Chapter #8

TOWARD WIDER EXPLANATIONS OF TECHNOLOGY ADOPTION
The Case of Secondary Education Teachers in Bucharest, Romania

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ABSTRACT
The dominant theoretical model in the field of technology adoption by individuals, TAM, has come under recent criticism for having had an oversimplifying effect on research.
This paper aims to widen the universe of possible explanations of *ICT use* and *intentions* of use, by simultaneously testing for a large number of variables advanced by the main theories in the field. The study is based on a survey of 845 secondary education teachers primarily from Bucharest, Romania.
Our regression analysis (OLS) results show that: 1) a high percentage (60%) of variance is explained; 2) the results of the *use* and *intentions* models are quite different; main relevant direct explanatory variables for use express capability, opportunity and social influence: *ICT access*, *ICT skills*, and *observability*; while the main explanatory variables for intentions are *computer enjoyment*, *compatibility*, *perceived usefulness*, *image* and *self-efficacy* denoting psychological motivations; 3) TAM variables, *perceived usefulness* and *perceived ease of use*, don't play a very important role (the former is significant in the model of intentions only, and the later not at all), suggesting that broader models of direct determinants of technology adoption need to be constructed.

Keywords: technology adoption, information and communications technology, secondary education, teachers, Romania.

1. INTRODUCTION

There are several theories which can be considered the main or most influential in the study of information technology adoption by individuals, whether in the area of education or others: Innovation Diffusion Theory (IDT), Theory of Reasoned Action (TRA), Technology Acceptance Model (TAM), Social Cognitive Theory (SCT), and Theory of Planned Behavior (TPB). Most research studies in the past 30 years have usually investigated models suggested by one of these theories, plus a few variables suggested by others. There have been very few studies that have developed comprehensive models positing most variables of the most important theories against one another in a unitary model. The field has come under criticism – primarily directed at TAM – for proposing rather limited and simplistic models (Benbasat, & Barki 2007; Bagozzi 2007). In particular, in the context of TAM, arguably most dominant theoretical model, much of literature has made rather limiting assumptions presupposing a low number of direct effects on the adoption of technology. As a result, questions remain about the significance, relevance and sufficiency of variables central to some theories when posited against variables advanced by competing theories.

This chapter proposes a widening of perspective by developing a broader theoretical model, including most variables proposed by the most influential theories, and applying it in an empirical study of technology use by secondary education teachers in Romania. In doing so, we are not only widening the theoretical perspective, but contributing with results about an understudied country.

Section 2 of this chapter presents, what we consider are the main theories in the field, also the theories which are the basis of our model development. In Section 3, we are developing our own comprehensive model of technology adoption, explaining the categories and classes of variables, and variables themselves, down to the level of items of measurement for each variable (on which our questionnaire was based). Section 4 discusses data and measurement issues including application of questionnaire and data validity and reliability issues. In section 5, we discuss data analysis and interpretation. Finally, section 6 presents our conclusions.

2. LITERATURE REVIEW

We discuss what we believe are the five most important theories of technology adoption. Due to limitations of chapter length, we present them very briefly, focusing only on their contributions regarding individual adoption of technology and variables advanced.

2.1. Innovation diffusion theory (IDT)

Innovation Diffusion Theory (IDT) (see Figure 1(a), below) proposes a large number of individual level determinants of technology adoption/use (Rogers, 1983). These are: 1) the (perceived) *relative advantage* of innovative technology over its alternative; 2) *compatibility* of technology with one's values, experiences and needs; 3) technology's *complexity*, in as much it might be easy or difficult to use and understand; 4) *trialability*, the degree to which an innovation can be tried temporarily; 5) *observability*, extent to which an innovation use is socially visible.

Later research has re-conceptualized and added to the individual level determinants of adoption. *Personal innovativeness* has been conceptualized as a personality trait (Flynn & Goldsmith, 1993). The class of variables called by Rogers, *types of innovation decision* (see Figure 1(a)), has been redesigned as a unidimensional construct: *voluntariness*, defined as the "the degree to which use of innovation is perceived as being voluntary, or of free will". Similarly, *image*, defined as the degree to which using an innovation increases social approval of an individual, has been included in the IDT as an explanatory variable of adoption (Moore & Benbasat 1991).

IDT variables have found empirical support in various studies of information technology adoption/ acceptance (e.g. Leonard-Barton & Deschamps, 1988; Gharavi, Love, & Cheng, 2004; Agarwal & Prasad, 1997; Agarwal & Prasad 1998; Agarwal and Prasad 1999).

2.2. Theory of reasoned action (TRA)

TRA is a general theory of human behavior developed by Fishbein and Ajzen (1975; Ajzen & Fishbein, 1980). TRA states that reasoned / voluntary *behavior* depends on *behavioral intention*. The *intention* depends on: *attitude toward behavior*, and *subjective norm* – an individual's perception of social pressure to perform (or not) the behavior. These are seen as broader constructs determined each by more specific relevant *beliefs and evaluations* and *normative beliefs* (see Figure 1(b), below).

