

The relationship between age, technology acceptance model and grades obtained in the training of professional emergency services.

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Abstract

This contribution reports on findings from a study on firefighters' grades obtained in technology-supported training courses in Catalonia. The role of firefighters has changed dramatically over the past few years and will continue to do so as modernization progresses. This will have implications for everything associated with the service and in particular in relation to the type and delivery of basic training. The wider role of rescue work and the demands of community fire prevention require skills that need to be taught in a different manner. A review of current research concerning distance learning (Holmgren, 2015) and the use of digital technologies shows that there are few studies on firefighter training. This paper aims to describe and analyse the relationships between the firefighters' age, the intention to use technology to learn and the grades obtained in online training courses. To explain the influence of digital literacy on individuals' intention to pursue online learning, we integrate the concept of digital literacy with the Unified Theory of Acceptance and Use of Technology (measured using the TAM2 questionnaire). Technology-supported distance learning is an increasingly common mode in practical professional training courses. In line with this development, campus-based firefighter training in Catalonia is implemented using a distance mode and blended courses. Data has been analysed from two courses carried out in a Moodle environment, one of which was delivered in a blended learning mode for aspiring firefighters and another was presented in e-learning mode for active firefighters with different levels of experience. The total number of participants was 247. The results obtained when analysing the variables of age, grade obtained and TAM2 scores show that there is no significant relationship between them. However, we have found a relationship in the case of the intention to use technology for learning and the grade obtained in the course. The results suggest that the acceptance and, therefore, the use of technology does not depend on the student's age. We have found a positive relationship in the case of students on the Basic Training Course for Firefighters in the Intention to Use (IU), Perceived Usefulness (PU) and Voluntariness (V) scales referring to the grades they obtained.

Keywords

Firefighters, training, emergency services, e-learning, blended learning.

1. Introduction

Tapscott (1988) and Prensky (2001a, 2001b), as well as other proponents of the concept of 'digital natives', claim that the current generation of undergraduates possesses advanced knowledge and skills in Information Communication Technologies (ICT) and is highly motivated to learn in this mode. In contrast, there are studies that reveal a variation in the levels of students' access and a greater tendency to use ICT for social, rather than academic purposes. Recent empirical studies suggest that high levels of digital competencies are not necessarily tied to age (Corrin, Lockyer and Bennett, 2010; Jelfs and Richardson, 2013). Along the same lines, the generalized transfer of web 2.0 practices from a personal to a learning environment has not been empirically contrasted (Jones and Healing, 2010; Waycott, Bennett, Kennedy, Dalgarno and Gray, 2010). On the contrary, it seems that this transfer depends more on elements related to the learning environment, and with student and teacher interaction (Corrin et al., 2010; Jones and Healing, 2010; Selwyn, 2009). Most of these studies are based

on students in higher education and vocational training, but there is a lack of information in the context of professional and lifelong networked learning.

A review of recent scientific publications shows that the study of computer-mediated training of emergency services personnel covers different aspects of such training. From a general perspective, Pettersson (2015) carried out an extensive study on the digitization of medical training in Sweden, while Passos, Nazir, Mol and Carvalho (2016) focused on the use of online collaborative environments in the training of emergency services. At the same time, Holmgren (2012, 2014a, 2014b, 2015, 2016 and 2017) has conducted comprehensive research on the differences between face-to-face and online firefighter training and the perspective of the different protagonists: students, teachers and executive staff. More specifically, Kolmanič, Guid and Nerat (2013) analysed the use of multimedia online environments in the training of firefighters. On the other hand, Cha, Han, Lee and Choi (2012) compared the use of different mechanisms of virtual reality and their success in learning, as did Moreno, Posada, Segura, Arbelaz and García-Alonso (2014) and Xu, Lu, Guan, Chen and Ren, (2014). Houtkamp, Toet and Bos (2012) also analysed the impact of virtual reality on the training of firefighters, focusing on a specific aspect: the importance of sound in the recreation of virtual scenarios. In recent years, the use of serious games in the training of fire-service personnel has also been addressed: the comparison between the different serious games available (Williams-Bell, Kapralos, Hogue, Murphy and Weckman, 2015), their impact on training (Helder, Wijkmark and Pareto, 2016), their usefulness in improving the safety and well-being of firefighters (Wener et al., 2015) and the use of mobile devices in training (Quinn, 2014).

