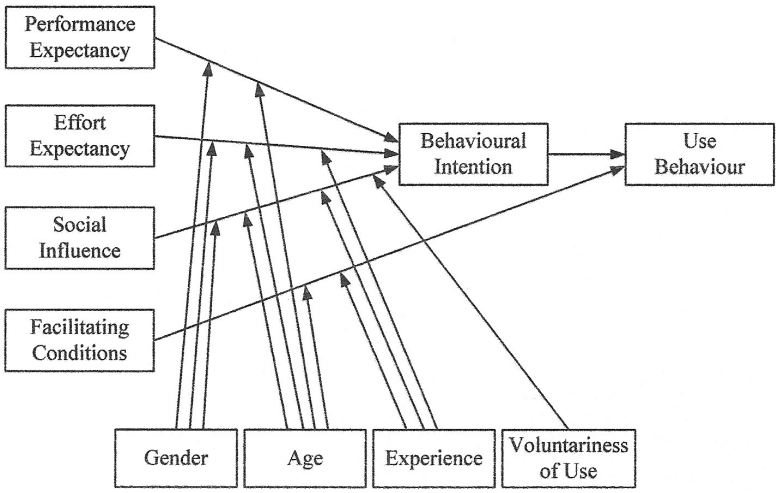

Fig. 2. Unified Theory of Acceptance and Use of Technology Model (UTAUT) [25].

performance expectancy, effort expectancy, social influence and facilitating conditions. Gender, age, experience and voluntariness of use are posited to mediate the impact of the four key determinants on usage intention and behaviour.

Despite the benefits, we found the following drawbacks for UTAUT. First, in contrast to TAM, the literature review showed that there is minimal research applying UTAUT as a ground theory in the field of e-learning acceptance (see: Appendix A). Secondly, as in the case of TAM, there are also mixed results in existing studies about the importance of UTAUT determinants. These are the reasons why UTAUT needs future validations and refinements.

3. RESEARCH MODEL AND HYPOTHESES

Because of its novelty in the field of user acceptance research, its outperformance and relatively small presence in existing literature regarding e-learning, UTAUT was chosen as a ground theory in this study, where we investigated students' perceptions about using Moodle. Although the attitude toward using the technology was not theorised as a direct determinant of behavioural intention in [25] the construct was found to be a significant predictor of behavioural intention in several acceptance studies (see Appendix A). Therefore, the attitude toward using the system was concluded in our research model (see Fig. 3).

The following subsections explain UTAUT constructs and corresponding causal relationships, as defined in our research, where we investigated the major drivers of Moodle user's acceptance as perceived by IT/IS students.

3.1 Performance expectancy

Performance expectancy (PE) is the degree to which an individual believes that using the system will help him or her achieve gains in job performance. In this study, PE stands for the degree to which a student believes that using Moodle will help them perform better in learning. PE pertains to TAM's PU, which has been found to have an impact on attitudes toward using a system in different studies where TAM was a ground theory (see: Appendix A). Therefore, we suggest the following hypothesis:

H1: PE will have a significant influence on students' attitudes toward using Moodle.

Secondly, Venkatesh et al. [25] have demonstrated that PE is the strongest predictor of intention to use a technology. Accordingly, we propose the following hypothesis:

H2: PE will have significant influence on students' intention to use Moodle.

3.2 Effort expectancy

Effort expectancy (EE) is the degree of ease associated with the use of a system. In this study, EE stands for the degree of ease associated with the use of Moodle. EE includes, among constructs from other theories, the PEOU from TAM. Previous studies [22, 26] have revealed that PEOU has an influence on attitudes toward using the system. Therefore, we propose:

H3: EE will have a significant influence on student's attitudes towards using Moodle.

The PEOU assumes that a system perceived to be easier to use is more likely to induce the perception of usefulness and behavioural intention. Therefore, the following hypothesis was formulated:

H4: EE will have a significant influence on student's intention to use Moodle.

3.3 Social influence

Social influence (SI) as a direct determinant of behavioural intention is represented as a subjective norm in various theories [25]. SI is the degree to which an individual perceives that important people believe they should use the new system. In this study, SI stands for student's belief that other students, who are important to him or her, think they should use Moodle to perform better in learning. Accordingly, the following hypotheses were proposed:

H5: SI will have a significant influence on student's attitudes towards using Moodle.

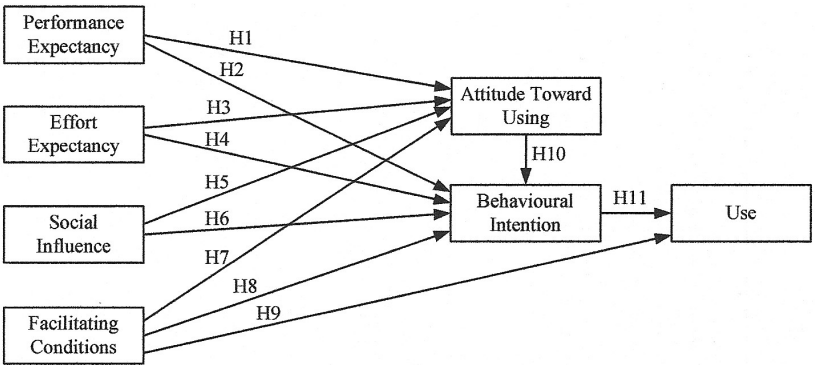

Fig. 3. The hypothesized model and variables.

H6: SI will have a significant influence on student's intention to use Moodle.