Several studies have found at least some evidence for the significance and relevance of TRA's attitude(s) and subjective norm in understanding technology use (e.g. Davis, Bagozzi, &Warsaw, 1989; Moore & Benbasat, 1996; Karahanna, Straub, & Chervany, 1999; Mishra, Akman, &Mishra, 2014). TRA, however, is probably more relevant in the study of technology adoption as a predecessor of the Technology Acceptance Model, and Theory of Planned Behavior.

2.3. Social cognitive theory (SCT)

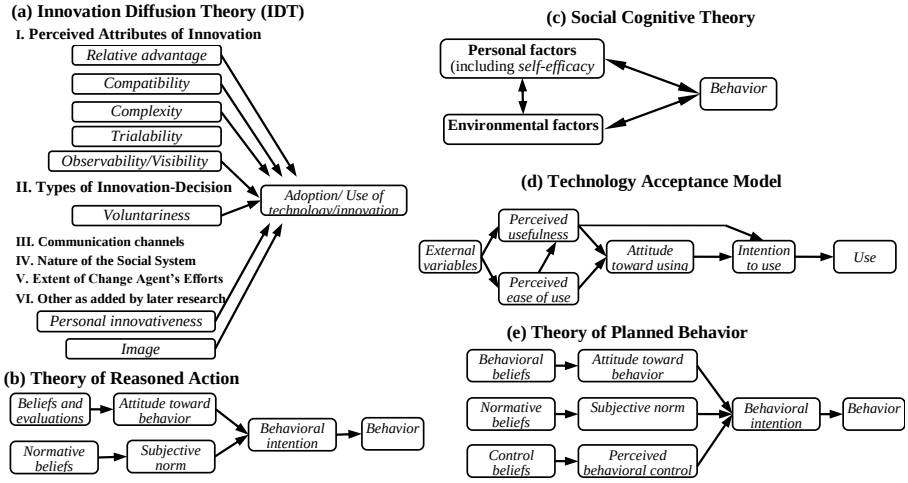
Developed by Albert Bandura (1982), the Social Cognitive Theory (SCT) (see Figure 1 (c), abaixo) main relevant contribution to technology adoption literature is the construct of *self-efficacy* defined as: "beliefs in one's capabilities to organize and execute courses of action required to manage prospective situations" (Bandura, 1997, p.2; Bandura, 1982). In addition, SCT emphasized the role of self-conscious emotions like *anxiety*. SCT and the *self-efficacy* variable were used quite extensively in empirical research of technology adoption in- or outside education. Many studies have found evidence for its significance and substantive relevance as a predictor of, either behavioral intention, or actual behavior (e.g. Hill, Smith, &Mann, 1987; Compeau, Higgins, &Huff, 1999; Igbaria & Ivari, 1995; Venkatesh & Davis, 1996; Holden & Rada, 2011).

2.4. Technology acceptance model (TAM)

Technology Acceptance Model (TAM) (see Figure 1(d), below) (Davis 1989; Davis, Bagozzi, Warshaw, 1989) builds on TRA by focusing exclusively on *attitudes* and ignoring *norms*. It assumes that information technology *use* (behavior) is determined by *intention* which at its turn is determined by a global *attitude* toward technology. Attitude is determined by two relevant specific attitudes: *perceived usefulness* of the technology to be used, and its *perceived ease of use*. All other variables are assumed as antecedents of these two variables.

Many studies have provided evidence for the predictive power of *use* and *intention of use* of technology in business (e.g. Szajna, 1994; Igbaria, Ivari, & Maragahh, 1995; Igbaria & Ivari, 1995) and in education (e.g. Yuen & Ma, 2002; Hu, Clark, & Ma, 2003; Teo, 2011), TAM having become the dominant theoretical model in the field. However, it has also come under criticism for: focusing on two explanatory variables and either failing to elucidate which are their antecedents (Benbasat & Barki, 2007); or failing to take into account alternative influences (Bagozzi, 2007).

Figure 1.
Main theories explaining technology adoption by individuals.



2.5. Theory of planned behavior (TPB)

The Theory of Planned Behavior (TPB) (Ajzen, 1985) (see Figure 1(e), acima), is an expansion of TRA. TPB adds the construct of *perceived behavioral control* (mainly based on *self-efficacy*) as a direct determinant of both behavioral *intention* and actual *behavior*. TPB found empirical support in a number of studies of technology adoption (e.g. Taylor & Todd, 1995; Koufaris, 2002).

3. TOWARD A COMPREHENSIVE MODEL OF TECHNOLOGY ADOPTION

We develop our model by constructing a typology of variables where categories and classes are distinguished based on theoretical causal mechanism and locus of measurement (for more details see Ogrezeanu, 2015). In constructing the classes of variables we build particularly on TPB. Once categories and classes of variables are developed we populate them with variables originating from the theories discussed but also from other research or our own additions.

At the highest level we distinguish between four *categories* of variables (all have been used explicitly or implicitly throughout the literature, but were never used systematically all four at once): 1) *attitudes/ beliefs* which can be related to the behavior, object of behavior or other relevant objects; 2) *psychological traits* – are somewhat stable psychological traits of individuals; 3) *social & sociotechnical context variables* are variables characterizing the social, institutional, technological context in which the individual acts; and lastly: 4) *bio-socio-economic-demographic-professional characteristics* of individuals.