Beyond the different possibilities of using technology to support the training of emergency services, it is also important to better understand how the professionals involved perceive the use of technology. To achieve this goal we have used the Technology Acceptance Model (TAM).

TAM was proposed by Davis (Davis, Bagozzi and Warshaw, 1989) and is based on the Theory of Reasoned Action (Ajzen and Fishbein, 1980) and its later development, the Theory of Planned Behavior (Ajzen, 1991). The model suggests that when presented with a new technology, the user decides how and when to use it based on different factors. Among the main factors that influence how and when it is used are the perceived ease of use and utility. In this contribution, the TAM2 model is used (Venkatesh and Davis, 2000). The application of questionnaires based on the Technological Acceptance Model is widely documented (Edmunds, Thorpe and Conole, 2012; Escobar-Rodriguez and Monge-Lozano, 2012; Giannakos and Vlamos, 2013), although not without controversy (Nistor, 2014). Nistor has pointed out that the TAM model has been questioned for its excessive simplification of the concept of acceptance and it seems that the relationship between the user's intention and their effective behaviour is not sufficiently documented in empirical research.

The main aim of this contribution is to analyse the relationship between the age of the workers studied, their intention to use technology for learning (measured using the TAM2 questionnaire) and the grades obtained obtained in online and blended teaching courses. It is important to understand how learning processes are influenced and transformed when technology-supported learning is introduced into the context of professional and lifelong networked learning. In summary, the key questions that this study aims to answer are:

RQ1. Is there a relationship between age and grades obtained?

RQ2. Is there a relationship between the variables measured by TAM2 and grades obtained?

RQ3. Is there a relationship between age, the variables measured by TAM2 and grades obtained?

2. Methodology

2.1. Context

In Catalonia, the management of emergency services corresponds to the Government of the Generalitat of Catalonia¹². There are two fire departments that collaborate with each other, but which are differentiated by their geographical scope of action and by the public administration on which they depend. The fire brigade of the Generalitat of Catalonia has been entrusted with the functions of fire prevention and extinction, as well as rescue across the region of Catalonia³, except in Barcelona which has its own fire service⁴. To this end, the Generalitat of Catalonia's fire department has more than 5,000 members, made up of professional firefighters and volunteers. The city of Barcelona's fire department has commissioned functions very similar to those of the Generalitat's fire department and has a staff of more than 600 people. The Generalitat of Catalonia's fire department has a mixed structure, with both professional and volunteer staff, as in many countries around the world (Knight, 2013). In the case of firefighters in Barcelona, the entire staff is professional.

Training fire department personnel is the responsibility of the School of the Fire Service and Civil Protection, which is part of the Catalan Public Security Institute. The training provided by this school is divided into the following areas: firefighter training (7,838 hours taught in 2016) and civil protection training (1,077 hours taught in 2016.⁵)

The data in this study were obtained during the first semester of 2017 and include the courses carried out by the School of the Fire Service and Civil Protection during the 2016-2017 academic year.

2.2. Sample

The sample in the present study is taken from four courses carried out during the 2016-2017 academic year, and is made up of a total of 247 students divided into the following courses: Basic Training Course for Firefighters of the Generalitat of Catalonia and Basic Course on Emergency Management.

The following summary table shows the main characteristics of the courses studied:

Table 1. Detail of the number of students and the time distribution of the training.

Name of the course	Number of students	Classroom training hours	Online training hours	Total hours
Basic Training Course for Firefighters of the Generalitat of Catalonia	153	610	90	700
Basic Course on Emergency Management	94	0	18	18
TOTAL	247	610	108	718

As shown in Table 1, the number of students on each course is very different as is the number of hours of training and their distribution between face-to-face and online training. These differences are important and should be taken into account when drawing conclusions from the analyses carried out.

Table 2. Personal variables. Distribution of students by sex and age range.

Course	Number of students	Sex				Ages								
		M	%	F	%	20-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	Not available
Basic Training Course for	153	147	96	6	4	7	69	51	19	6	1	0	0	0

¹ The autonomous government of Catalonia is called the Generalitat.

² Statute of Autonomy of Catalonia, 2016. Article 132.

³ Law 5/1994, of 4 May, on the regulation of fire prevention and extinction and rescue services in Catalonia, and Law 9/2010, of 7 May, modifying Law 5/1994, of 4 May, on the regulation of fire prevention and extinction and rescue services in Catalonia.