3.4 Facilitating conditions

Facilitating conditions (FC) are defined as the degree to which an individual believes that an organisational and technical infrastructure exists to support the use of a system. This construct includes aspects of the technological and/or organizational environment that are designed to remove the barriers to use. In this study, FC is defined as the degree to which student believes that he or she has necessary skills and technical equipment for using Moodle. Behavioural intentions cannot occur if objective, FC is not fulfilled [3]. Therefore, we propose the following hypotheses:

H7: FC will have a significant influence on student's attitudes toward using Moodle.
H8: FC will have a significant influence on student's intention to use Moodle.
H9: FC will have a significant influence on student's Moodle usage.

3.5 Attitude toward use

Attitude toward using technology (ATU) is an individual's overall affective reaction to using a system. It stands for an individual's liking, enjoyment, joy and pleasure associated with technology use. The ATU has been demonstrated as a determinant of behavioural intention in different studies (see Appendix A). We therefore suggest the following hypothesis:

H10: Student's ATU of Moodle will have a significant influence on his or her intention to use Moodle.

3.6 Behavioural intention

Since the behavioural intention (BI) was found to be a significant determinant of actual use of technology in different research studies [27] (also in e-learning—see: Appendix A), we propose the following hypothesis:

H11: Student's BI to use Moodle will have significant influence on his or her Moodle usage.

4. RESEARCH METHODOLOGY

Quantitative research in the form of an online questionnaire based survey was performed to test the stated hypotheses. In this section, the development of the measurement instrument, the sampling process and data analysis approach are described.

4.1 Instrument development

Empirical data were collected by means of an online questionnaire containing 36 questions. The research instrument questions were organized into the following two groups: (1) demographic questions about the respondents' gender, age, years of study, internet experience, Moodle experience, voluntariness, etc. (see Table 1 for the others); and (2) measures for the UTAUT constructs. The UTAUT constructs were operationalized according to the items that were used for estimating UTAUT [25] and adapted to the context of Moodle (see in Appendix B). The UTAUT measuring items were Likert-like items on a 7-point scale from 'strongly agree' to 'strongly disagree'. Some questions were worded with proper negation in order to achieve the desired balance in the questionnaire.

To reduce measurement errors, the development of the online questionnaire involved the following steps. First, a pre-test of the questionnaire was performed with nine faculty colleagues. The main goal of the pre-test was to improve the content of the measuring items. Therefore, the colleagues were asked to examine the questionnaire for meaningfulness, relevance and clarity. According to the remarks and propositions in their feedback, several measurement items were refined and rewritten. After the pre-test, a pilot test of the questionnaire was performed with a non-random sample of twenty-five volunteers constituted of faculty staff and students, who were available at the time. The main goal of the pilot test was to empirically validate the reliability of the questionnaire—to check whether the measurement instrument lacked accuracy or precision [28]. Data collected from the pilot test was analysed using SPSS to check the internal consistency of the measurement items. The statistical test results confirmed a solid reliability for all measurement items, except for the SI and FC construct. In order to improve the reliability of these two constructs, three measuring items were added to the SI construct and two items to the FC construct.

4.2 Sampling process

The sampling process of the actual survey was performed in the following manner. Since Moodle is an open-source system that can be downloaded, deployed and used for free, it is hard to identify the current number of Moodle users. Every month, the number of registered users increases by approximately 1,300. The statistical report from June 2010 [29] indicates that at the time of this report, 49,579 Moodle sites from 213 countries have been registered and validated. So far, over 3.5 million online courses using Moodle have been established and more than 35 million Moodle users have been registered.

Our sample frame was limited to students that use Moodle at the Institute of Informatics at the Faculty of Electrical Engineering and Computer Science in Maribor. The students captured by our frame are full time students studying technical studies in different academic and professionally-oriented Bologna study programmes [30]: computer science and information technologies, electrical engineering, informatics and technologies of communication, media communications, telecommunications, etc. It is worth mentioning that the

majority of students are male. At the time of research, 115 online courses were established and 1,566 users were registered and a complete list of subjects is available to all members of the Faculty of Electrical Engineering and Computer Science at [16]. A typical student enrols in approximately 5 online courses, which normally last for 15 weeks. The online courses are categorized into categories related to the study programmes and there are approximately 17 courses in a category. A systematic random sampling process, where every member of the sample frame had an equal chance of being selected, produced a sample of 800 Moodle users. The students that participated in the pilot test were excluded from the sample frame in the random sampling process. A request form for participation in the online survey was sent to the selected students. 284 online surveys were started, of which 235 were successfully finished and 49 returned incomplete. The usable response rate was thus 29%.

4.3 Statistical analysis

The data received from respondents was analyzed in the following way. To describe the main features of an average participant in this study, descriptive statistics has been used on the respondents' characteristics data. Structural equation modelling (SEM) was used to test the fit of the proposed theoretical model (Fig. 3.) with empirical data. SEM was applicable because it encourages confirmatory rather than exploratory modelling and is therefore suited to theory testing. SEM was applied with a two-stage model-building process, as proposed by different researchers [31–32]. SEM consists of two main parts [31]: the measurement model specifying how latent variables or hypothetical constructs are measured in terms of the observed variables or indicators, and the structural model specifying causal relationships between endogenous and exogenous variables and assigning the explained and unexplained variances.

The measurement model was estimated using confirmatory factor analysis to test whether the proposed constructs possessed sufficient validation and reliability. To assess the reliability and validity of the measurement instrument used in this study, internal consistency, composite reliability and convergent validity were demonstrated. After assessing the reliability and validity of the measurement instrument, the measurement model was estimated. A variety of statistics have been used to assess the goodness-of-fit for a hypothesized model for data, as proposed by Rainer and Miller [33]. After the final measurement model passed the goodness-of-fit tests, the structural part of the research model was estimated using SEM on the structural model. The structural model was also tested for a data fit with appropriate goodness-of-fit indices.