Within the first category, following TPB we distinguish between three main types of (we term them all) *attitudes*: 1) behavioral attitudes, 2) normative attitudes/beliefs; 3) control attitudes/beliefs. However we depart from TPB in that we interpret them as *classes* of variables rather than single variables.[1]

In line with Vallerand and colleagues (Vallerand, 1997; Guay, Vallerand, & Blanchard, 2000), we consider that behavioral motivating attitudes are to be classified into: *extrinsic motivations* – i.e. aimed at outcomes of behavior, seeking beneficial outcomes and avoiding non-beneficial ones –, and *intrinsic motivations* – seeking pleasurable and avoiding unpleasable emotions during behavior performance. Within our model we consider among extrinsic motivations: *perceived usefulness* of technology (as defined by TAM) and *image* (as defined by IDT). Within intrinsic motivations, we consider *perceived ease of use* (TAM), *computer enjoyment* (Carroll & Thomas, 1988; Vallerand, 1997) , and *computer anxiety* (SCT; Igbaria, Pavri, & Huff , 1989; Compeau et al, , 1999). Within normative attitudes/motivations, we consider *compatibility* (IDT). Within control attitudes and beliefs, we include *computer self-efficacy* (from SCT and TPB) and *ICT skills*. With regard to the later, it is rather surprising that, while there is a broader literature and policy concern about the importance of *ICT skills* or *e-skills* for the knowledge economy (e.g. Allen & Velden, 2001; Statz 2001; European Commission 2010), few researchers have studied the effect of this variable within the technology adoption/acceptance literature (e.g. Leonard-Barton & Deschamps, 1988). Many studies have considered that the concept of skills is exhausted by *self-efficacy* (Igaria, Ivari, & Maragahh, 1995; Albion, 1999; Teo, 2009) or *computer experience* (Igbaria, Pavri, & Huff, Tabata & Johnsrud, 2008). We propose that this is a separate construct from *self-efficacy* and we introduce it as such in our study.

In addition to attitudes, we consider the category of *psychological traits*, be they *stable traits* also termed *personality traits* – where we include *personal innovativeness* (specifically *computer innovativeness*, as suggested by IDT), or semi-stable ones like *work satisfaction* (e.g. Mariani, Curcuruto, & Gaetani 2013).

Apart from the above classes, we propose a separate class of *sociotechnical (context) variables*. We include here: *technology access/availability, technical support availability* (both theoretically related to TPB and behavioral control but see Table 1 below for more exact references), *observability*, *voluntariness* (both from IDT). Broader social/institutional characteristics can be included such as: *school type*, *location type*, etc.

Finally, we consider the broad class of *individual bio-socio-economic-demographic-professional characteristics*. This includes *bio-demographics* such as *age* and *gender*. *Professional characteristics* including *teaching degree* (in Romania teachers advance, in order, from *"debutant"* to *tenured*, *degree II, degree I*), *teaching discipline* (our sample included the following classes: *mathematics, Information and Communication Technology* (ICT), *Romanian language and literature*, and *English language and literature*, *others*).

This typology, description of variables, their classes, categories, number of items, expected relationship with dependent variables, etc. are presented graphically in Figure 2. Further details about each variable's definition and items used in its measurement are given in Table 1, below.

[1] TPB was somewhat ambiguous in that it allowed for multiple variables in each class (e.g. various attitudes toward behavior, or subjective norms) but each was presumed to be antecedent to a single overarching attitude (e.g. attitude toward behavior, subjective norm (singular)) and all influence within each class were supposed to be mediated by that overarching variable. We pose that such presupposition is methodologically and substantively limiting, and whether such mediation occurs should be subject of empirical research rather than theoretical presupposition.

Figure 2.
Our comprehensive model of technology adoption.

