Analysis from the Student Perspective on the Implementation of Learning Technologies in Mining Engineering

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Abstract. The emergence of new technologies such as virtual reality, mobile applications, web platforms and holograms are very useful for the development of learning; for this reason this research focuses on knowing the interest of the students of the Professional School of Mining Engineering in relation to the use of these technological learning systems. For this purpose, we used a survey as a measuring instrument based on the external variables of the Technology Acceptance Model 3 (TAM3) and the answers were based on the Likert scale; additionally, the processing and interpretation was carried out using the Statistical Package for the Social Sciences (SPSS). Relationships were established through the Pearson coefficient (r> 0). We identified the interest perceived by the students of the Professional School of Mining Engineering related the implementation and use of technological systems of learning, identifying weak variables such as the Subjective Standard, which refers to the need for help in the use of a learning platform, and the lack of experience in the use of these systems. On the other hand, a web platform is being developed that will satisfy visual and interactive needs of the student and the professor.

Keywords: TAM3, SPSS, Learning, Technology, Mining Engineering

1 Introduction

Technology has evolved rapidly over time, especially in the area of information and computer technology (ICT) [1], with the emergence of these, a new tool has been produced that may be linked to the teaching-learning cycle [2]. Today, some universities are beginning to use technological learning systems in various fields such as medicine, history, education, and neurosciences [1], this brings several benefits for students and teachers, since learning and teaching have been able to improve with the implementation of new technologies. Its adoption in higher education is considered an innovation, it is possible to highlight computer graphics, augmented reality, computational dynamics and virtual worlds [3] [4] [5].

Mining Engineering is a professional program that covers broad aspects, both theoretical and practical due to its own nature, so the implementation of learning technologies applied to these fields of Mining Engineering is required, since efficient acquisition is required of these skills for competent professional development. Nowadays, achieving an interaction between them is difficult, due to the implementation of laboratories in universities will require investment of time, space, and money; as usually happens in different universities [6] [7].

The aim of this research is to describe the need for the implementation of these learning technologies and the interest of their application in the Professional School of Mining Engineering, providing valuable information to help different engineering schools, so it is suggested that learning has to go hand in hand with technology, because it has a rapid development, obtaining considerable benefits. We also discuss the building of a web platform that is still in development, which aims to establish an interaction between students and teachers through an appropriate interface, taking into account the results obtained in the virtual survey based on the external variables of the TAM3 model [8] [7].

1.1 Current issue about learning technologies implementation

1.1.1 Professors related problems

Usually, professors do not train in the learning technologies use, so there are inexperienced professors and also beginners, there is a lack of security to implement technological learning systems in their classrooms [9], for that reason they do not have the ability to encourage students to apply and use them.

The involvement of professor satisfaction and student motivation mean that there is an improvement in user learning [2].

1.1.2 Students related problems

Very rarely, students' opinions about the use of application technologies are taken into account in order to have a better development in terms of their learning, such as what happened to the students surveyed, in which a virtual platform was applied ignoring their opinions and the aspects necessary for the interaction between the theoretical and practical field, so that students and teachers do not take advantage of the use of this virtual learning platform. The opposite is what happened at University College Cork, since a previous survey was conducted for the use of applications in clinical practice, where the student perspective was analyzed, since this is vital to determine if the technology is correctly applicable to the field of interest. [10]. For this reason, it is recommended that surveys be carried out for the implementation of new future technologies available in the higher study houses [11] [12].

An investigation was carried out based on the review of 365 documents published in *Computers & Education*, where it was concluded that there is less than expected regarding the evaluation of the use of educational technologies, to improve learning in university environments [13]. However, there is the case where the student is encouraged to use these types of technologies, which are important for his virtual practical work, being able to develop better in the learning of the subject [1] [7].

Students who generally use technological learning systems understand that these devices contribute to their academic development; Although, they consider that for this to happen, there must be easy handling of the application to be used and also the availability of equipment for handling [10].

