Acceptance and use of computer-based assessment in university students

Aceptación y uso de la evaluación basada en computadora en estudiantes universitarios

http://doi.org/10.32870/Ap.v16n1.2476

Julián Gerardo Torres Kauffman*
Iván Olmos Pineda**
Juan Manuel González Calleros***

ABSTRACT

The rapid development of information and communication technologies (ICT) has opened new possibilities for teaching and assessment practices in higher education, including computerbased assessment (CBA). Since the effective development of this depends on student acceptance, the present study analyzed the constructs that affect the intention to use CBA through the computer-based assessment acceptance model (CBAAM) at a private university in Mexico. The methodology was quantitative and divided into two phases: 1) application of an assessment with multiple-choice questions with automatic grading, and 2) testing of the measurement and structural model of the CBAAM instrument with 84 first-semester engineering students. The results indicate that playful perception has a direct effect on the use of CBA, while facilitating conditions, computer self-efficacy, perceived ease of use, goal expectation, social influence, and content only have indirect effects. The acceptance model studied explains approximately 47% of the variation in the intention to use. It is recommended to investigate other variables that affect the purpose of use and to apply the model in other contexts for further confirmation.

Keywords
Technology acceptance; higher education; computer-based assessment; electronic assessment

RESUMEN

El rápido desarrollo de las tecnologías de la información y la comunicación (TIC) abrió nuevas posibilidades para las prácticas de enseñanza y evaluación en la educación superior, entre estas se encuentra la evaluación basada en computadora (computer based assessment, CBA). Ya que el desarrollo efectivo de esta depende de la aceptación de los estudiantes, en el presente estudio se analizaron los constructos que afectan la intención de utilizar la CBA mediante el modelo de aceptación de evaluación basada en computadora (computer based assessment acceptance model, CBAAM) en una universidad privada de México. La metodología fue cuantitativa y se dividió en dos fases: 1) aplicación de una evaluación con preguntas de opción múltiple con evaluación automática, y 2) prueba de la medición y el modelo estructural del instrumento CBAAM con 84 estudiantes del primer semestre de ingeniería. Los resultados indican que la percepción lúdica tiene un efecto directo sobre el uso de la CBA, mientras que las condiciones facilitadoras, la autoeficacia informática, la facilidad de uso percibida, la expectativa de meta, la influencia social y el contenido solo tienen efectos indirectos. El modelo de aceptación estudiado explica aproximadamente 47% de la variación de la intención de uso. Se recomienda investigar otras variables que afectan el propósito de usar y aplicar el modelo en otros contextos para mayor confirmación.

Palabras clave
Aceptación de la tecnología; educación superior; evaluación basada en computadora; evaluación electrónica

Received: September 29, 2023
Accepted: January 30, 2024
Online Published: March 22, 2024

* Estudiante del Doctorado en Sistemas y Ambientes Educativos de la Benemérita Universidad Autónoma de Puebla, México. ORCID: https://orcid.org/0000-0001-7247-2769, correo electrónico: julian.torresk@alumno.buap.mx | ** Doctor en Ciencias de la Computación por el Instituto Nacional de Astrofísica, Óptica y Electrónica. Profesor investigador en la Benemérita Universidad Autónoma de Puebla, México. ORCID: https://orcid.org/0000-0003-1698-000X correo electrónico: ivan.olmos@correo.buap.mx | *** Doctor en Ciencias Económicas y Administrativas por la Université Catholique de Louvain. Profesor investigador en la Benemérita Universidad Autónoma de Puebla, México. ORCID: https://orcid.org/0000-0002-9661-3615, correo electrónico: juanmanuel.gonzalez@correo.buap.mx

INTRODUCTION

In recent years, synchronous and asynchronous modalities (Chau *et al*., 2021) of teaching and learning have gotten a lot of attention, especially after the contingency caused by the covid-19 pandemic. This fact contributed to the acceleration of digitalization in educational institutions, so that various universities have adopted e-teaching and e-learning to replace traditional educational activities in the classroom (Tang *et al*., 2021).

Several researchers have focused on users' acceptance or rejection of technological applications and their respective measurement instruments in various fields, including education (Granic & Marangunic, 2019). Although many research models have been generated in this area, the technology acceptance model (TAM), introduced by Davis (1989), became one of the most critical factors that affect the adoption of its use by users. The importance of applying technology in teaching and learning activities has been emphasized (Scherer *et al*., 2019), with assessment being one of the key factors in educational practice.