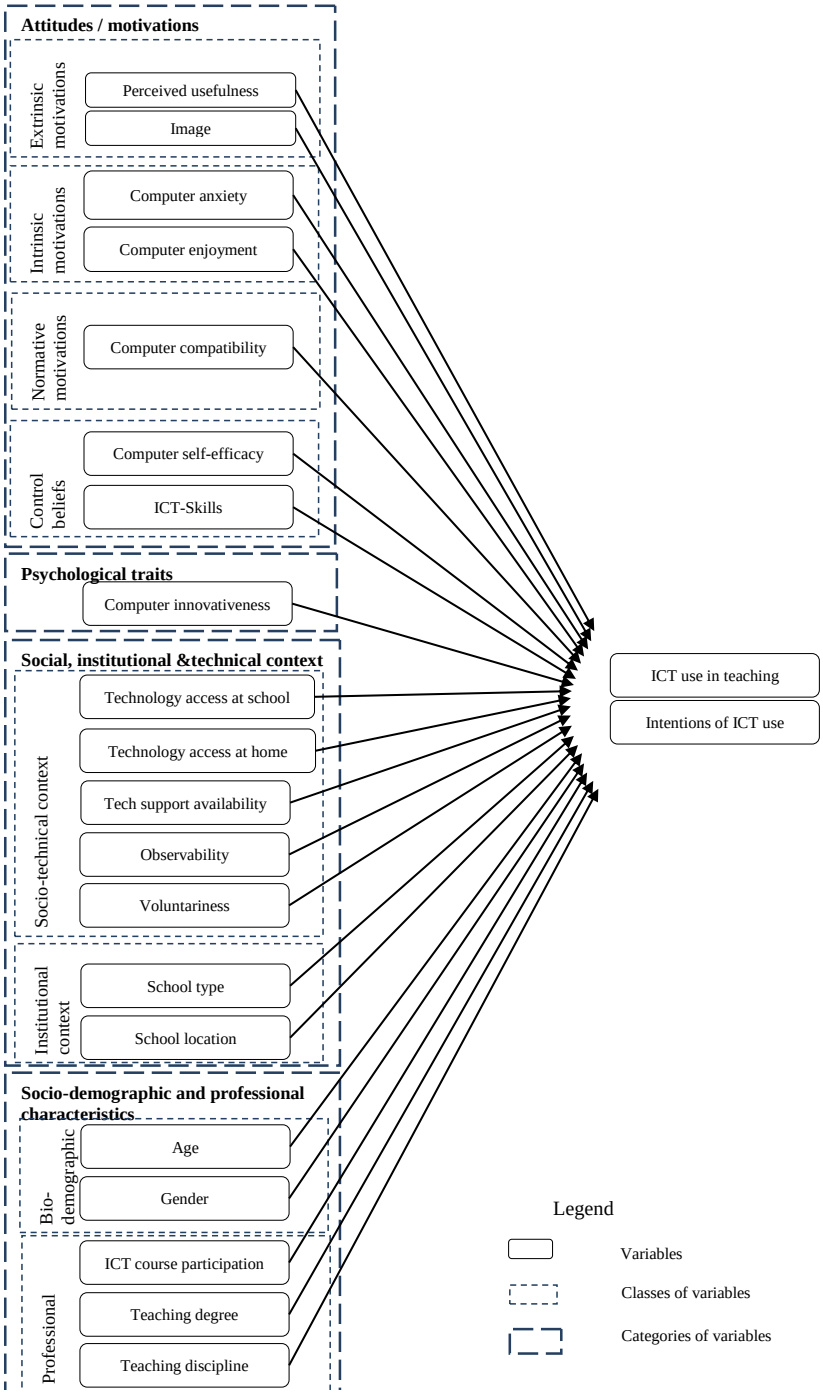


Table 1.
Description of model variables, classes, number of items and Cronbach's α.

Category	Class	Variable	Definition	Exp. relation	References	Items in questionnaire	Items No.	Cronbach α
Dependent variables	NA	*ICT use in teaching*	The extent to which teachers use a set of various ICTs in their teaching (computers, email, electronic documents, digital textbooks, video projectors, the Internet; elearning platforms)		Davis 1989; Davis et al. 1989.	Q15. On average how often do you?... 1. Use computers in relation to our activity. 2. Use email to communicate with pupils. 3. Use email to communicate with colleagues. 4. Print out teaching materials or tests. 5. Use computers in classrooms for teaching. 6. Use digital textbooks. 7. Use (other) digital materials. 8. Use video projectors in classes. 9. Ask pupils to use digital materials from the internet or sent by you for classes. 10. Use the Internet to prepare classes. 11. Use e-learning platforms (like AEL, Moodle, etc,) in classes.	11	.848
		Intention to use ICT in teaching	The extent to which a teachers intends to use ICTs in teaching in the future			Q22. How interested are you for the future to: (4 point scale) 1. To use ICTs in teaching activity. 2. To use digital textbooks in teaching activity. 3. To use auxiliary digital teaching materials. Q23. How probable do you think it is that in the next 5 years…? (5 point scale) 1. You would use ICTs in your teaching significantly more [than now]? 2. Use digital textbooks in your activity. 3. Use auxiliary digital materiasl in your teaching. Q24. How much do you want that in the future…? (5 point scale) 1. Use ICTs in your teacing activity significantly more. 2. Use digital textbooks in your teaching activity. 3. Use auxiliary digital materials in your teaching activity.	6	.934
Attitudes/ Motivations	Extrinsic motivations	*Perceived usefulness*	"the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis 1989)	+	Davis 1989; Davis et al. 1989.	Q17. To what extent do you agree with the following statements: (5 point scale) 4. Using computers and the Internet makes /would make my teaching easier. 5. Using computers or the Internet increase/would increase the quality of my teaching activity. 6. Computers, computer programs and the Internet are useful in my teaching activity.	3	.885
		Image	"the degree to which adoption/usage of the innovation is perceived to enhance one's image or status in one's social system" (Karahanna et. al 1999)	+	Agarwal and Prasad 1997; Karahana et al. 1999.	Q19. How about the following statements? To what extent do you agree with them? 1. Teachers who use ICTs in their teaching have a better reputation than those who don't. 2. Teachers who use ICT in teaching are better appreciated by colleagues. 3. Teachers who use ICTs in teaching are better appreciated by pupils.	3	.897
	Intrinsic motivations	*Perceived ease of use*	"the degree to which a person believes that using a particular system would be free of effort" (Davis 1989).	+	Davis 1989; Davis et al. 1989.	Q17. (see general question above) 7. I find computers and the Internet easy to use. 8. I find using the computers and computer software easy to learn. 9. It is easy to make computers, computer programs, and other electronic equipment do what I need them to do.	3	.857
		Computer anxiety	"the fear of apprehension felt by individuals when they used computers or when they consider the possibility of computer utilization" (Simonson et al. 1987).	-	Igbaria et al. 1989; Compeau & Higgins 2008; van Raaij and Schepers 2008	Q19. See general question above. 7. I feel an apprehension toward using ICTs in my work. 8. I am afraid to think wi could destroy documents I work on by pressing the wrong key. 9 I find computers quite intimidating.	3	.772
		Computer enjoyment	The extent to which individuals enjoy working with computers.	+	Teo 2007; Carroll and Thomas 1988; Davis at al. 1992	Q18. How about the following statements? To what extent do you agree with them (5 point scale) 4. Using computers and computer programs is/would be pleasant. 5. I feel well when I use computers and computer programs. 6. I anticipate with pleasure those aspects of my work which involve the use of computers and computer programs.	3	.914