1.1.3 Learning Related Problems

In the teaching of Mining Engineering there are restrictions to access mining and geological fields, this means that there is an impediment to visualization of the student's future field of work [3] [7] so this causes a deficit in the learning of The matter.

There are universities where learning limits have been identified by 2D image visualization, as is the case of Bina Nusantara University, where students had difficulties in the course of anatomy of the human body due to technological deficiency [2] [14].

1.2 Technology Acceptance Model (TAM3)

It is decided to use certain external variables of the TAM3 [15] which are presented in Table 1, in order to determine if the students of the Professional School of Mining Engineering are interested in the use of technological learning systems [16] [13].

Table 1

Variable	Conceptualization
Computer Self-efficacy (CSE)	It shows the percentage that indicates if one is capable enough to handle and control a technological system [17].
Perceptions of External Control (PEC)	It is the quantification of the existence of the necessary conditions for the technological system to function properly [18].
Computer Anxiety (CANX)	Presence of the feeling of fear or fear, stress situations when interacting with technological systems [19].
Computer Playfulness (CPLAY)	It is the ability of an individual to be able to interrelate with a technological system [20].
Perceived Enjoyment (ENJ)	It is the satisfaction and enjoyment that an individual possesses when interacting with a technological system [15].
Objective Usability (OU)	Variable that is obtained by the experience of using some technological system [15].
Subjective Norm (SN)	Influence of one individual on another for the use of a technological system [21].
Voluntariness (VOL)	It establishes whether an individual will use a technological system of his own accord or by constriction [22].
Image (IMG)	It refers to the added value that the individual possesses when using technological systems [22].
Job Relevance (REL)	It is the level of utility that an individual give to technology systems for the development of their activities [22].
Output Quality (OUT)	It refers to the correct performance of the functions of the technological system [22].
Result Demonstrability (RES)	It is the benefit that an individual obtains in the performance of his activities when using the technological system [22].
Experience (EXP)	Quantity and quality in the use of learning technologies. [9]

2 Material and methods

2.1 Environment and population

It has been directed towards the students of the Professional School of Mining Engineering at Católica de Santa María University a virtual survey using Google Forms. We worked with students from first to tenth semester of the Professional School of Mining Engineering, the population being a total of 479 students, the level of confidence considered was 95% and the margin of error was 5%. The result of the minimum standard sample size is 214 students according to the estimate of population proportions. Table 2 shows the number of students participating in the survey for each semester.

Table 2

Semester		Frequency	Percentage
Valid	2	72	28
	4	47	18
	6	54	21
	8	26	10
	10	59	23
	Total	258	100.0

2.3 Surveys using external variables of TAM3

Technology Acceptance Model 3 has been used, because it is designed to address the acceptance of technology and thus be able to conduct a survey based on the external variables proposed by Venkatesh, such as voluntariness, experience, subjective norm, image, relevance at work, quality of exit, demonstrability of results, self-efficiency against technology, perception of external control, anxiety towards technology, joy against technology, objective usability and perception of enjoyment [15].

It has been considered to use all external variables of Technology Acceptance Model 3, because they are considered more relevant with respect to Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) which is one of the most important acceptance models together with TAM3 [13]. The TAM3 was considered unlike UTAUT2, because the external variables of the TAM3 facilitate the intention and maintain voluntariness, unlike UTAUT2 which predominates individual conditions such as gender, age, price value [23].

The questions were asked according to the definitions and characteristics of each external variable shown in Table 1, which were evaluated using the Likert scale establishing a multiple choice response range (1 - Strongly disagree, 2 - Disagree, 3 - Neither agree nor disagree, 4 - Agree, 5 - Strongly agree) [24]. The following website https://docs.google.com/spreadsheets/d/1DaGr2ctfdmUbZWk4XmZ1pDez8EmOUype1V8PNm8bCv8/edit?usp=sharing, shows the questions asked in the survey conducted on October 28, 2019.

