Educational technology acceptance across national and professional cultures: a European study

Nicolae Nistor · Aytaç Göğüş · Thomas Lerche

Abstract The continuous development of new platforms and environments for technology-enhanced learning emphasizes the increasing importance of research in educational technology acceptance (ETA). Responding to this need, the unified theory of acceptance and use of technology (UTAUT) proposes a major ETA model. However, the UTAUT has been so far validated only in restrained contexts. The ongoing internationalization of education calls for extending ETA research and the UTAUT across national and professional boundaries. Therefore, this study aims at cross-cultural validation of the UTAUT by examining a large sample ($N = 4,589$) of educational technology users from three European countries, Germany, Romania and Turkey. As a first conclusion, the UTAUT questionnaire displays adequate validity, reliability, and measurement equivalence across cultures, which further enables UTAUT-based comparisons of the cultural groups. Secondly, the effect of technology use intention on the actual use behavior proves to be extremely weak. Several possible explanations are proposed along with suggestions for future research. Thirdly, for the first time in ETA research the cultural sample diversity allows the verification of correlations between acceptance and culture. Thus, this study makes headway in the integration of culture (sensu Hofstede) in the UTAUT by suggesting effects of power distance, individualism, masculinity, uncertainty avoidance and long-term orientation on performance and effort expectancy, perceived social influence, computer

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anxiety, technology use intention and actual use behavior. Fourthly, for educational practice the presented results suggest several ways of anticipating and supporting ETA in multicultural user groups.

Keywords Educational technology acceptance · Unified theory of acceptance and use of technology · Culture · Germany · Romania · Turkey

Introduction

The continuous development of new platforms and environments for technology-enhanced learning emphasize the increasing importance of research in educational technology acceptance (ETA). Over two decades of acceptance research (see an overview in Šumak et al. 2011) resulted in several models, synthesized by Viswanath Venkatesh and his colleagues in the unified theory of acceptance and use of technology (UTAUT; Venkatesh et al. 2003; 2012). So far, the UTAUT was verified in several studies, however most of these were carried out in Western countries with strong technological infrastructure, and involved young participants with technology-related professions, hence with extensive knowledge and skills related to the studies technology. The low diversity of the examined samples, and especially their restricted cultural diversity limit the applicability of the UTAUT. Current tendencies such as the increasing internationalization of education call for cross-cultural validation of ETA theories and models.

Against this background, the study at hand aims at extending the validity of the UTAUT across cultures. Accordingly, acceptance and cultural data from three different European countries—Germany, Romania and Turkey—is examined. Additionally to national cultures, professional cultures are examined by involving participants from the fields of science, technology, engineering and mathematics (STEM), as well as participants from non-STEM fields. Diversity in terms of sex, age, educational degree and life environment is also a requirement.

The paper at hand provides an overview and data reanalysis of a larger ETA study carried out during the past 5 years. Partial results are published in Göğüş et al. (2012) and Nistor et al. (2013). Only now, the collected data reaches the critical mass that allows performing statistical operations that give close insight in the effects of culture on ETA.

Educational technology acceptance

Technology acceptance models are based on the view of acceptance as an attitude towards technology. As stated by the theory of reasoned action and its expanded version, the theory of planned behavior (Ajzen and Fishbein 2000), human action is guided by behavioral, normative and control beliefs that lead to a behavioral intention, which further induces the use behavior. In the context of technology adoption, the reasoned action and planned behavior approach resulted in several theories, synthesized by Venkatesh et al. (2003) in their UTAUT that describes technology use under the influence of use intention, further determined by performance expectancy, effort expectancy, and social influence. Additionally, facilitating conditions directly determine technology usage. The influence of the predictors named above on behavioral intention and use behavior is moderated by users' age, sex, experience, and by the voluntariness of use. Nistor et al. (2013) increase the explanatory power of the UTAUT model by additionally considering the role of computer

anxiety and computer literacy for ETA (cf. Beaudry and Pinsonneault 2010; Conti-Ramsden et al. 2010).

An open issue relates to the effect of technology use intention on the actual use behavior. Bagozzi (2007) points out that intention and behavior are usually measured with the same methods, mostly self-report, therefore common methods variance can inflate the correlation (Podsakoff et al. 2012). In some cases, using objective methods, such as log files analysis, to measure technology use behavior may result in non-significant correlations (Nistor et al. 2012). The UTAUT suggests as a possible explanation that moderator variables such as experience with technology or voluntariness of use (Venkatesh et al. 2012) decrease the effect of use intention on use behavior. However, empirical evidence is insufficient to substantiate this assumption. A further limitation of the UTAUT lies in the low diversity of samples. Most participants appear to be young technology users from Western countries, with technological professions and displaying a high acceptance level. Additional validation is therefore necessary.

The cultural context of educational technology acceptance

There are numerous definitions of culture, in general (Triandis 1972), as well as of organizational culture (Schein 2004) and technological culture (Leidner and Kayworth 2006). Hofstede (2001) defines culture as patterns of thinking, feeling and potential acting, which have been learned throughout a lifetime, and which are likely to be used repeatedly and are unlikely (or difficult) to be changed by the individual. Cultural patterns are shared within a social environment such as nation, ethnicity or profession. Available cross-cultural ETA research literature (an overview is provided by Leidner and Kayworth 2006) deals with national cultures, identified and compared by the geographical location of the participants. In addition, this study examines also professional cultures, defined by participants' education and professional practice in a given domain.