	Normative beliefs/ motivations	*Computer compatibility*	The degree to which information technologies are perceived as consistent with a teacher's teaching discipline, methods and workstyle.	+	Rogers 1983; Moore and Benbasat 1991;	Q18, See general question above. 1. using ICTs is compatible with the discipline(s) I teach. 2. Using ICTs fits well with my workstyle. 3. Using ICTs fits well with my teaching methods.	3	.921
	Control beliefs / abilities	*Computer self-efficacy*	The beliefs in one's capacity to execute [work related] courses of action related to computers/technology.	+	Bandura 1982; Hill et al. 1987; Compeau and Higgins 1995	Q20. How about the following statements: To what extent do you agree with them? 7. I have the capacity to use various ICTs effectively in my work. 8. If I want to use ICTs in various aspects f my work I am confident that I can use them without problems. 9. If I want to certain results in my work by using ICTs, I am confident I can obtain them.	3	.902
		ICT Skills (or literacy)	The ability to use the computer, related hardware and computer software.	+	Simonson et al. 1987; Tondeur et al. 2008.	Q3. How would you assess your abilities to do the following activities related to computer use? (6 point scale) 1. I can work with files and documents (create, save, rename, delete, search) 2. I can use a text editor (like Word, Open Office Writer, etc.). 3. I can use a presentation program (like PowerPoint, Open Office Impress, etc); 4. I can use a spreadsheet program (e.g. Excel, Open Office Calc, etc.). 5. I can use/read non editable PDF documents. 6. I can use/read eBooks. Q4. Can you perform the following technical activities? 1. Installing a new computer. 2. Installing a new printer, scanner or other peripherals (video projector, webcam, external storage equipment, etc.) 3. Connecting a computer to a local netwok (wired or wireless); 4. Installing software applications. Q5. Can you…? 1. Use email. 2. Search on the Internet (using Google, Wikipedia, etc.). 3. Read blogs. 4. Write/post online, on a blog, Wikipedia, forums. 5. Use social networks (like Facebook, MySpace, etc.)\ 6. Download files .7. Make voice calls on the Internet (Skype, MSN, etc.)	16	.905
Psychological traits	Stable/ Personality traits	*Computer innovativeness*	The willingness and propensity of an individual to try out novel, possibly risky courses of action and technologies.	+	Flynn 1993; Agarwal and Prasad 1998.	Q17. See general question above. 1. I usually experiment with new approaching and ICT tools in my teaching. 2. I like to be among the first to use new ICTs. 3. I prefer to let others confront the difficulties of implementing new methods and techniques based on ICTs before I use them.	2	.884
	~~Semi-stable traits~~	~~*Work Satisfaction*~~	Reported satisfaction with work	+	Mariani, Curcuruto and Gaetani 2013.	Q20. See general question above. 4. I am generally happy with work conditions in my school. 5. I am generally satisfied with my work. 6. I am generally satisfied with my salary.	3	~~.510~~ **
Social and sociotechnical context	Socio-technical context	*Technology access at school*	The extent to which the individual perceives to have access to technology at work/school.	+	Becker 2000; Mathieson, Peakock and Chin 2001; Teo 2009	Q8. How available for work are the following technology types in your school? 1. \Computers in classrooms 2. Computers in computer labs. 3. Digital textbooks, 4. Auxiliary teaching materials and digital content. 5. Printers. 6. Video projectors 7. Internet connection in the classrooms. 8. Internet connection in computer labs. 9. Fax machines. 10. e-learning platforms	10	.789
		Technology access at home	The extent to which the individual perceives to have access to technology at home.	+		Q6. Which of the following equipment are found in your home?... 1. Personal desktop computers 2. Laptop computer 3. Tablet.	8	~~.564~~ , .845 **