⁴ http://interior.gencat.cat/ca/arees_dactuacio/bombers/coneix_els_bombers/que_fan_els_bombers/

⁵ Catalan Public Security Institute. Annual Report 2016.

Firefighters of the Generalitat of Catalonia														
Basic Course on Emergency Management	94	90	96	4	4	3	18	20	20	15	8	2	2	6
TOTAL	247	237	96	10	4	10	87	71	39	21	9	2	2	6

The distribution of students by sex (Table 2) shows a clear predominance of males over females. These data are consistent with gender distribution in the Generalitat of Catalonia's fire department. The distribution of students by age ranges (Table 2) shows that 80% of students are between 26 and 40 years of age. This distribution seems logical given the specific characteristics of the group studied: emergency services personnel.

Table 3. Distribution of students by level of education.

Course	Number of students	Primary education	Secondary education	Higher education	Not available
Basic Training Course for Firefighters of the Generalitat of Catalonia	153	2	59	91	1
Basic Course on Emergency Management	94	6	32	6	50
TOTAL	247	8	37	97	51

As can be seen in Table 4, and considering that it was not possible to obtain data on the training level of 51 students (21% of the sample), it is important to note the high overall educational level of the personnel studied: 15% have secondary education level and 39% have higher education level.

3. Data Gathered

3.1. TAM2

In the present work, the TAM2 model was used to gather data (Venkatesh and Davis, 2000). The TAM 2 questionnaire contains 26 questions, and all items were measured on a seven-point Likert scale grouped into nine variables: Intention to Use (IU), Perceived Usefulness (PU), Perceived Ease of Use (PEU), Subjective Norm (SN), Voluntariness (V), Image (I), Job Relevance (JR), Output Quality (OQ) and Result Demonstrability (RD).

The response rate is shown in Table 4. The percentage of responses in the Basic Training Course for Firefighters of the Generalitat of Catalonia was 30.72% and in the Basic Course on Emergency Management course it was 78.72%.

Table 4. TAM2 response rate.

Course	Students	N. answers TAM 2	Response rate (total)
Basic Training Course for Firefighters of the Generalitat of Catalonia	153	47	30.72%
Basic Course on Emergency Management	94	74	78.72%
TOTAL	247	121	48.98%

3.2. Grades obtained

At the end of both courses, the official grades ranging from 0-10 were collected in the Basic Training Course for Firefighters of the Generalitat of Catalonia and 0-100 in the Basic Course on Emergency Management. Both the TAM2 questionnaire data and the official grades were collected in early September 2017.

4. Data Analysis

The presentation of the data analysis performed follows the research questions formulated at the beginning of this work.

RQ1. Is there a relationship between age and grades obtained?

The relationship between the age variable and the grades obtained is studied. The study of the sex variable has been rejected because only 4% of the students are women.

The conditions of application of the Pearson correlation coefficient in the two distributions are satisfied.

The hypotheses from which we start are:

H₀: There is no relation between the variables of age and grades obtained or, if any, it can be explained by the influence of chance.

H₁: There is a relationship between the variables of age and grades obtained not only due to chance.

Basic Training Course for Firefighters of the Generalitat of Catalonia:

As can be seen in Table 5, the correlation obtained between the variables age and grade ($r = -.017$) is not significant (.912), which allows us to conclude that there is no relationship between age and final grade obtained.

Table 5. Basic Training Course for Firefighters of the Generalitat of Catalonia and Basic Course on Emergency Management. Correlations and significance of the variables of age and grade.

Correlations		Basic Training Course for Firefighters of the Generalitat of Catalonia		Basic Course on Emergency Management	
		Age	Grade	Age	Grade
Age	Pearson correlation	1	-.017	1	-.100
	Sig. (2-tailed)		.912		.419
	N	47	47	68	67
Grade	Pearson correlation	-.017	1	-.100	1
	Sig. (2-tailed)	.912		.419	
	N	47	47	67	73

Basic Course on Emergency Management:

As in the Basic Training for Firefighters course, we did not observe a relationship between the variables of age and grade obtained ($r = -.100$ with a significance of .419). (Table 5)

RQ2. Is there a relationship between the variables measured by TAM2 and grades obtained?