Hofstede describes culture using five dimensions that were initially identified in a worldwide study among IBM staff (Hofstede 2001):

Power distance index (PDI) represents the extent to which the less powerful members of a culture accept the unequal distribution of power within the same culture.

Uncertainty avoidance (UAI) deals with the intolerance for unstructured, i.e. novel, unknown, surprising or unusual situations that the members of a society show.

Individualism (IDV) (vs. collectivism) refers to the quality of ties between individuals, and to the degree of integration into cohesive groups within society.

Masculinity (MAS) (vs. femininity) is a preference for assertiveness, achievement and material success; contrasted with femininity, which emphasizes relationships, modesty and caring.

Long-term orientation (LTO) (vs. short-term orientation) comprises values such as thrift and perseverance, as opposed to respect for tradition, the fulfillment of social obligations and face-saving, which are representative of short-term orientation.

Hofstede and McCrae (2004) demonstrate that these dimensions of culture are linked to individual personality traits, thus connecting the individual with the social level. On this ground, in their discussion of cultural influences on ETA, Venkatesh and Zhang (2010) regard cultural MAS/feminity as the sum of gender-specific individual behaviors. Similarly, in this paper UAI at cultural level is regarded as aggregated individual uncertainty avoidant behavior, which is further a result of perceived risk (Im et al. 2008). Some researchers (e.g., Grenness 2012) regard the linkage between individual and social level of analysis as a conceptual and methodological issue, which includes as a consequence the

restricted use of statistic tools (Nistor et al. 2013). Nevertheless, such connections appear desirable for future research (Peterson 2007).

In general, Hofstede's theory of culture has been criticized with respect to several aspects. His position is regarded as deterministic and western functionalist. He defines national culture as a homogeneous and static entity. He disregards the mixing, co-constructing and adapting of cultures. He oversimplifies premises and overgeneralizes results (see overview in Livian 2011). Adepts of Hofstede's theory call for future research to clarify the interdependencies between individuals and national cultures, find complementary alternatives to cultural values research, develop qualitative approaches, reconsider cultural boundaries, model intercultural dynamics (Peterson 2007). In spite of conceptual and methodological difficulties, Hofstede's approach has generated interest, as attested by a large number of related studies in the fields of economy and management (e.g. Brodbeck and Frese 2006), psychology (e.g., Fischer et al. 2010), or technology-enhanced learning (e.g., Cronjé 2011). Besides the number of published studies that are based on Hofstede's model, the main argument for applying it is the consistent pattern of findings that, as Ess and Sudweeks (2006) underline, successfully map important cultural differences. Complexity reduction, as operated by Hofstede, appears comparable with the simplifications inherent to technology acceptance models (Bagozzi 2007). Both culture and ETA are complex phenomena reduced to a small number of dimensions, which may impose limitations, but also reveal aspects worth exploring. For these reasons, we regard Hofstede's culture dimensions as appropriate for the aims of the research reported here.

National culture and educational technology in Europe

In spite of sustained efforts of political, administrative and economic unification, European countries display large differences in terms of technological and educational infrastructure, as well as in terms of culture. These differences are well illustrated by the three countries chosen for this study. Germany lies in west-central Europe, Romania in Southeastern Europe, and Turkey partially in Southeastern Europe, partially in Western Asia. The majority languages are Germanic, Romance and, respectively Turkic. Majority religions are catholic and protestant in Germany, orthodox in Romania, and Muslim in Turkey. While all three countries have democratic political systems, Germany and Turkey have longer democratic tradition, whereas Romania moved from communism to Western democracy in the early 1990s. Romanian economy is still being reformed and reconstructed, Turkish economy is further developed, while German economy can be regarded as highly developed. The level of development is, however, regionally different in each of the three countries. In Germany, there are economical and infrastructural differences between the Western and the former communist Eastern federal states. In Romania, the capital concentrates an important part of the economic resources, as well as in Turkey. Cultural differences are also present within Romania between Transylvania and the rest of the country, due to a different ethnic structure of the population. With respect to technology and its educational use, Germany displays high technology diffusion, while Turkey and Romania make efforts to intensify the use of educational technology. Distance education is a geographical necessity in large regions of Turkey; a regular, however relatively small part of higher education in Germany; and an experiment in Romania (Dittler et al. 2005; Özdemir and Kılıç 2007; Parola and Ranieri 2010).

Hofstede (2001) describes German culture as characterized by relatively low power distance, moderately high IDV, MAS and uncertainty avoidance, and relatively low long-time orientation; Romanian culture as extremely power distant, moderately to weakly

individualist and masculine, extremely uncertainty avoidant (LTO data is missing); Turkish culture in connection with a moderately high level of power-distance, a moderately low level of IDV, a moderate level of MAS, and a high level of UAI (LTO data is missing, too).