						4. Printer. 5. Scanner. 6. Smartphone. 7. Landed Internet connection. 8. Mobile Internet connection.		
		Tech support availability	The extent to which a teacher perceives to have technical support available at school.	+	Becker 2000; Mathieson ; Teo 2009	Q11. Is there any person in your school specialized in and paid for offering support to teachers in using computer or other electronic equipment? Q12. From your experience, how available is this person. Q14. Are there colleagues, teachers who are good with computers, who you can ask for support in using computers and other equipment?	3	.863
		Observability	The degree to which ICTs are observable by teachers among relevant colleague teachers.	+	Rogers 1983; Agarwal and Prasad 1997.	Q19. See general question above. 4. In our school there are many teachers who use ICTs in their teaching. 5. Generally, in the teaching community in Romania I notice that teachers use ICTs often. 6. In my teaching discipline I often encounter teachers who use ICTs.	3	.801
		Voluntariness	The degree to which the use of ICTs is perceived as voluntary, of free will.	+	Moore and Benbasat 1991; Agarwal and Prasad 1997	Q20. See general question above. 1. The school leadership requires/encourages the use of ICTs by teachers. 2. School inspectorate in the county I work requires/encourages the use of ICTs by teachers. 3. The National Ministry of Education requires/encourages the use of ICTs by teachers.	3	.849
	Social/ institutional context	*School type (by education level)*	Refers to the education level (by ISCED classification), whether (in our sample) lower secondary education (ISCED 2) or upper secondary education (ISCED 3).	+	UNESCO & UNESCO Institute for Statistics 2012	Q32. Type of educational institution you work in (5 categories specific to Romanian educational system – recoded then into two ISCED categories)	1	NA*
		School location	Location as to whether within Bucharest or outside.	?		Q28. In which locality is the school you work in? (recoded as a dummy after)	1	NA*
Socio-demographic and professional characteristics	Bio-demographic characteristics	*Age*	Respondent's age	-	Dykk and Smitter 1994; Venkatesh et al 2003.Parasuraman and Igbaria 1994.	Q26. Year of birth	1	NA*
		Gender	Respondent self-reported gender	?		Q25. Gender/sex	1	NA*
	Professional characteristics	*ICT course participation*	Number of ICT courses to which responded participated in the past.	+		Q21. How many courses in ICTs and e-learning, of the following types, have you participated in?... 1. Courses financed by HRDSOP (a human resource development structural funds program) 2. University or post-university courses. 3. AEL courses (AEL a governmental program and e-learning platform? 4. Courses at the Teachers' Houses (county level institutions).	4	.529 **
		Teaching degree	In Romania, teachers advancement in career takes place on 4 levels from "debutant" (entry level) to "tenured", "degree II", and degree I.	?		Q30. What is your teaching degree?	1	NA*
		Teaching discipline	Our samples included teachers of the following disciplines: mathematics, Information and Communications Technology (ICT); Romanian language and literature; English language, Others	?		Q29. What disciplines are you teaching, in decreasing order of hours taught?	1	NA*

* not available due to measurement using one item only; ** see discussion in text, Section *4.*

4. DATA AND MEASUREMENT

Data for this study was collected by means of a questionnaire filled by participants to the "MAGISTER Educational Forum"[2], in Bucharest, on March 17-19, 2015. The theme of the questionnaire was the use of technology and various attitudes toward technology (many of which are discussed in this paper as determinants of technology use). Most questions of the questionnaire are presented in

Table 1, acima. Out of 1209 participants, 845 valid questionnaires were returned, for a response rate of 69.8%. Respondents were secondary education teachers aged between 24 and 70 (mean 43.3 years), predominantly female (92%), mostly from schools in Bucharest (82%). It should be noted that in focusing our empirical work on Romania we are adding to only a couple of contributions to the field studying this country (Nistor, Wagner, Istvanffy, & Dragotă, , 2010; Ogrezeanu & Ogrezeanu 2014).

Most variables were measured with multiple items/indicators, as displayed in

Table 1, acima. Cronbach's α test revealed high values, well over .7 (usually over .8 with some over .9), for most variables (see

Table 1, last column).). Three variables had lower α, at around .5. To deal with low reliability scores we followed Bollen and Lenox's distinction between *cause* and *effect* indicators, and their recommendations (Bollen, 1984; Boolen & Lenox, 1991). Where indicators were considered strictly as effects of the latent construct they are measuring, like *work satisfaction*, the internal consistency requirement was considered high. Failing to meet the .7 threshold meant that the variable was dropped out of the study. In the case of ICT access at home, indicators were considered at least partially causes of the latent construct and some items were considered alternatives to the realization of the same function, such as owning laptop and owning desktop computers. In this case, α was recalculated between a new indicator (sum of owning laptop and desktop) and the rest resulting in a high value .845, therefore the variable was kept in the analysis. Finally where all items were considered as alternative causes/constituents of the latent variable, like in the case *ICT course participation*, the requirement of high internal consistency (high α) was dropped and the variable kept as such in the study, despite it not meeting the .7 threshold.

The Campbell and Fiske (1959) test for discriminant validity was calculated for each pair of multi-item variables. Only in the case of one pair it revealed a value above .85 (namely .881, corresponding to r =.808) for *Computer enjoyment* and *Compatibility*. Since the two were deemed semantically quite different, and since the sample we used was quite large, we kept them in the analysis, making note to pay extra attention to possible multicollinearity in the analysis phase.

We identified 1.8% missing values which were imputed using the EM procedure in IBM SPSS.

In the case of *ICT course participation* a nonlinear transformation (square root) was operated to reflect decreasing marginal effects and compensate for positive skewness and high kurtosis.