Statistical analysis was performed using the SPSS statistical package together with AMOS 17.0 software. AMOS is a covariance-based approach similar to LISREL, in which the covariance structure obtained from the observed data is used to simultaneously fit measurement and structural equations specified in the model. AMOS was used to estimate the measurement and the structural model using the maximum likelihood estimator.

5. RESULTS

Surveying sample respondents with the above-defined questionnaire and performing data analysis as defined in section 4.3 resulted in the following data.

5.1 Sample characteristics

Table 1 lists the student respondent characteristics. The results indicate that most students are male. The average student is between 21 and 22 years old. The respondents have solid internet experience; half of the students described themselves as 'very experienced.' Most of the students have already had experience with a web-based courseware system like Moodle. From the results, it is obvious that the use of Moodle was in most cases obligatory. Another important fact is that students use the system frequently; more than half of students use it daily.

5.2 Measure reliability and validity

Before testing the hypotheses, measurement items in the questionnaire were first assessed for content and construct reliability and validity. To ensure content validity, the measurement items were adopted from Venkatesh et al. [25].

Table 2 summarizes the results of internal reliability, composite reliability and convergent validity for measurement instrument constructs. The internal consistency of the constructs was assessed by Cronbach's a, which is a commonly used index for testing reliability [34]. Cronbach's a is used for estimating the extent to which multiple indicators for a latent variable belong together. A usually adequate level of Cronbach's a is 0.70 [35] and this is the value that is commonly used by researchers, such as [22–23, 36–37]. Since the estimated Cronbach's a values for UTAUT constructs exceeded the cut-off value (see Table 2), the constructs showed a reasonable level of reliability.

The composite reliability measures for all of the constructs exceeded the recommended level of 0.70 (see Table 2), which is often cited as a lower threshold [38]. As the third indicator of convergent validity, the average variance extracted (AVE) was estimated. AVE measures the overall amount of variance that is attributed to the construct in relation to the amount of variance attributable to measurement error [39]. If the AVE is less than 0.5, then the variance due to measurement error is greater than the variance captured by the respective construct [38]. AVEs for individual constructs were between 0.560 and 0.755 (see: Appendix A), consequently the measurement model passed the

Table 1. Sample characteristics (n = 235)

Demographic characteristics		**Frequency**	**Percentage**
Gender	Male	188	80.0
	Female	47	20.0
Age	18–20 years	45	19.1
	21–22 years	124	52.8
	23–24 years	48	20.4
	25–26 years	15	6.4
	more than 26 years	3	1.3
Years of study	Less than a year	69	29.4
	1–2 years	64	27.2
	2–3 years	45	19.1
	3–4 years	36	15.3
	4–5 years	15	6.4
	more than 5 years	6	2.6
Internet experience	No experience	0	0.0
	Some experience	2	0.9
	Experienced	117	49.8
	Very experienced	116	49.4
Moodle experience	No experience	1	0.4
	Some experience	33	14.0
	Experienced	164	69.8
	Very experienced	37	15.7
Voluntariness	Voluntarily	189	80.4
	Obligatory	46	19.6
Number of courses where Moodle is used (for the present academic year)	1	4	1.7
	2	28	11.9
	3–5	127	54.0
	5–8	61	26.0
	8–13	16	6.8
	13–21	3	1.3
Frequency of Moodle use	A couple times a year	2	0.9
	A couple times a month	4	1.7
	Weekly	81	34.5
	Daily	148	63.0

Table 2. Instrument reliability and validity

Construct	**Item**	**Factor loading**	**Internal consistency Cronbach a $\geq$ 0.70**	**Composite factor reliability $\geq$ 0.70**	**Convergent validity Average Variance Extracted $\geq$ 0.50**
Performance Expectancy	PE2	0.77	0.815	0.821	0.605
	PE3	0.84			
	PE4	0.73			
Effort Expectancy	EE1	0.83	0.901	0.902	0.755
	EE2	0.89			
	EE3	0.89			
Social Influence	SI5	0.74	0.833	0.847	0.651
	SI6	0.91			
	SI7	0.76			
Facilitating Conditions	FC4	0.63	0.739	0.781	0.560
	FC5	0.99			
	FC6	0.54			
Behavioural Intention	BI1	0.77	0.858	0.865	0.682
	BI2	0.89			
	BI3	0.81			
Attitude Toward Using	ATU2	0.76	0.848	0.849	0.653
	ATU3	0.83			
	ATU4	0.82			

Notes: χ^2 = 194.963; df = 120; χ^2/df = 1.625; GFI = 0.918; AGFI = 0.883; CFI = 0.969; RMSR = 0.054; RMSEA = 0.052; NFI = 0.942; NNFI (TLI) = 0.960; PNFI = 0.742.

Table 3. Discriminant validity

	PE	EE	SI	FC	ATU	BI
PE	**0.61**					
EE	0.23	**0.76**				
SI	0.42	0.16	**0.65**			
FC	0.32	0.47	0.22	**0.56**		
ATU	0.56	0.22	0.41	0.34	**0.65**	
BI	0.19	0.06	0.20	0.16	0.18	**0.68**

convergent validity check. Moreover, the correlations of potentially overlapping constructs were used to assess discriminant validity. All the AVE estimates (diagonal values in Table 3) exceeded the squared correlation values (off-diagonal values in Table 3). These estimates suggest that constructs are more strongly correlated with their indicators than with other constructs in the model [26].