Professional culture and educational technology

Professional cultures are usually regarded in educational research as a typical context for acquiring and applying knowledge and skills. It seems to be unanimously accepted that professions in the domains of STEM fields promptly adopt top technologies, including educational applications, in a fashionable way (Wang 2010). Presumably, the fast technology diffusion is due to the fact that STEM professionals possess more related knowledge and skills. Venkatesh et al. (2003, 2012) regard technology-related experience as a moderator variable of the technology acceptance model. Accordingly, experience reduces users' dependence of facilitating conditions, thus reducing the influence of facilitating conditions on use behavior. Also, with increasing experience, technology use becomes routine, which is less dependent on individual use intention. Recently, Venkatesh et al. (2012) introduced the construct of habit in technology use, which has a positive effect both on use intention and on actual usage of technology. Technology-related experience and habit are certainly organic elements of professional culture, hence very likely to be associated with STEM professions, and to display all the effects stated by the UTAUT.

However, professional cultures are less studied from the perspective of Hofstede's (2001) cultural dimensions. Nistor et al. (2013) find cultural differences between STEM and non-STEM professionals from Germany and Romania in the dimensions PDI, IDV and UAI. These differences are not as strong as those between national cultures; nevertheless they reach statistical significance.

Towards the integration of culture in ETA models

A few recent studies apply Hofstede's view of culture values within the frame of the UTAUT, concluding that attitudes towards educational technology co-vary with the cultural dimensions as follows.

Performance and effort expectancy

Masculinity is expected to have a positive effect on performance expectancy, and a negative effect on effort expectancy (Venkatesh and Zhang 2010). Thus, members of masculine cultures should expect increased performance, members of feminine cultures reduced effort, from educational technologies.

Social influence

Individualism should diminish social influence and its effect on technology use intention (Venkatesh and Zhang 2010; Zakour 2007).

Computer anxiety

Uncertainty avoidance may be an anxiety-reducing strategy, as suggested by Beaudry and Pinsonneault (2010), and thus have a negative effect on computer anxiety in the sense that

members of uncertainty avoidant cultures may regard technology as control instruments that help avoiding unexpected situations.

Technology use intention and behavior

Uncertainty avoidance (Veltri and Elgarah 2009; Zakour 2007) or perceived risks (Im et al. 2008) may have negative effects on the intention to use technology. In this view, technology use is considered to be an uncertain situation, which contradicts the above cited assumption of technology as control instrument (Beaudry and Pinsonneault 2010).

However, these are assumptions and isolated research results. Moreover, power distance and LTO do not seem to be a research topic, yet. From methodological point of view, the cited studies fail to test measurement invariance across cultures, which may imply validity issues in the sense that the same questionnaire items may have different meanings and thus measure different constructs in different languages (He and van de Vijver 2012). Thus, an overall picture of the relationship of ETA and culture, integrating cultural dimensions in the UTAUT, is still missing.

Research aims

Against the background of the reviewed literature, this study aims at (1) validating the UTAUT instrument across national cultures in Germany, Romania and Turkey, and across professional cultures involving educational technology users with STEM versus non-STEM professions; (2) finding significant differences (a) in terms of acceptance, (b) in terms of national and professional culture between the examined user groups; (3) validating the UTAUT model across national and across cultures, and finally (4) finding correlations between ETA and culture.

The research is focused on technology use for learning and instruction. This includes self-directed and informal learning. The study is grounded using the UTAUT and two additional constructs. These two constructs are computer anxiety (Nistor et al. 2013) and computer literacy. The latter may prove relevant in environments with low technology diffusion and have a significant moderating effect on acceptance (Venkatesh et al. 2012). Thus extended, the model is addressed in the following as the UTAUT+.

Methodology

A correlation study was conducted, recording transversal data in a one-shot survey from various educational technology users. In order to increase the probability that the participants are familiar with learning in general and specifically with educational technology, we chose people with an academic degree (including faculty and teachers, from universities, schools and adult education centers) and university students. The sample was chosen randomly within a range aimed at overcoming the limits of the previous studies, i.e. sample size and sample diversity in terms of age, profession and acceptance level. First analyses of the German and Romanian sub-samples were published in Nistor et al. (2013), and of the Turkish sub-sample in Göğüş et al. (2012).

The total sample ($N = 4,589$) included $n = 1,849$ German, $n = 1,017$ Romanian, and $n = 1,723$ Turkish educational technology users. Concerning participants' educational status, the survey participants were $n = 1,079$ undergraduate students (working at the same

time like all participants), $n = 2{,}408$ had a university diploma, and $n = 701$ had a master, a doctoral degree or higher. The participants had professions either in STEM fields (i.e. science, technology, engineering, and mathematics; $n = 1{,}569$) or in non-STEM fields ($n = 3{,}019$). The sample provided further diversity in terms of sex (2,646 female and 1,942 male participants) and age (2,367 participants were under 30 years old, 1,697 were between 30 and 50, and 525 were over 50). An overview of the sample structure is provided in Table 1.