The e-assessment, according to its broadest definition (Joint Information Systems Committee, JISC, 2007), includes the use of a computer as part of any activity related to assessment, whether summative, formative or diagnostic. Authors such as Kundu and Bej (2021), Al-Qdah and Ababneh (2017), Jordan (2013) and Timmis *et al*. (2016) point out that, within the literature, terms such as: computer-based assessment, digital assessment, computer-based testing, computer-assisted assessment, computer-assisted testing, computer-administered testing, technology-enhanced assessment, enabled assessment by technology, computerized assessment, computerized testing, web-based assessment, e-examination, e-testing and online assessment, are generally considered synonyms of e-assessment.

Although the adoption of e-learning has been widely studied, the amount of research focused on computer-based assessment (CBA) is limited (Mo *et al.,* 2022). Among the features of most next-generation e-learning platforms is that they provide support for online assessment, and in many cases this support includes automatic assessment of tests. A good example is a multiple-choice test, where students must choose the correct answer from several possibilities.

Acceptance of computer-based assessment

Although various technology acceptance studies have been carried out in the field of education, most have focused on the acceptance of e-learning. Much of these works used TAM as the base model, and although it was expanded with other constructs, there are few investigations that have used it without extending it (Imtiaz & Maarop, 2014). TAM was developed specifically to model users' acceptance of computer-related technologies

(Davis, 1989). Furthermore, this model suggests that the acceptance of the use of a new ICT application is significantly determined by two factors: perceived usefulness (PU) and perceived ease of use (PEOU).

Regarding instruments on the acceptance of computer-based assessment, little research has been conducted. Most of these studies have been carried out by Terzis *et al*. (2012a, 2012b, 2013) and Terzis and Economides (2011), as well as by Nikou and Economides (2017). Specifically, Terzis and Economides (2011) constructed the computer-based assessment acceptance model (CBAAM), with a 30-item scale, to investigate students' intention to use CBA. The objective of this work was to adapt the CBAAM instrument to a different context and time to analyze its application in CBA.

It should be noted that when reviewing the literature, no instruments were found with reports of reliability and validity to measure the acceptance and intention to use of a computer-based assessment system (CBA) by Mexican university students.

HYPOTHESIS AND CBAAM DEVELOPMENT

CBAAM was built on previous acceptance models, such as the technology acceptance model (TAM), the theory of planned behavior (TPB), and the unified theory of acceptance and use of technology (UTAUT). In CBAAM, two additional variables (content and goal expectation) were added on top of the current measurement variables. This model combined the constructs developed below to study the acceptance of a CBA system.

Perceived playfulness

Moon and Kim (2001) expanded the TAM by adding the perceived playfulness construct, which is defined by three dimensions:

- Concentration: determines if the user is focused on the activity.
- Curiosity: establishes if the system aroused the user's cognitive curiosity.
- Enjoyment: stipulates whether the user is enjoying the interaction with the system.

Although these dimensions are interdependent and linked, each of them alone does not reflect the total interaction of users with the system. A successful implementation of a CBA can maintain users' concentration, curiosity and enjoyment, therefore, the CBAAM assumed that the intention to use is positively affected by the perceived playfulness, as indicated in the following hypothesis:

- H1: Perceived playfulness will have a positive effect on the intention to use CBA.

Perceived usefulness

As mentioned, perceived usefulness is used to evaluate the extent to which a person believes that his or her job performance will increase by using a particular computer system. Numerous researchers have provided evidence on the impact of perceived usefulness on users' intention to use when using a learning system. The CBAAM also assumes that learner concentration, curiosity, and enjoyment will increase as a result of having a useful system, leading to the following hypotheses:

- H2: Perceived usefulness will have a positive effect on intention to use CBA.

- H3: Perceived usefulness will have a positive effect on perceived playfulness.

Perceived ease of use

Similarly, it was discussed that perceived ease of use measures a person's belief that using a computer system is effortless. Previous research has shown that perceived ease of use has a direct effect on perceived usefulness and intention to use (Venkatesh & Davis, 1996). Likewise, the CBAAM assumes that perceived ease of use will have a positive impact on perceived playfulness, because a system that can be used without much effort will allow users to use it without any discomfort. For the above effects of perceived ease of use, the following hypotheses were established:

- H4: Perceived ease of use will have a positive effect on the intention to use CBA.

- H5: Perceived ease of use will have a positive effect on perceived usefulness.

- H6: Perceived ease of use will have a positive effect on perceived playfulness.