The results of the tests for unidimensionality, reliability and convergent and discriminant validity provide evidence of the internal and external validity of the measurement instrument and scales.

5.3 The measurement model

The model that specifies how observed variables depend on unobserved, or latent, variables is called the measurement model. Figure 4 represents the final measurement model in Amos which is modelled in the following way: (a) the covariance between each possible pair of latent variables is modelled with two-headed arrows, (2) the latent variables are connected to their respective indicators by straight arrows, (3) straight arrows connect from the error and disturbance terms to their respective variables, and (4) there are no direct effects (straight arrows) connecting the latent variables. According to the modification indices provided by AMOS, some indicators (PE1, EE4, SI1–SI4, FC1–FC3, ATU1) have been cut off from the initial measurement model and then the overall fit model for the final measurement model was estimated to ensure a good data fit with the model.

The estimated final measurement model fit measures are also presented in Fig. 4. The χ^2 value was 194.963 with 120000 degrees of freedom. The χ^2 statistic is being used as a fundamental statistical measure in SEM to quantify the differences between covariance matrices [40]. Researchers strive to get a low (non-significant) χ^2 because a low value indicates a good fitting of the model with the data [33]. However, the χ^2 value is sensitive to sample size—as the sample size increases so does the χ^2 value [40–41]. Therefore, in studies with a bigger sample size, a normal $\chi 2$ is estimated, which is a ratio of χ^2 to the degrees of freedom for the model. Generally, χ^2:df ratios on the order of 3:1 or less are desired [40]. For the measurement model in this study, the normal χ^2 was 1.625, indicating a good model fit. The GFI measures the overall degree of model fit—the relative amount of variance in a sample that the model predicts. A GFI values approaching 0.90 indicates a well-fitting model [40]. The GFI value for the measurement model was 0.918. The AGFI

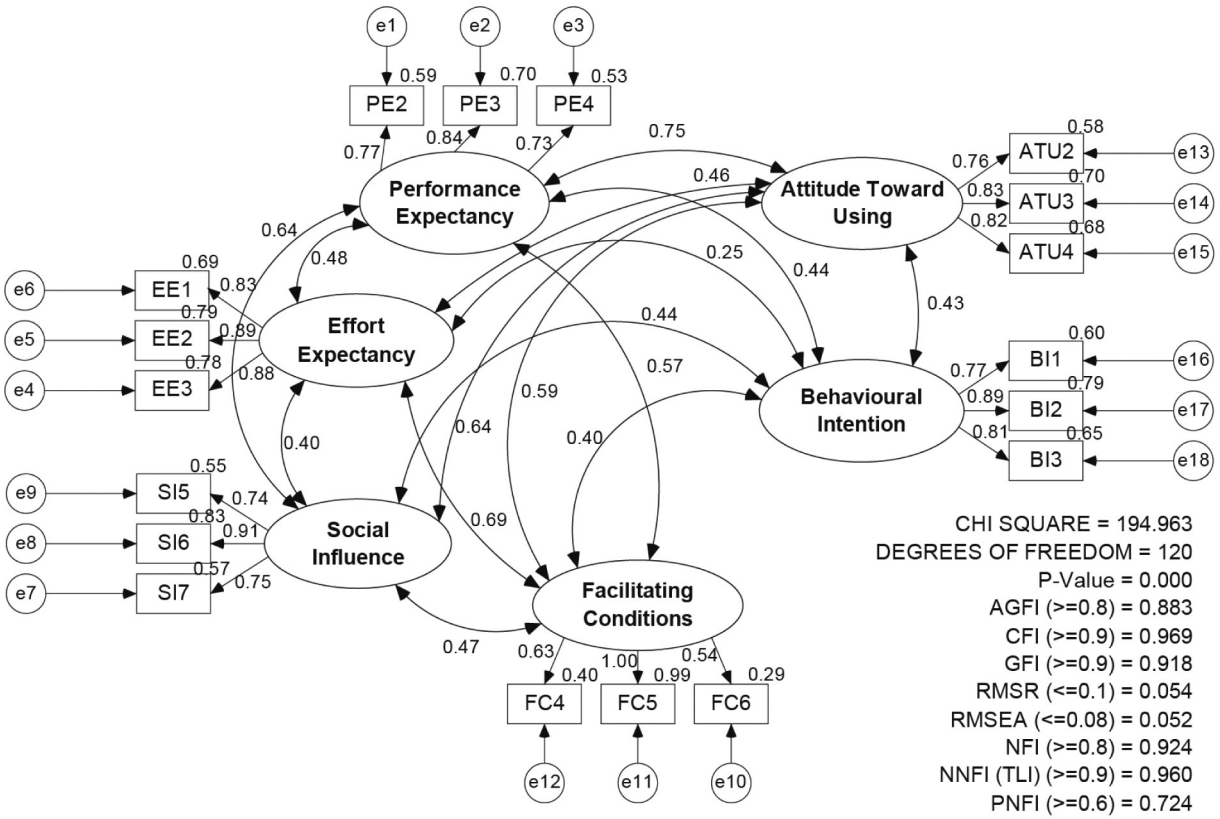

Fig. 4. The final measurement model—standardised regression weights and correlation values estimated by Amos.