The independent variables performance expectancy, effort expectancy, social influence, facilitating conditions, computer anxiety and computer literacy were measured, as well as the dependent variables use intention and use behavior. Additionally, the demographic variables age, sex, geographic location and profession were registered. The research instrument consisted of the questionnaire proposed by Venkatesh et al. (2003, 2012) in German, Romanian and Turkish version, with variable values ranging from $1 =$ very low to $5 =$ very high acceptance. Aimed at surveying general attitudes and intentions towards technology, the questions were framed about "the computer as a learning tool", with specific references to office software, information search on the Internet, communication and interactions between Internet users (e.g. e-mail, discussion forums, chat, etc.), and e-learning. Computer literacy was self-assessed based on the statement "I know what the following are and how they work", related on the technologies mentioned above. Separate

Table 1 Sample description (one Romanian participant provided no demographic data)

| | Geographic location | | | |
	Germany	Romania	Turkey	Total
Sex				
Female	1,152	666	828	2,646
Male	697	350	895	1,942
Age				
Under 30	1,427	403	537	2,367
30–50	258	434	1,005	1,697
Over 50	164	180	182	525
Profession				
STEM	469	398	702	1,569
Non-STEM	1,380	618	1,021	3,019
Educational status				
Undergraduate	969	46	64	1,079
Graduate	671	529	1,208	2,408
Master, doctorate and higher	209	41	451	701
Life environment				
Village	132	280	13	425
Town (≤100,000 inhabitants)	714	190	143	1,047
City (>100,000 inhabitants)	1,003	547	1,567	3,117
Survey medium				
Online	1,837	286	768	2,891
Pen and paper	12	731	955	1,698
Total	1,849	1,017	1,723	4,589

instrument validation in German, Romanian and Turkish language is provided in Göğüş et al. (2012) and Nistor et al. (2013) along with the corresponding questionnaires. The participants' cultural values were measured using a German, Romanian and Turkish version of Values Survey Model VSM94 provided by Hofstede (2012).

Data was collected calling for voluntary participation, partially online ($n = 2{,}891$) and partially using pen-and-paper forms ($n = 1{,}698$). Data analysis was performed using IBM SPSS Statistics version 19, R version 2.15.1, and R package with plspm version 0.2-2 and Lavaan version 0.4-14. Since Hofstede's (2001) cultural dimensions are defined on group level, the usual statistical tests such as t test or ANOVA, which are defined on individual level, may not be applied. In order to make more reliable statements on cultural dimensions, i.e. to be able to specify the statistical significance of the results, the Welch t test was adapted based on Carmer's decomposition theorem and a correction factor depending on the sample size (Lerche and Kiel 2013). This test is addressed in the following as 'Welch-Lerche test'.

Results

Instrument validation

Besides the assessment of convergent and discriminant validity, and reliability provided in Göğüş et al. (2012), the measurement equivalence across cultural subgroups was assessed by multi-group confirmatory factor analysis, testing five models with different levels of invariance (He and van de Vijver 2012). As recommended by MacCallum et al. (1996), the root mean square error of approximation (RMSEA) was regarded as most relevant model accuracy indicator. RMSEA avoids issues of sample size by analyzing the discrepancy between the hypothesized model and the population covariance matrix. While RMSEA ranges from 0 to 1, with smaller values indicating better model fit, Hu and Bentler (1999) recommend a cut-off value close to 0.06. As shown in Table 2, the UTAUT+ instrument reached strong invariance across national cultures (model 3), and respectively strict invariance with equal factor loadings, intercepts, residuals and means (model 5) across professional cultures. Thus, the measurement equivalence was considered adequate, meaning that the same constructs were measured in the same way in all three questionnaire languages. This further enabled the comparison of subgroup models' path coefficients in the further statistical data processing.

Differences in technology acceptance

The measured acceptance variables were analyzed for the entire sample, as well as specifically for countries, geographical regions, and professional groups (Table 3). In general, participants report high and very high performance and effort expectancy, facilitating conditions, computer literacy; moderate social influence; low to moderate computer anxiety; moderate to high intention to use educational technology; and very high actual use. As a remarkable pattern of findings, while German and Romanian participants report high performance expectancy and low effort expectancy, participants from Turkey report both high performance expectancy and high effort expectancy.

According to one-way ANOVA with LSD post hoc all differences between countries and regions are statistically significant ($p < 0.000$). While in general the expectancies of increased performance are higher than those of decreased effort, the collected data show

Table 2 Measurement invariance of the UTAUT+ instrument across national and professional cultures

Tested models	Assumed degree of measurement invariance	Invariance across national cultures RMSEA	Invariance across professional cultures RMSEA
Model 1: configural invariance	Same factor structure imposed on all groups	0.047	0.046
Model 2: weak invariance	Equal factor loadings	0.053	0.045
Model 3: strong invariance	Equal factor loadings and intercepts	0.067	0.045
Model 4: strict invariance	Equal factor loadings, intercepts and residuals	0.087	0.046
Model 5: strict invariance	Equal factor loadings, intercepts, residuals and means	0.130	0.047

that German participants are moderate in this respect. Further, German users perceive the lowest social influence and the highest facilitating conditions; they report the lowest computer anxiety and the highest computer literacy, further moderate use intention and the highest technology use behavior. Romanian users are also moderate in their expectancies, on the other hand they perceive the strongest social influence and the lowest facilitating conditions. They report moderate computer anxiety, the lowest computer literacy, the highest technology use intention and the lowest actual use behavior. Finally, Turkish educational technology users have at the same time the highest performance and effort expectancies; they report moderate social influence, facilitating conditions and computer anxiety; also, they report the lowest technology use intention, and moderate use behavior.