[2]Event organized by *Niculescu Publishing House*, see Acknowledgements section..

5. DATA ANALYSIS AND INTERPRETATION

Data analysis was carried out using IBM SPSS 23 using Ordinary Least Squares (OLS) analysis. Results are presented in Table 2, abaixo. OLS was considered the method of choice due to the fact the dependent variables (intention and use) were operationalized as indexes of several items, this giving them a quasi-continuous character.

Our models for *intentions* and for *use* explain and very similar and large proportion of variance, close to 60%. This is an exceptionally high goodness of fit for individual level behavioral models in general and for technology adoption models in particular, especially in the context of a purely linear model with no interactions among variables. This indicates that the large number of variables may be a good approach to improving the explanatory power models.

One of the most striking aspects of our results is that the significant variables for *intentions* are quite different from those for *use*. In fact, usually variables significant in one model are insignificant in the other. The only exceptions are *ICT access* both *at school* and at work, but even in these cases the findings are heterogeneous. While these variables are highly significant and relevant in the *use* model, they have small influences in the *intentions* model (and surprisingly access at school has a negative direct effect on *intentions*, indicating a mechanism whereby low access indicate high desire/intentions for future more use and high access, low desire for additional use). Thus, *intentions of use* are mainly explained by "psychological" motivations: intrinsic motivations like *computer enjoyment*; normative motivations like *compatibility*; and extrinsic motivations like *perceived usefulness* and *image*. Actual *ICT use* is explained primarily by "capability", "opportunity" and social factors such as *ICT skills*, *ICT access* (both *at school* and *at school*) and *observability*. This finding is more surprising in the case of behavior than intentions, since in the former's case psychological motivating attitudes, the main direct determinants advanced by the various theories discussed, seem to "drop out of significance" in the case of explaining the *use* behavior.

Our findings also show that both behavior and intentions are more complex (than some models suggest – especially based on TAM – with at most 1, 2 or three other variables). Both models show a number of 10 direct determinants that are significant while also a large number (17-18) of variables are also rejected (as insignificant). This rejects TAM's assumption that there are only two direct determinants of intentions to use and behavior: *perceived usefulness* and *perceived ease of use*, and that all other variables are to be considered as their antecedents. Our analysis based on two comprehensive models suggests that there are plenty of other direct determinants of ICT use and behavior. In fact the two TAM predictors are not the most important. *Perceived ease of use* is insignificant (as direct determinant) in both models, while *perceived usefulness* is significant only in the model of intentions, having the 3rd most explanatory power in that model.

Table 2.
Regression analysis results.

		Dependent variable: ICT use in work (teaching)					Dependent variable: intention to use ICT in teaching				
		B	***SE***	***β***	***t***	***p***	***B***	***SE***	***β***	***t***	***p***
Constant		-0.068	0.230		-0.297	0.767	0.755	0.211		3.585	0.000
ICT use in teaching							0.047	0.032	0.051	1.456	0.146
Perceived usefulness		0.054	0.035	0.051	1.523	0.128	0.159	0.032	0.166	4.937	0.000
Image		0.004	0.020	0.005	0.208	0.835	0.082	0.018	0.116	4.593	0.000
Perceived ease of use		-0.034	0.034	-0.037	-0.983	0.326	-0.004	0.032	-0.005	-0.137	0.891
Computer anxiety		-0.010	0.023	-0.012	-0.458	0.647	-0.015	0.021	-0.019	-0.720	0.472
Computer enjoyment		-0.030	0.038	-0.034	-0.770	0.441	0.203	0.035	0.253	5.768	0.000
Computer compatibility		0.040	0.035	0.049	1.125	0.261	0.140	0.032	0.191	4.342	0.000
Computer self-efficacy		0.008	0.030	0.008	0.262	0.793	0.092	0.028	0.105	3.326	0.001
ICT Skills (or literacy)		0.194	0.026	0.266	7.390	0.000	0.014	0.025	0.021	0.572	0.568
Computer innovativeness		0.158	0.024	0.216	6.629	0.000	0.016	0.022	0.024	0.704	0.482
Technology access at school		0.539	0.047	0.295	11.449	0.000	-0.098	0.046	-0.059	-2.108	0.035
Technology access at home		0.065	0.011	0.139	5.751	0.000	0.026	0.010	0.063	2.529	0.012
Tech support availability		-0.024	0.018	-0.033	-1.379	0.168	-0.014	0.016	-0.020	-0.851	0.395
Observability		0.095	0.024	0.115	4.022	0.000	0.003	0.022	0.004	0.139	0.889
Voluntariness		-0.033	0.023	-0.039	-1.478	0.140	-0.028	0.021	-0.035	-1.337	0.182
School type:	*Lower secondary*										
	Upper secondary	0.120	0.035	0.082	3.395	0.001	0.010	0.033	0.007	0.307	0.759
	Other	0.264	0.098	0.061	2.699	0.007	-0.049	0.090	-0.012	-0.544	0.586
School location	*Bucharest*	-0.030	0.045	-0.016	-0.661	0.509	-0.035	0.041	-0.020	-0.851	0.395
	Other										
Age		-0.001	0.002	-0.018	-0.599	0.549	-0.005	0.002	-0.068	-2.214	0.027
Gender		-0.007	0.062	-0.002	-0.106	0.916	-0.022	0.057	-0.009	-0.391	0.696
√ICT course participation		0.025	0.019	0.032	1.335	0.182	0.043	0.017	0.060	2.465	0.014
Teaching degree	*Beginner*	-0.033	0.077	-0.012	-0.431	0.667	-0.075	0.071	-0.030	-1.064	0.287
	Tenured	-0.100	0.048	-0.057	-2.108	0.035	-0.014	0.044	-0.009	-0.322	0.748
	Degree II	-0.061	0.049	-0.031	-1.232	0.218	-0.018	0.045	-0.010	-0.394	0.694
	Degree I										
Teaching discipline	*Mathematics*	-0.199	0.042	-0.125	-4.689	0.000	0.056	0.039	0.038	1.423	0.155
	ICT	0.274	0.068	0.100	4.032	0.000	0.037	0.063	0.015	0.587	0.557
	Romanian										
	English	0.060	0.043	0.038	1.398	0.162	0.084	0.039	0.057	2.124	0.034
	Other	0.075	0.050	0.034	1.507	0.132	0.011	0.046	0.005	0.242	0.809
Overall model statistics	*N*			845					845		
	R^2			.612					.611		
	Adjusted R^2			.599					.598		