2.5 Statistical Analysis

In this article, descriptive statistics were used to obtain frequencies, percentages, level of significance, standard deviation, correlation coefficient and arithmetic mean, which were obtained through the Statistical Package for the Social Sciences (SPSS).

3 Results

Through the study carried out, we found a strong technological acceptance by the students of the Professional School of Mining Engineering, since it is shown in Table 3, generated in SPSS, which in 92.3% of the external variables of our interest TAM3 are above the arithmetic mean of the Likert scale, where the minimum response was 1 (Strongly disagree) and the maximum was 5 (Strongly agree) of the 258 students who conducted the survey. According to the values of the standard deviation and the variance, it is possible to distinguish which are the items where there is greater dispersion between the responses.

Table 3
Descriptive Statistics

	N	Minimum	Maximum	Average	STD.	Variance
IMG	258	1	5	4.54	.717	.514
REL	258	1	5	4.60	.722	.522
OUT	258	1	5	3.92	1.001	1.001
RES	258	1	5	4.40	.793	.629
CANX	258	1	5	4.38	1.018	1.037
CPLAY	258	1	5	4.59	.691	.477
CSE	258	1	5	4.43	.792	.627
ENJ	258	1	5	4.53	.695	.483
OU	258	1	5	4.09	.983	.965
PEC	258	1	5	3.84	1.036	1.073
SN	258	1	5	3.48	1.291	1.667
EXP	258	1	5	3.79	1.093	1.196
VOL	258	1	5	3.84	1.023	1.047

In Table 3, the variables that had the lowest arithmetic mean were identified, the Subjective Standard whose argument is "I do not need the help of a person (teacher or instructor) for the use of a technological learning system," he says. with the lowest average (3.48), because 47.3% of the sample recorded their response with a value less than 4 on the Likert scale and has the highest variance (1,667), because there is a high value of dispersion in student responses, which means that there is a problem in this external variable.

For the Experience that has as an argument "I have experience in the use of some technological learning system", it has a score of (3.79), being 37.6% of the interviewees who had a voting record of less than 4 and also has a variance of (1,196).

Table 4 shows the bilateral correlation of the external variables, if the value of the correlation is close to unity, it means that there is a strong relationship between the two variables, otherwise the relationship strength of the variables will be weak. When it is zero there is no relationship force. It is also identified that the hypotheses raised for each variable are accepted due to the bilateral significance.

Table 4
Correlations

	IMG	REL	OUT	RES	CANX	CPLAY	CSE	ENJ	OU	PEC	SN	EXP	VOL
IMG	1												
REL	,729**	1											
OUT	,208**	,175**	1										
RES	,513**	,565**	,305**	1									
CANX	,308**	,286**	,191**	,413**	1								
CPLAY	,429**	,545**	,232**	,620**	,438**	1							
CSE	,344**	,379**	,206**	,540**	,373**	,598**	1						
ENJ	,458**	,470**	,253**	,568**	,429**	,674**	,598**	1					
OU	,244**	,268**	,549**	,311**	,170**	,310**	,298**	,377**	1				
PEC	,239**	,291**	,442**	,378**	,251**	,372**	,319**	,391**	,460**	1			
SN	,182**	,158*	,130*	,235**	,244**	,207**	,341**	,280**	,222**	,134*	1		
EXP	,182**	,231**	,208**	,344**	,306**	,305**	,421**	,335**	,191**	,246**	,588**	1	
VOL	,200**	,232**	,158*	,314**	,182**	,322**	,212**	,342**	,196**	,325**	,333**	,435**	1

**. The correlation is significant at the level 0,01 (bilateral).
*. The correlation is significant at the level 0,05 (bilateral).

Computer Self-efficacy (CSE), Perceptions of External Control (PEC), Computer Anxiety (CANX), Computer Playfulness (CPLAY), Perceived Enjoyment (ENJ), Objective Usability (OU), Subjective Norm (SN), Voluntariness (VOL), Image (IMG), Job Relevance (REL), Output Quality (OUT), Result Demonstrability (RES).