The differences in acceptance variables between STEM and non-STEM professions are all significant ($p < 0.000$) excepting participants' technology use intention (n.s.). Participants with STEM professions have both higher performance and higher effort expectancy, they report higher social influence, facilitating conditions and computer anxiety, furthermore lower computer literacy than participants with non-STEM professions. Their technology use intention is lower, their actual use behavior is higher than those of the non-STEM participants.

Differences in culture

Hofstede's profiles were calculated for the national and professional cultures included in the sample (Table 4). The German culture appears to be moderately power-distant, highly individualistic, feminine and uncertainty avoidant, and moderately long-time oriented. The Romanian culture is characterized by lower power distance and IDV, higher MAS, less uncertainty avoidant, and similarly moderate long-time oriented. The Turkish culture displayed the lowest power distance index, relatively high IDV and feminity, moderate UAI and LTO. STEM professional culture scored lower in power distance, IDV, and uncertainty avoidance, higher in MAS, and slightly higher in long-time orientation.

The statistical significance of the cultural differences was tested applying the Welch-Lerche test, according to which all cultural differences both between countries and between professions are significant ($p < 0.000$). There are also significant differences between regions of a country. Between Eastern and Southern Germany, there are

Table 3 Values of the UTAUT+ variables for the entire sample and for the cultural subgroups

	PE		EE		SI		FC		CA		CL		UI		UB	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Entire sample	4.34	0.76	2.76	1.34	3.30	1.09	4.12	0.88	2.64	1.42	4.41	1.08	3.74	1.23	4.57	0.66
Germany	4.22	0.85	1.98	0.91	2.92	1.10	4.19	0.92	1.67	0.90	4.82	0.48	3.73	1.34	4.76	0.41
Eastern Germany	4.31	0.76	1.94	0.86	2.99	1.06	4.20	0.87	1.74	0.89	4.83	0.45	3.83	1.24	4.79	0.38
Southern Germany	4.11	0.93	2.03	0.96	2.84	1.14	4.17	0.98	1.58	0.90	4.81	0.51	3.61	1.43	4.74	0.44
Romania	4.38	0.65	1.78	0.63	3.75	0.90	4.04	0.81	2.18	1.03	3.40	1.65	4.06	0.90	4.30	0.85
Moldavia	4.46	0.62	1.70	0.62	3.77	0.93	4.15	0.72	2.09	0.96	4.66	0.48	4.15	0.89	4.40	0.73
Transylvania	4.26	0.65	1.89	0.60	3.70	0.87	3.89	0.83	2.30	1.04	1.48	0.59	3.94	0.90	4.19	0.93
Walachia	4.43	0.68	1.77	0.69	3.80	0.92	4.14	0.91	2.15	1.15	4.60	0.68	4.13	0.93	4.31	0.95
Turkey	4.44	0.69	4.16	0.70	3.44	1.05	4.10	0.86	3.96	1.01	4.56	0.66	3.56	1.24	4.51	0.68
Istanbul	4.49	0.69	4.17	0.71	3.44	1.07	4.21	0.79	4.02	1.00	4.62	0.66	3.56	1.26	4.57	0.67
Turkey, outside Istanbul	4.38	0.69	4.15	0.70	3.43	1.03	3.95	0.93	3.88	1.02	4.48	0.66	3.57	1.21	4.43	0.67
STEM professions	4.40	0.71	2.87	1.39	3.44	1.04	4.25	0.83	2.75	1.50	4.33	1.21	3.76	1.20	4.61	0.64
Non-STEM professions	4.30	0.78	2.69	1.31	3.22	1.11	4.06	0.89	2.58	1.37	4.45	0.99	3.73	1.24	4.55	0.66

Table 4 Hofstede's cultural dimensions scores in Germany, Romania, Turkey and regions of them

	PDI	IDV	MAS	UAI	LTO
Germany	36.1	92.1	−29.9	77.0	45.6
Eastern Germany	38.8	92.7	−27.2	83.6	46.5
Southern Germany	33.1	91.6	−32.8	69.8	44.6
Romania	20.8	67.3	38.6	65.2	53.7
Moldavia	24.7	65.7	40.2	61.4	53.3
Transylvania	12.6	66.5	34.4	68.9	53.9
Walachia	30.7	74.2	44.7	66.7	54.6
Turkey	9.6	76.4	3.4	43.7	42.5
Istanbul region	11.7	79.0	3.9	46.0	42.1
Turkey, outside Istanbul	6.9	73.3	2.8	40.9	42.9
STEM	17.7	77.7	6.8	55.5	46.9
Non-STEM	25.4	82.4	−7.0	65.1	45.9

significant differences in PDI ($p < 0.01$), UAI ($p < 0.000$), LTO ($p < 0.05$). Within Romania, Moldavia significantly differs from Transylvania in terms of PDI ($p < 0.000$) and UAI ($p < 0.05$); Moldavia significantly differs from Wallachia in terms of IDV ($p < 0.01$); Transylvania differs from Wallachia in terms of PDI ($p < 0.000$) and IDV ($p < 0.05$). In Turkey, the Istanbul area significantly differs from other regions in terms of PDI ($p < 0.05$), IDV ($p < 0.01$) and UAI ($p < 0.05$).