6. CONCLUSIONS AND DISCUSSION

Our analysis validates the need for and usefulness of comprehensive, inclusive models of technology adoption in education. Our models accounted for 60% of variation in the dependent variables *ICT use* and *intentions to use*. However, more importantly, in presenting significant results about the direct effects of some variables we have the added advantage of having controlled for other variables proposed by competing theories, thus lowering the risk of omitted variable bias.

We found that most relevant predictors of intentions are psychological, motivations such as *computer enjoyment, compatibility, perceived usefulness, image*, while actual *use* behavior is mainly a function of capability (*ICT skills*) opportunity (*ICT access at work/school* and *at home*) and social influence of peers (observability). The heterogeneity of findings concerning *intentions* versus actual *behavior* may indicate the need for further theoretical effort to provide separate explanations for the two. Finally, our findings suggest that the principal TAM variables are not the main direct predictors of *ICT use* and *intentions of use*, therefore we suggest that the research should renounce this assumption of TAM that the two mediate all other influences.

From the practical standpoint of education management and policy, there are several actionable conclusions we can draw. The use of computers by teachers does seem to depend mostly on their *access* to technology and their *ICT skills*. While both are rather intuitive findings, neither is trivial. Access means existence of not just computers in computer labs but their access possibly in classrooms, access to various software, projecting and printing equipment, etc. Moreover, access means not only equipment's existence as school endowment, but actual ease of access by teachers, i.e. sufficient numbers and procedurally easily accessible. It is also important to talk of *ICT skills* as specific skills and not just as the broader concept of *computer self-efficacy*. In other words, to support computer use by teachers, educational managers and policy makers have to make hardware and software technologies available (hopefully according to a technology in education use plan) and insure that teachers have the specific skills to use those specific technologies.

Furthermore, in terms of motivating teachers to use technology, the triad: *enjoyment, compatibility* and *usefulness* (in this order) has to be kept in mind. A correct model of technology use means technologies are made enjoyable by teachers, teachers are trained, not only to acquire technology specific skills but an understanding of how those technologies are compatible (i.e. can be integrated) with their discipline and methods, and finally how they are useful from a effectiveness and efficiency point of view. Finally, it is important to note that there is a social snowball effect reinforcing information technologies use in education: observing that other use technology, as well as one's reputational gains from technology use may reinforce further technology use. As such, educational managers can encourage technology related social interaction among teachers such as: seminars, courses, events related to technology in education, thus facilitating both learning and mutual encouragement.

Our study was limited to a sample of teachers in Bucharest, Romania. Whether any aspects of the findings are generalizable in any way should be subject of further studies of using, like this one, broad ranges of explanatory variables, in other contexts. Our findings are also limited to direct effects on ICT adoption. Variables found significant are prime candidates to be considered as having such direct effects. However, having found some variables insignificant suggests that they have no direct effects but does not rule them as irrelevant. They may have relevant indirect effects as antecedents of direct effects. We are currently working on exploring such indirect effects. In doing so we see the benefit of proceeding from large number of variables direct effect studies, like this one, and studying the antecedents of significant direct effects, instead of limiting our focus to the antecedents of TAM variables.

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KEY TERMS & DEFINITIONS

Technology adoption: in the context of this article refers to the process by which individuals decide (with some degree of permanence) and live by that decision to use a specific technology or type of technology. In our context we refer to information technology in particular. Research of technology adoption at individual level has focused on either intentions to use technology or the actual use, or both. Therefore, is often used as a generic term for both intentions to use technology and actual use. Some authors prefer to use *technology acceptance* with the same meaning, but largely the two terms adoption and acceptance have been used interchangeably. Technology adoption at individual level is quite different from technology adoption at group or organizational level where adoption may mean more than just individual use but organizational decisions, purchase of technology, development and deployment, and finally user take-up.

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