Table 4. Model fit summary for the final structural model

Fit index	Recommendation	Model
χ^2	Non-significant	200.215
Degrees of freedom (df)	n/a	135.000
p		0.000
χ^2/df	< 3.00	1.483
Goodness-of-fit index (GFI)	> 0.90	0.919
Adjusted Goodness-of-fit index (AGFI)	> 0.80	0.886
Comparative fit index (CFI)	> 0.90	0.971
Root mean square residuals (RMSR)	< 0.10	0.050
Root mean square error of approximation (RMSEA)	< 0.08	0.045
Normed fit index (NFI)	> 0.80	0.918
Non-normed fit index (NNFI)	> 0.90	0.963
Parsimony normed fit index (PNFI)	> 0.60	0.724

measure is an extension of the GFI, adjusted for degrees of freedom. As claimed by Hair, Black, Babin and Anderson [40], AGFI values approaching 0.80 suggest a well-fitting model. The AGFI value in the case of our measurement model was 0.883. The estimated CFI value for the measurement model was 0.969. The CFI compares the existing model fit with a null model fit, assuming that the latent variables in the model are uncorrelated. Preferable values for the CFI are equal to or greater than 0.90 [26]. The estimated RMSR for the measurement model was 0.054. The RMSR is a non-normed indicator of the average of the residual covariance between the observed and the estimated input matrices [40]. The values of the RMSR are less than 0.10 and indicate a well-fitting model as proposed by Hair, Black, Babin and Anderson [40]. The RMSEA value for the measurement model was 0.052. According to practical experience, an RMSEA value of about 0.08 or less indicates a close fit for the model [41].

The NFI value for the measurement model is 0.924, once again indicating a well-fitting model. The NFI is the ratio of the difference in the χ^2 value for the fitted model and a null model divided by the χ^2 value for the null model [40]. Acceptable values for the NFI are greater than 0.80, as stated by Rainer and Miller [33]. In the case of the measurement model in this study, the estimated NNFI value was 0.960, indicating a good model fit, since values approaching a value of 1 suggest a better fit [33]. In comparison to NFI, the NNFI (called also Tucker Lewis index) is actually a comparison of the normed χ^2 values for the null and specified model [33]. The estimated PNFI value was 0.724, which indicates a good parsimonious fit, since the recommended value is 0.60. The χ^2 statistic was significant, but because of the sample size and the number of observed variables, the adjusted χ^2 statistic, the GFI, the AGFI, the CFI, the RMSR, the RMSEA, the NFI, the NNFI, and the PNFI should be emphasized. The estimated values for the mentioned measures were above or below the recommended values; therefore the final measurement model fit the data moderately well.

5.4 The structural model

A structural model specifies how the latent variables are related to each other and is therefore modelled as a set of exogenous and endogenous latent variables connected by straight arrows. Fig.5. shows the final structural model modelled in Amos together with goodness-of-fit estimates. According to the modification indices provided by Amos, one indicator of the construct ATU (ATU3) was removed to provide a better fit for the final structural model. The structural model analysis demonstrated a good fit according to the goodness-of-fit indices (discussed above), and as listed in Table 4.

The results of the final structural model (see Fig. 6) show that performance expectancy (β = 0.457; p<0.001), social influence (β = 0.322; p<0.001) and facilitating conditions (β = 0.244; p<0.05) positively effect attitudes toward using Moodle. These results provide support for the hypotheses H1, H5 and H7. The statistical results also indicate support for the H6 and H8 hypotheses, meaning that both social influence (β = 0.238; p<0.05) and facilitating conditions (β = 0.225; p<0.05) influence the behavioural intentions for using Moodle. In the end, as was the result in many different studies, behavioural intentions were a strong indicator behind the actual use of Moodle (β = 0.501; p<0.001), supporting hypothesis 11. However, there was statistically insufficient evidence regarding the impact of performance expectancy and effort expectancy on behavioural intentions. This means that the analysis did not support the hypotheses H2 and H4. There was also no significant relationship between effort expectancy and attitude towards using the system; therefore, hypothesis H3 was not supported. The results also indicated that there was no significant relationship between facilitating conditions and the actual use of Moodle; thus hypothesis H9 was also not supported. According to the results, student's intentions of using Moodle are not influenced by their attitudes towards using the system. Therefore, the hypothesis H10 was not supported.

To test, how gender, age, experience and voluntariness mediate the impact of individual determinants of students' attitudes and behavioural intention, we performed a multiple-group analysis, provided by Amos. Before performing the multiple group analysis in Amos, we conducted appropriate