UTAUT+ validation across cultural subgroups

The UTAUT+ model was first tested for the entire sample. The model complexity required path analysis, i.e. either partial least squares (PLS) or structural equations modeling (SEM) with latent variables. Given that the tested model includes a construct (computer literacy) that has not been previously measured in this form, the method of PLS is appropriate (Bentler and Weeks 1980; Bollen 1989). The model goodness of fit is adequate (CFI = 0.977, Tucker–Lewis index TLI = 0.971, RMSEA = 0.048). The resulting path coefficients are shown in Fig. 1. The tested model explains $R^2 = 0.24$ of the variance in technology use intention, and $R^2 = 0.27$ of the variance in actual technology use behavior. The strongest predictor of educational technology use intention is participants' performance expectancy. The strongest predictors of the actual use behavior are perceived facilitating conditions and computer literacy. The effect of use intention on the corresponding behavior is extremely weak.

Further, the procedure was repeated testing the UTAUT+ for the three involved national cultures, and the two professional cultures. Path coefficients were subsequently compared. In the comparison between national cultures (Fig. 2), for German users performance expectancy has the largest influence, for Romanian users effort expectancy has the largest influence on use intention. Social influence is similar in all three cultures. Among the predictors of use behavior, facilitating conditions and computer anxiety are particularly important for Romanian users, whereas computer literacy has the strongest impact for Turkish users. In all three cases, the influence of use intention on use behavior is very weak.

Comparing STEM and non-STEM cultures (Fig. 3), it appears that performance expectancy is the strongest intention predictor for non-STEM, and effort expectancy for STEM. Social
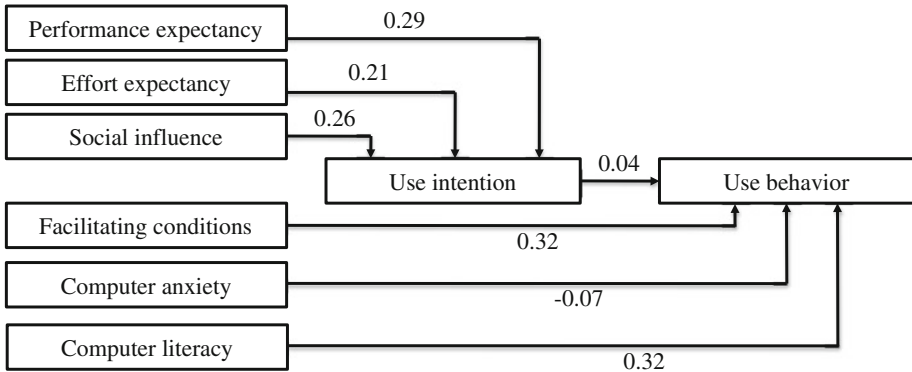
Fig. 1 The UTAUT+ model with path coefficients for the entire sample
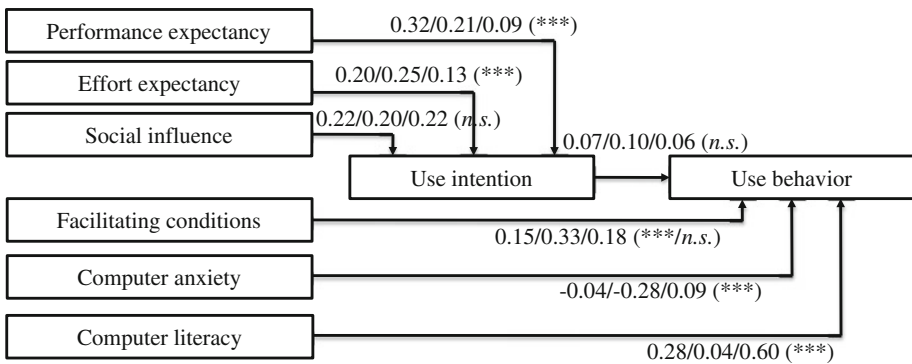
Fig. 2 The UTAUT+ model with path coefficients for different national cultures (Germany/Romania/Turkey); significance of group comparisons: ***$p < 0.000$
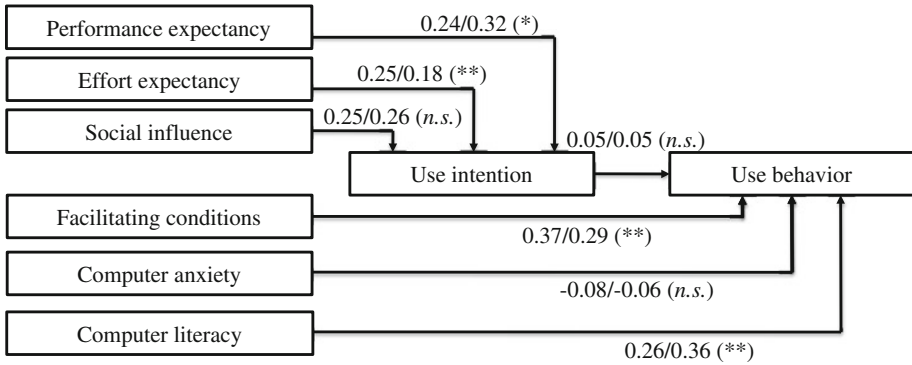
influence has the same impact on use intention. Facilitating conditions are in both professional cultures the strongest predictor of technology use behavior, however this is stronger in the STEM culture. In the non-STEM culture, computer literacy has a stronger influence on use behavior. In both cultures, the influence of intention on behavior is very weak.