4 Discussion

According to the results it is determined that the students of the Professional School of Mining Engineering are willing and in accordance with the implementation of learning technologies according to the data in Table 3 where the external variables are accepted by the students and the average of the results for each question is greater than 4 points on the Likert scale [24], this means that the implementation of technologies focused on learning would be accepted, such as those suggested in a study about the application of virtual laboratories to science and engineering education [3]. So it should be taken into account that an interactive technological system is needed, with a pleasant and easy-to-use interface so that the user does not take long to understand it, as well as the provisions of a study about mobile applications to the learning of science [11], which comments on the connections that must be established with the student about the principles of instruction and the design characteristics for the best integration of the same with the technological learning systems.

As analyzed in Table 3 it is understood that some students do not usually use technological learning systems, so it is intended to assist the user through teacher-student interactions and the use of learning games is also recommended, until the student feels safe of being able to manipulate the system on its own, pretending that it can acquire the desire to use the application and can interact with the implemented technology, as mentioned in a study referring to human anatomy [1]. This can determine a significant increase in performance and may be able to integrate into a specialized course of introduction to psychology [5].

Within the analysis of the Subjective Standard variable we understand that some students need quick answers to solve the problems, so trained personnel (recommending that they be teachers) are required to respond to any problem that may arise in the operation of some technological system of learning taking into account the environment where this is carried out, since there should be no barriers to integrate a mobile technology, coinciding with a study carried out in 2018 [10], such as poor Wi-Fi connectivity, low quality of the educational content of the learning technologies, and difficulties of hardware and software integration.

According to the results in Table 3 of the Voluntariness variable, certain students surveyed feel obliged to use a technological learning system because perhaps it causes disinterest in the monotony of the interface, for this reason it is suggested to develop a dynamic system that provides the confidence and the expected joy to the student to enter the platform without any obligation, since this cause can cause anxiety and stress, so there would be a deficiency in obtaining learning in practice [10] [14]. It is important to assist the user through teacher-student interactions and the use of learning games is also recommended, until the student feels safe of being able to manipulate the system on its own, pretending that it can acquire the desire to use the application and can interact with the implemented technology, as mentioned in a study referring to human anatomy [1]. This can determine a significant increase in performance and may be able to integrate into a specialized course of introduction to psychology [5].

Regarding Table 4 of correlations of the variables, it can be observed that the levels of significance are less than 0.05, so a null research hypothesis is discarded, and responds to the Pearson coefficient, showing that there is a low correlation in The variables have the meaning that each variable has its own field of study, being independent in what is required to analyze and interpret, as is the case in a study conducted at Cracow University of Economics [12] and in the same way we find the same case in an article about the evaluation of technological acceptance in engineering [7].

On the other hand, a web platform is being developed that seeks to meet all the requirements of the variables worked in this article, emphasizing this work in the variables that have a score less than 4 in the average Likert scale. Web platform link under development: https://epim.ucsm.ehg.pe/
The design of this technology is intended to support researchers, teachers, developers of technological learning systems, and also include engineering knowledge as described in these investigations [13] [3].

5 Conclusions

Innovation is very important for an educational institution, as well as the opinion of the population in which a technological learning system is going to be inserted, for this reason the perception of the students of the Professional School of Mining Engineering was collected and analyzed, where it is concluded that they have the necessary acceptance by them for the implementation of learning technologies to improve their performance in the theoretical and practical courses and they have the intention of using new methods of academic interaction such as virtual reality, web platforms, mobile applications and holograms, according to the interpretation of the data through SPSS.

The development of the web platform mentioned in the discussion will have the necessary aspects to meet the teaching needs of the teacher, taking into account the aspects required by each external variable of TAM 3, especially those that obtained a score less than 4 points in the survey carried out, this will allow to complement learning while gaining experiences different from those of a conventional class.

There is little research on the implementation of learning technologies in the teaching of Mining Engineering, so that, with this project, we want to encourage all students to contribute their knowledge and creativity to this science in developing learning technologies.

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