In the case of the study of the relationship between the variables of TAM2 scores and grades obtained, the following hypotheses have been formulated:

H₀: There is no relation between the TAM2 score variable and the grade obtained or, if any, it can be explained by the influence of chance.

H₁: There is a relationship between the variables of the TAM2 score and grade obtained, not due solely to chance.

Basic Training Course for Firefighters of the Generalitat of Catalonia:

As can be seen in Table 6, the correlation obtained between the variables TAM2 and grade ($r = -.165$) is not significant (.265), which allows us to conclude that there is no relationship between the TAM2 score and the final grade obtained in the course.

Table 6. Basic Training Course for Firefighters of the Generalitat of Catalonia and Basic Course on Emergency Management. Correlations and significance of the variables of grade and TAM2 score.

Correlations		Basic Training Course for Firefighters of the Generalitat of Catalonia		Basic Course on Emergency Management	
		Grade	TAM2	Grade	TAM2
Grade	Pearson correlation	1	.165	1	.014
	Sig. (2-tailed)		.267		.908
	N	47	47	73	73
TAM2	Pearson correlation	.165	1	.014	1
	Sig. (2-tailed)	.267		.908	
	N	47	47	73	74

Basic Course on Emergency Management:

As in the Basic Firefighter Training course, we did not observe a relationship between the variables of age and final grade ($r = .014$ with a meaning of .908). (Table 6)

If we analyse the results scale by scale we see that in the case of the Basic Course on Emergency Management there is no significant correlation with the grades obtained and the different TAM2 scales (Table 7), but in the Basic Training Course for Firefighters of the Generalitat of Catalonia, there is (Table 7). Specifically, the significant correlations between the variables of grade and TAM2 scales (not due exclusively to chance) are Intention to Use (IU), Perceived Usefulness (PU) and Voluntariness (V).

Table 7. Basic Course on Emergency Management and Basic Training Course for Firefighters of the Generalitat of Catalonia. Matrix of correlations between the grades obtained and the different TAM2 scales (fragment).

Correlations											
		Basic Course on Emergency Management									
		Grades	IU	PU	PEU	SN	V	I	JR	OQ	RD
Grades	Pearson correlation	1	-.045	.014	.069	.029	-.011	.037	.070	.057	-.069
	Sig. (2-tailed)		.705	.904	.564	.810	.926	.755	.557	.634	.563
	N	73	73	73	73	73	73	73	73	73	73
		Basic Training Course for Firefighters of the Generalitat of Catalonia									
	Pearson correlation	1	.301*	.293*	.148	.105	-.307*	.057	.192	.263	.089
	Sig. (2-tailed)		.040	.045	.321	.482	.036	.704	.197	.074	.551
	N	47	47	47	47	47	47	47	47	47	47

* Correlation is significant at the 0.05 level (2-tailed).

An examination of the table indicates that there are three significant correlations. Specifically, the grade obtained in the course and the Intention to Use (IU) is positive; that is, as the grade increases, we find a higher score on the scale that measures the intention to use. The same is true of the relationship between grades and Perceived Usefulness (PU). What is curious is that people who obtain a higher grade in the course have a lower willingness (V - Voluntariness) to use the online learning environment.

RQ3. Is there a relationship between age, the variables measured by TAM2 and grades obtained?

In the case of the study of the relationship between the variables of age, TAM2 scores and grade obtained, the following hypotheses have been formulated:

H₀: There is no relationship between the variables of age, TAM2 score and grades obtained or, if any, it can be explained by the influence of chance.

H₁: There is a relationship between the variables of age, TAM2 score and grades obtained, not only due to chance.

The results obtained when analysing the relationships between the variables of age, grade and TAM2 score show very similar results to the analyses carried out previously. There is no significant relationship between the variables studied in any of the cases, as can be seen in Table 8 for the Basic Training Course for Firefighters of the Generalitat of Catalonia and the Basic Course on Emergency Management.

Table 8. Basic Training Course for Firefighters of the Generalitat of Catalonia and Basic Course on Emergency Management. The matrix of correlations between age, grade obtained and TAM2 score.