The correlation between educational technology acceptance and culture

To examine the correlations between acceptance and culture, the sample was regionally divided, so that $N = 9$ cases of different cultures were obtained. Seven of these were regions of Germany, Romania and Turkey, further two were the STEM and non-STEM cultures. Bivariate correlations (Kendall's τ-b, two-tailed) between the mean values of the acceptance variables and the cultural dimensions of the groups were calculated (Table 5).

Predictors of technology use intention

The hypothesized positive correlation between MAS and performance expectancy was found ($τ = 0.44$), however it is only marginally significant ($p < 0.09$). The correlation

Performance expectancy — 0.24/0.32 (*)

Effort expectancy — 0.25/0.18 (**)

Social influence — 0.25/0.26 (n.s.)

0.05/0.05 (n.s.)

Use intention   Use behavior

Facilitating conditions — 0.37/0.29 (**)

Computer anxiety — -0.08/-0.06 (n.s.)

Computer literacy — 0.26/0.36 (**)

Fig. 3 The UTAUT+ model with path coefficients for different professional cultures (STEM/non-STEM); significance of group comparisons: $**p < 0.01$, $*p < 0.05$

Table 5 Correlations (Kendall τ-b, two-tailed, $N = 9$) between cultural dimensions and acceptance variables

	PDI		IDV		MAS		UAI		LTO	
	τ	p	τ	p	τ	p	τ	p	τ	p
PE	−0.22	0.40	−0.22	0.40	**0.44^t**	**0.09**	−0.44^t	0.09	0.06	0.83
EE	−0.39	0.14	0.17	0.53	**−0.28**	**0.30**	−0.39	0.14	−.67*	0.01
SI	−0.17	0.53	**−0.61***	**0.02**	0.94**	0.00	−0.17	0.53	0.44^t	0.09
FC	0.22	0.40	0.33	0.21	−0.11	0.68	0.00	0.99	−0.17	0.53
CA	−0.67*	0.01	−0.11	0.68	0.11	0.68	**−0.67***	**0.01**	−0.28	0.30
CL	0.50^t	0.06	0.39	0.14	−0.28	0.30	0.28	0.30	−0.22	0.40
UI	0.22	0.40	−0.33	0.21	0.44	0.09^t	**0.22**	**0.40**	0.83**	0.00
UB	0.33	0.21	0.67*	0.01	−0.56*	0.04	0.11	0.68	−0.39	0.14

$**\ p < 0.01$, $*\ p < 0.05$, $^t\ p < 0.10$; hypothesized correlation *bold*

between MAS and effort expectancy is negative as hypothesized, however non-significant. In addition to the expected relationships, a strong negative correlation was found between effort expectancy and LTO ($\tau = -0.67$, $p < 0.01$). Further there is a strong, negative and significant correlation ($\tau = -0.61$, $p < 0.05$) between IDV and social influence. There is also a very strong positive correlation between MAS and social influence ($\tau = 0.94$, $p < 0.01$). The hypothesis of a negative correlation between UAI and technology use intention is not supported. On the other hand, use intention is strongly and positively correlated with LTO ($\tau = 0.83$, $p < 0.00$).

Predictors of technology use behavior

As expected, computer anxiety is strongly and significantly correlated with UAI ($\tau = -0.67$, $p < 0.05$), furthermore with PDI ($\tau = -0.67$, $p < 0.05$). Technology use behavior is positively correlated with IDV ($\tau = 0.67$, $p < 0.05$) and negatively with MAS ($\tau = -0.56$, $p < 0.05$).

Discussion

UTAUT validation

Probably as the first piece of ETA research that examines cross-cultural measurement equivalence, this study validates the UTAUT+ along with the corresponding measurement instrument in three, very different European cultures and languages. Germany displays a high degree of technology diffusion, therefore it appears representative for the majority of the previous acceptance studies, while Romania and Turkey are new and less studied cultural research settings. In this sense, the study extends the applicability of ETA as conceptualized by Venkatesh et al. (2003, 2012). Another extension of the original UTAUT is done by including computer anxiety and computer literacy as additional predictors. Although computer anxiety has only a very weak influence on use behavior, it is nevertheless an organic model component with a clear meaning and relatively strong cultural differences (Beaudry and Pinsonneault 2010).