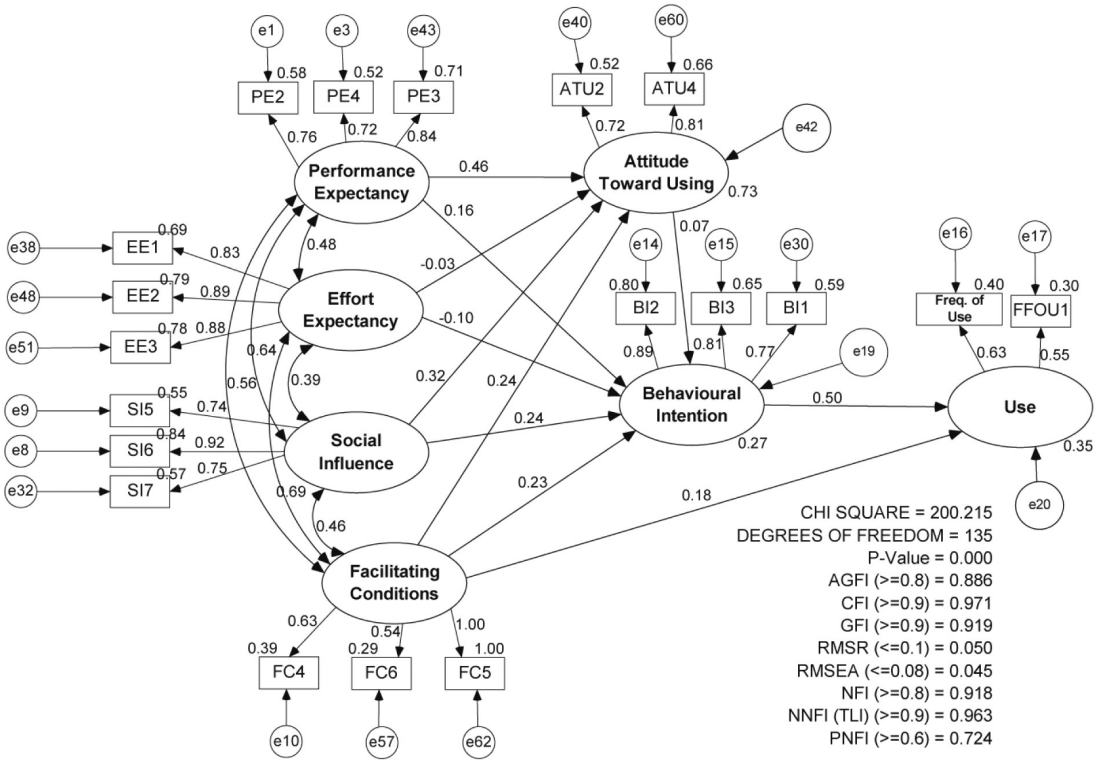

Fig. 5. Standardised solution of the structural model and model-of-fit indices estimated by Amos. Quantities close to variables are their squared multiple correlations. Quantities near paths are standardized loadings or correlations.

Table 5. Hypothesis testing results

Hypothesis	Effects	Path coefficient	Remarks	Effect stronger for
H1	PE → ATU	0.457***	Supported	male, younger, very experienced
H2	PE → BI	0.157^{NS}	Not supported	
H3	EE → ATU	-0.028^{NS}	Not supported	
H4	EE → BI	-0.104^{NS}	Not supported	
H5	SI → ATU	0.322***	Supported	younger, very experienced
H6	SI → BI	0.238*	Supported	younger, female, experienced, voluntary
H7	FC → ATU	0.244*	Supported	younger, very experienced
H8	FC → BI	0.225*	Supported	younger, experienced
H9	FC → U	0.177^{NS}	Not supported	
H10	ATU → BI	0.070^{NS}	Not supported	
H11	BI → U	0.501***	Supported	male, younger, very experienced

Notes: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; ^{NS} $p > 0.05$.

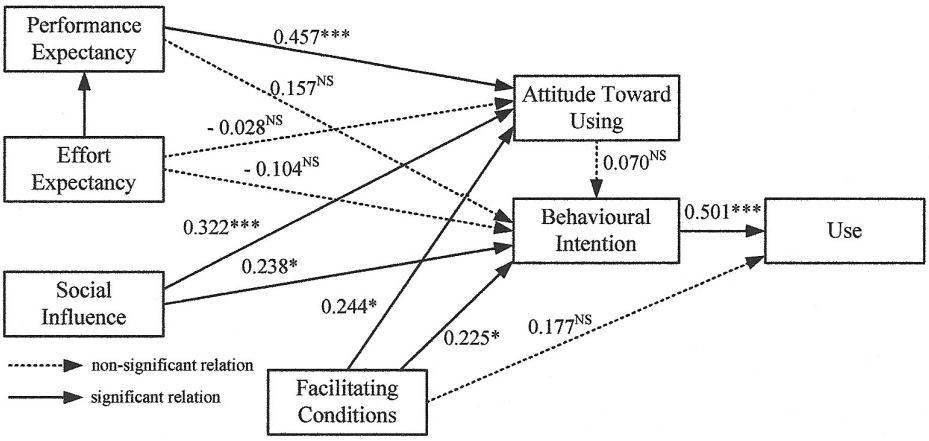

Fig. 6. Results of a structural model analysis—hypotheses testing results (the dotted lines represent insignificant relationships while other lines represent significant causal links at: *, $p<0.05$; **, $p<0.01$; ***, $p<0.001$)

statistical tests (t-test, ANOVA) in order to check whether there were significant differences in means for independent population groups. Table 5 summarizes the hypothesis testing results and the results of the multiple-group analysis.

6. DISCUSSION

The results of the present study showed that performance expectancy, social influence and facilitating conditions have a direct effect on attitudes toward using Moodle, where performance expectancy is the strongest determinant of attitudes for students. On the other hand, effort expectancy does not influence learners' attitudes toward using Moodle. Students' intention for using the system is not a result of their perceptions of performance expectancy and effort expectancy, but is caused by social influence and facilitating conditions. Behavioural intentions were shown to be a strong indicator for the actual use of Moodle.

Attitudes towards using Moodle being directly affected by performance expectancy reveals that if e-learning technology is perceived to be useful and helpful in getting better grades and knowledge by using the system, students are going to like using Moodle. Several other studies came to a similar result, where perceived usefulness was found to play an important role in affecting students' attitudes toward using an e-learning system [7, 22–23, 26]. A slightly surprising and contradictory result with regard to several acceptance studies [22, 24, 26] is that the behavioural intention to use Moodle is not the result of student's perception about how useful the system is. The performance expectancy in this study did not have a significant impact on behavioural intentions for using the system. But, from the perspective of voluntariness, this result may not be so surprising. Students in this study are using Moodle mainly because they have to use it. Student's behavioural intentions were found to be a strong predictor of actual use of the system, which was also an expected outcome.

Students' attitude toward using an e-learning system is also not reflected by student perceptions about the ease of using the system or effort expectancy. In other words, students are not going to like using Moodle just because they perceive it to be easy. These results confirm the same conclusion for the non-significant connection between perceived ease of use and attitude, found by Lee, Cheung and Chen [23]. These results, however, contradict the results of studies published by Ngai, Poon and Chan [7], Liu, Liao and Pratt [22] and Teo [26].