Correlations		Basic Training Course for Firefighters of the Generalitat of Catalonia			Basic Course on Emergency Management		
		Age	Grade	TAM2	Age	Grade	TAM2
Age	Pearson correlation	1	-.017	-.249	1	-.100	-.181
	Sig. (2-tailed)		.912	.091		.419	.142
	N	47	47	47	67	67	67
Grade	Pearson correlation	-.017	1	.165	-.100	1	.014
	Sig. (2-tailed)	.912		.267	.419		.908
	N	47	47	47	67	73	73
TAM2	Pearson correlation	-.249	.165	1	-.181	.014	1

	Sig. (2-tailed)	.091	.267		.142	.908	
	N	47	47	47	67	73	73

The descriptive statistics of both courses reveal very interesting information: the means are very similar in the three studied variables (Table 15 and Table 16). The age presents an average of 31.38 in the case of the Basic Training Course for Firefighters and 36.91 in the course on Emergency Management. The difference can be explained by the fact that in the basic firefighters' course the students are seeking to become firefighters, while those taking the course on emergency management are active firefighters. The average grades obtained are very similar: 8.58 and 82.41, as are the means of the TAM2 scores: 131.55 and 129.19. The standard deviations of the studied variables are also very similar to the exception of the standard deviation of the score obtained. This difference (0.34 and 13.73) can be explained by the fact that all those taking the basic firefighters' course all passed with very similar grades, while on the emergency management course some participants failed with very low grades.

Table 9. Basic Training Course for Firefighters of the Generalitat of Catalonia and Basic Course on Emergency Management. Mean and standard deviation.

Descriptive statistics	Basic Training Course for Firefighters of the Generalitat of Catalonia			Basic Course on Emergency Management		
	Age	Rating	TAM2	Age	Grade	TAM2
Mean	31.38	8.5947	131.55	36.91	82.4192	129.19
Std. deviation	3.505	131.55	17.553	7.673	13.73097	18.990
N	47	47	47	67	73	73

5. Discussion

In this study, we used the TAM2 questionnaire to investigate the relationship between the participants' scores (the acceptance of the technology), the grades they obtained and their ages. The overall results do not support this relationship at the general level. All the general results obtained show quite clearly that there is no relationship between the variables listed above. However, we have found a relationship in the case of those participating in the Basic Training Course for Firefighters of the Generalitat of Catalonia in the Intention to Use (IU), Perceived Usefulness (PU) and Voluntariness (V) scales, although this only referred to the grades obtained and not to the participants' age.

As previously explained, the correlations are low and positive in the case of the IU and PU scores, i.e. the students with higher IU and PU scores get higher and also lower grades, but this is negative in the case of the V score; that is, students with high V scores obtained lower grades. These results are particularly interesting because they have been obtained from one course and not in the other of the two analysed. It is important to remember that both courses are very different and the participants belong to different groups: the basic firefighters' course is for applicants to the service and the course on emergency management is for active professionals and volunteers. The duration of each course is also very different (700 hours in the case of the Basic Training Course for Firefighters of the Generalitat of Catalonia and 18 hours in the case of the Basic Course on Emergency Management) and the basic training course uses a blended modality, while the emergency management course is online. These differences suggest the possibility that there are variables such as those that are determinant in the relationships studied in this work.

It is very striking that in the online course on emergency management for active professionals there is no relationship between the variables of age, grade and TAM2 score, although the means and standard deviations of the two courses are very similar except in the case of the standard deviation of the Emergency Management Course in which, as explained above, the high standard deviation is due to the fact that there are students who have passed and others who have failed.

6. Conclusions

The data analysis carried out allows us to conclude that there is no relationship between the different variables studied. It appears that the level of acceptance of technology among emergency services personnel does not

depend on the age of the students nor is it related to the grade obtained in the course. Therefore, we can affirm that the results obtained coincide with the research cited at the beginning of this work and suggest that the acceptance and, therefore, the use of the technology does not depend on the student's age (Corrin et al., 2010; Jelfs and Richardson, 2013). Furthermore, we can also conclude that there is no relationship between the use of technology in the teaching and learning processes and the grades obtained by students.

7. Limitations and future directions

This paper presents two important and related limitations. Throughout the data collection process, only two courses that give a sample with $n = 247$ could be included in the work. The first limitation refers to the inclusion of two courses. The second is the size of the sample. These facts suggest two possible future lines of investigation: on the one hand, to extend the sample studied in the same fire brigade, and, on the other hand, to carry out similar studies in fire brigades in other countries in order to study the possible similarities or differences.

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Further information:

Attached is the link with the TAM2 questionnaire used in this work: <https://goo.gl/V2oE6J>