Technology use intention and behavior

Unlike previous research (e.g. Pynoo et al. 2012), nevertheless as anticipated by Bagozzi (2007), in this study there is a very weak link between technology use intention and actual use behavior. This may be due to high values of computer literacy, and to the fact that the educational use of computers has become habit—in the sense that habits are difficult to change, i.e. habitual behavior may be kept for a long time, even in spite of changes in attitudes and intentions (Venkatesh et al. 2012). Even if there are no explicit constraints to this usage, the diffusion of computers in education is so high that there is practically no alternative, so that computers are used for learning, no matter what users' intentions are. This may be an equivalent of forced use, thus increasing technology anxiety and decreasing technology trust, satisfaction and further use intentions (Liu 2012). All these explanations presume, however, that technology adoption is a rationale decision as conceptualized by Ajzen and Fishbein (2000). Alternatively, the educational use of computers might be regarded as the result of educational policy rather than of individual attitudes and preferences, or simply as fashion (Wang 2010). The implications of such influences for education are hardly known. Focused long-term research is recommended.

Culture and technology acceptance

As the certainly first piece of ETA research, this study tests correlations between ETA and culture, finding significant relationships, most of them in line with previous literature (Hofstede and McCrae 2004; Im et al. 2008; Nistor et al. 2013; Veltri and Elgarah 2009; Venkatesh and Zhang 2010; Zakour 2007). Given the theoretical assumption that ETA is influenced by culture, these correlations can be regarded as expressing causal relationships. In this sense, performance expectancy is likely to be positively influenced by cultural MAS (Venkatesh and Zhang 2010), and effort expectancy negatively by long-time orientation. This means that members of masculine cultures will primarily expect educational technology to enhance their learning performance, while the members of short-term oriented cultures will tend to expect effort minimization. Social influence will be weaker in individualistic cultures and stronger in masculine cultures. Moreover, technology use intention seems to be also directly and positively influenced by long-time orientation.
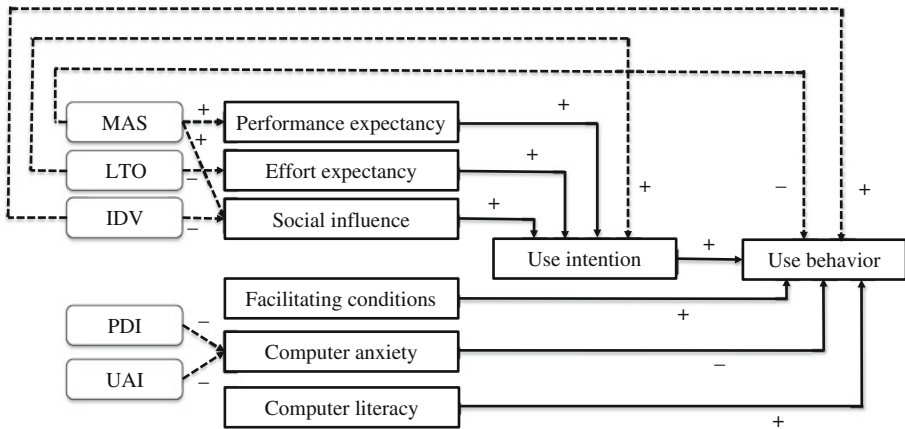
Fig. 4 The UTAUT+ model with culture variables

As for technology use behavior, this acceptance indicator lies under indirect positive influence of UAI and power distance via computer anxiety, which supports the assumption of UAI as an anxiety reduction strategy (Beaudry and Pinsonneault 2010). Further, technology use behavior apparently lies under the direct positive influence of IDV and direct negative influence of MAS. Hence, members of uncertainty avoidant and power distant cultures will tend to use less educational technology whereas members of individualist and feminine cultures will tend to use more educational technology. These relationships are represented in Fig. 4.

Conclusions

The use of educational technology requires taking into consideration the individual differences in ETA, especially when members of different—national and professional—cultures are involved. Different learners may have different expectations with respect to the design and outcome of computer-enhanced learning environments, and need different support. German participants' technology use intention appears to be mainly influenced by performance expectancy, while their use behavior is bound to their computer literacy. Romanian users' intention is equally impacted by performance and effort expectancy, and by social influence, while their use behavior is primarily a result of facilitating conditions and computer anxiety. For Turkish participants, social influence appears important for their use intention, while their use behavior is mainly driven by their computer literacy. Further on, in the STEM culture presenting educational technology as a possibility to reduce effort is likely to stimulate use intention, and offering appropriate facilitating conditions is the best way to support technology use behavior. In the non-STEM culture, emphasizing the potential of educational technology to increase professional performance is most likely to induce use intention, and fostering computer literacy appears as the best way to support technology use behavior.

Educational technology designers should provide means for the users to communicate their expectations and needs, as well as possibilities to fulfill them. Individual learners' characteristics, from which acceptance profiles are most important, should be considered in association with design elements of learning environments. Relying on the paradigm of mass-customization (Beaudry and Pinsonneault 2010), technology-enhanced learning environments may be designed for specific groups of users defined by national and professional culture.

While this study, corroborated by former studies, provides robust evidence for the UTAUT and its associated measure instrument's validity across cultures, the findings still have some limitations. One of them is due to the subjective character of the data, hence future research should also include objective data gained by methods such as observation or artifact analysis. Further validation of ETA instruments should include consequential validity (Messick 1989), observing changes in cultural values due to technology diffusion and acceptance assessment, and thus the reciprocal influences between technology and culture. The comparative study of ETA across cultures should be continued in order to provide deeper insight in the complex relationship between ETA and culture.

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