Students' attitudes toward using Moodle were shown to be influenced by their perceptions on whether others believe that they should use Moodle. We believe that social influence having a direct effect on student attitudes is an expected outcome, because in this study the use of Moodle was mostly mandatory. Venkatesh and Davis [19] also suggest that such effects could be attributed in mandatory contexts. And even more, according to the results of this study, social influence is shown to have a positive effect on the behavioural intentions of using the system. Today, students are well experienced internet users and usually have the necessary knowledge and equipment. This results in a positive attitude toward using Moodle. These results are somewhat contradictory to the findings of Venkatesh et al. [25], where the facilitating conditions did not have a significant impact on behavioural intentions, where the same effect was captured by effort expectancy.

7. LIMITATIONS

As in all empirical research, this study has some limitations that need to be identified and discussed. First, the sample is limited to students at a faculty that is more or less technically oriented. Although the results from this study are useful for describing the characteristics of a large population of students, the generalizations of the results are limited to full-time undergraduate students. The students that participated in this study are mostly obliged to use Moodle in their studies. Students were mostly male (80%) and all of them already possess technical skills when it comes to internet use.

Next, this study is limited only to one example of an e-learning system. Although Moodle is a modern and well-accepted e-learning system, the generalization of the results is limited to the characteristics and features provided by it. Moodle is an open source product and therefore extensions can be implemented. The actual implementation and deployment of Moodle can affect different students' perceptions like usefulness, easiness, and attractiveness. Because Moodle deployments' primary objectives are not the same in every case, this is another variable that will have to be addressed in future work as well. Perhaps as a new moderator construct in the UTAUT model. Therefore, the implementations and deployment characteristics should be considered when asking users how they feel about using the system.

In the case of Moodle being deployed at the Institute of Informatics at the Faculty of Electrical Engineering and Computer Science, not all of the available features provided by Moodle are being equally used in all online courses. The set of used features depends on the actual needs of a professor or a teaching assistant and also on the suitability of the features for a particular course. For example, in some courses the online quizzes are not used, because online quizzes simply cannot replace oral exams. The examination process demands live interaction between professor and student, and this is mandatory. According to the statistical data from Moodle deployed at the Institute of Informatics, it is clear that the electronic posting of student's homework is the feature that is most frequently used. Students often use Moodle as a

search tool for learning materials, on-line browsing through resources and downloading resources. Students also often use Moodle to overview the complete grades of individual courses. Online quizzes are also being frequently used by the students. However, there are features that are not being fully exploited by the students. Such features are: (a) an online calendar for a complete overview of events and dates for submission of homework, (b) asynchronous communication through the forum, (c) synchronous communication through an online chat service, (d) on-line subscription to exams, etc. Students very rarely use the built-in messaging system for communication with professors or teaching assistants. A wiki for collaborative online content creation, writing blogs and an e-dictionary are some examples of features that have not yet been used in the learning process.

8. CONCLUSIONS

This paper deals with research about acceptance and the use of an e-learning system where the state-of-the-art theory of technology acceptance was used as a ground theory. According to a review of existing literature, this study is one of the few attempts to investigate undergraduate students' perceptions about acceptance and use of an e-learning system, using UTAUT as a ground theory. Therefore, the present study contributes to the body of research on UTAUT, resulting in the empirical validation of the UTAUT research model within the context of an e-learning system: Moodle.

The results of this study have implications that are important to different e-learning stakeholders. Students do not like using an e-learning system just because it is easy to use, but rather because they find it useful for their studies. E-learning system developers should therefore keep up with new technology developments and exhaustively look for and build extensions with new and innovative solutions (Web 3.0) and build them into the e-learning system. The finding about the importance of usefulness in the use of an e-learning system is also significant for e-learning content providers. Teaching stuff has to take advantage of an e-learning system to make the best of it when providing students with learning materials, news, asynchronous and synchronous communication, etc. Although the content of e-learning materials is not directly addressed by this study, it should be considered. Students would maybe find the e-learning system more useful, if they get adequate learning materials and other attractive ways to supplement their knowledge using the system.

The findings of this study can also be a direction for researchers for their future work. Although the study has shown that UTAUT is a good foundation for research in understanding the level of technology acceptance, the results imply the need for extending the UTAUT model in the context of e-learning by investigating all the potential constructs and factors that may influence students' perceptions about the usefulness of an e-learning system in the learning process. We believe there are other constructs related to the user, technology and service domain characteristics that have a direct or indirect and significant impact on users' attitudes and intentions to use a technology. Our future research will therefore be dedicated to finding and evaluating such potential constructs. As a future direction for work, another moderator variable should be considered—the user's role. Not only students gain by using Moodle in the learning process. If properly used, professors and teaching assistants can gain a lot in the pedagogical process. Before e-learning systems were available, the online content for students was managed mainly individually, using some in-house solutions or in worst-case scenarios by editing personal web sites. Since e-learning systems like Moodle provide a great level of support for course and student management, tasks like online content management, student grades management, news announcements, quiz preparation, online assessments, etc., have never been more convenient. The role of the user in the use of an e-learning system is therefore another aspect for our future research, where we will try to answer what factors influence professors' and teaching assistants' perceptions in accepting or not accepting an e-learning system like Moodle. Or in other words, is an e-learning system like Moodle really an advantage of any kind in their pedagogical process? To answer this question we will continue our research by examining additional variables that could be used to extend the UTAUT model for e-learning domain.

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APPENDIX A

Review of literature in the field of e-learning acceptance studies in existing literature

Source	Ground Theory, Research Method (sample size)	Findings (causal relationships)		
		Exogenous	**Endogenous**	**Impact**
Brown [42]	TAM, Survey, (73)	EOF, EUND, CSE, CA	PEOU	Yes
		PEOU	PU	Yes
		PEOU	U	Yes
		PU	U	No
Wagner and Flannery [43]	TAM, Survey, (446)	SA, ISU, SD	ATU	Yes
		ATU, MSU, CA	PU	Yes
		ATU, PU, EDUL, BREX	BI	Yes
		BI	U	Yes
Lee et al. [23]	TAM, Survey, (544)	PEOU	PEN	Yes
		PEOU	PU	Yes
		PEOU	ATU	No
		PU, PEN	ATU	Yes
		PU, ATU, PEN	BI	Yes
Saadé and Kira [44]	TAM, Survey, (114)	PU, PEOU	ATU	Yes
		PEOU	PU	Yes
		AFF, ANX	PU	No
		AFF, ANX	PEOU	Yes
Marchewka et al. [45]	UTAUT, Survey, (132)	PE	BI	No
		EE, SI	BI	Yes
		Age, Gender	PE, EE, SI, FC, U	No
Ngai et al. [7]	TAM, Survey, (1236)	TS, PEOU	PU	Yes
		TS	PEOU	Yes
		TS	ATU	No
		PEOU, PU	ATU	Yes
		PEOU, PU	U	Yes
		PU, ATU	BI	No
		ATU, BI	U	No
Chiu and Wang [3]	UTAUT, Survey, (286)	PE, EE, SE, ATV, UV, IV, ANX	CI	Yes
		SI, FC, SIS, DER, RAL	CI	No
		EE	PE	Yes
		SE	EE	Yes
Liu et al. [22]	TAM, Survey, (190)	PEOU	PU	Yes
		PU, ATU	BI	Yes
		PEOU, PU	ATU	Yes
Var Raaij and Schepers [24]	TAM, Survey, (45)	PIIT	PU	No
		SN, PEOU	PU	Yes
		PIIT	PEOU	Yes
		PIIT	ANX	Yes
		ANX	PEOU	Yes
		PU	U	Yes
		PEOU, SN	U	No
Teo [26]	TAM, Survey, (475)	ATU, PU, SE	BI	Yes
		PU, PEOU, FC	ATU	Yes
		PEOU, SE	PU	Yes
		TC, FC	PU	No
		SE	PEOU	No

Notes: ANX—Anxiety, AFF—Affect, ATU—Attitude toward using, ATV—Attainment Value, BREX—Browser Experience, BI—Behavioural intention, CA—Computer anxiety, CI—Continuance intention, CSE—Computer Self Efficacy, DER—Delay in response, EDUL—Educational level, EE—Effort expectancy, EOF—Ease of finding, EUND—Ease of understanding, FC—Facilitating conditions, ISU—Information support, IV—Intrinsic value, MSU—Management support, PE—Performance expectancy, PEN—Perceived enjoyment, PEOU—Perceived Ease of Use, PIIT—Personal innovativeness in domain of IT, PU—Perceived Usefulness, RAL—Risk of arbitrary learning, SA—Software anxiety, SD—Self determination, SE—Self Efficacy, SI—Social influence, SIS—Social isolation, SN—Subjective norm, TC—Technology complexity, TS—Technical support, U—Use, UV—Utility value

APPENDIX B

UATUT Items and Scales

Item	Question	Adapted from
Performance Expectancy		*Venkatesh et al.[25]*
PE1	I would find Moodle usefull for learning.	
PE2	Using Moodle enables me to accomplish tasks more quickly.	
PE3	Using Moodle for learning increases my productivity.	
PE4	If I use Moodle, I will increase my chances of getting knowledge.	
Effort Expectancy		*Venkatesh et al. [25]*
EE1	My interaction with Moodle would be clear and understandable.	
EE2	It would be easy for me to become skilful at using the system.	
EE3	I would find Moodle easy to use.	
EE4	Learning to operate Moodle is easy for me.	
Attitude toward using technology		*Venkatesh et al. [25]*
ATU1	Using Moodle is a bad idea (negative).	
ATU2	Moodle makes learning more interesting.	
ATU3	Working with Moodle is fun.	
ATU4	I like working with Moodle.	
Social influence		*Venkatesh et al. [25]; Ajzen [46]; Moore and Benbasat [47]; Thompson et al. [48]*
SI1	In general, the faculty has supported the use of Moodle.	
SI2	Professors and teaching assistants use Moodle.	
SI3	Professors and teaching assistants think that I should use Moodle.	
SI4	I use Moodle because of the proportion of classmates that also use Moodle.	
SI5	Classmates that use Moodle have more success in learning.	
SI6	Classmates who influence my behaviour think that I should use Moodle.	
SI7	Classmates who are important to me think that I should use Moodle.	
Facilitating conditions		*Venkatesh et al. [25]; Ajzen [46]; Taylor and Todd [49]; Moore and Benbasat [47]*
FC1	I have the resources necessary to use Moodle.	
FC2	I have the knowledge necessary to use Moodle.	
FC3	Moodle is compatible with web browsers I use.	
FC4	A specific person is available for assistance with Moodle difficulties.	
FC5	I have control over using Moodle.	
FC6	Using Moodle is compatible with all aspects of my work.	
Behavioural intention		*Venkatesh et al. [25]*
BI1	I intend to use Moodle in the next 6 months.	
BI2	I predict I would use Moodle in the next 6 months.	
BI3	I plan to use Moodle in the next semester.	

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