Computer self-efficacy

Computer self-efficacy is defined, according to Compeau and Higgins (1995), as the perception that the individual has about his or her ability to use computers. Since previous work has demonstrated a significant link between computer self-efficacy and perceived ease of use, it is observed that computer self-efficacy not only directly influences perceived ease of use, but also exerts an indirect impact on usage intention. Based on these findings, the following hypothesis was proposed:

- H7: Computer self-efficacy will have a positive effect on perceived ease of use.

Social influence

Social influence can be defined as the effect of people's opinions, the influence of superiors and peers. This is made up of three elements: subjective norm (SN), image and voluntariness. For measurement, previous models (such as TRA, TPB, C-TAM-TPB and TAM2)[1] have employed constructs such as social factors (PCUM),[2] image (IDT)[3] and subjective norm (Venkatesh *et al.*, 2003). TAM2 indicates that subjective norm and image influence how users perceive the usefulness of a system; however, the subjective norm does not impact on the intention to use if the use of the system is voluntary. UTAUT, for its part, considers social influence as one of the four main constructs that directly affect the intention to use.

The CBAAM assumes that social influence impacts perceived usefulness. This conclusion is based on the observation that students, feeling insecure when using a CBA, are influenced by the opinions of their friends and colleagues. Likewise, they often discuss perceived usefulness and its added value as a main topic. Because CBA in CBAAM is voluntary, TAM2 suggests that it has no impact on usage intention, which is why CBAAM did not investigate its effect in this regard. Therefore, the only hypothesis raised about social influence is:

- H8: Social influence will have a positive effect on perceived usefulness.

Facilitating conditions

Facilitating conditions (FC) are defined as the set of factors that influence a person's belief in carrying out a procedure. These factors include various aspects, such as technical or online support, noted by Terzis and Economides (2011), and resources such as time and money. In the context of the CBAAM, FCs are conceived as the support provided during the use of a computer-based assessment. This implies that if users encounter difficulties when using a CBA, they should receive the necessary support to overcome these obstacles, which may include the assistance of an expert to answer questions and doubts from students,

[1] TRA: theory of reasoned action; C-TAM-TPB: combination of TAM and TBP; TAM2 is an extension of the original TAM.
[2] PCUM: PC utilization model.
[3] TDI: theory of diffusion of innovations.

especially in a university environment. For the above reasons, the following hypothesis was proposed:

- H9: Facilitating conditions will have a positive effect on perceived ease of use.

Goal expectancy

In the field of distance learning, several studies, such as those by Smith *et al*. (2003) have highlighted the importance of self-direction and goal orientation. It has been proposed that self-management of learning reflects the degree to which a person considers themselves capable of engaging in autonomous learning and maintaining self-discipline. Regarding the acceptance of technology, the orientation of learning objectives has been identified as an influential construct in the acceptance of learning. A new concept called goal expectancy (GE) was introduced in the CBAAM, inspired by the studies.

The GE represents a person's belief in their own readiness to use a CBA and is divided into two aspects: summative and formative assessments. In the case of summative assessment, the first dimension evaluates the student's satisfaction with their level of preparation, without focusing on qualitative or quantitative aspects. The second dimension contemplates the level of success desired by each student, based on their pre-exam expectations about performance based on their study and the perceived difficulty of the evaluation. Thus, each student establishes a goal related to a specific percentage of correct answers that he or she considers satisfactory.

It is considered that GE exerts a significant influence on perceived usefulness, although this relationship varies depending on the type of evaluation. In the case of summative assessment, it positively impacts perceived usefulness, as it allows students to understand and answer questions effectively. In contrast, in formative assessment the main value lies in the feedback that CBA offers to facilitate student learning. In this context, GE can have a negative impact on perceived usefulness, since students focus more on learning than on evaluating their knowledge. Furthermore, the CBAAM postulates that high GE leads to greater concentration and enjoyment during interaction with the CBA, which enhances perceived playfulness. If students are adequately prepared and confident in their performance, they are likely to engage more deeply with the system and enjoy the experience. Based on these concepts, the following hypotheses are formulated:

- H10: Goal expectancy will have a positive effect on perceived usefulness.

- H11: Goal expectancy will have a positive effect on perceived playfulness.

Content

The last construct of the CBAAM is content, considered by Wang (2003) as a crucial factor in student satisfaction. This concept examines whether the content is up-to-date, sufficient and useful, and meets the needs of users. In CBAAM, two dimensions of content are considered: the content of the course and the content of the questions. It is understood that the content of the course significantly influences the perceived usefulness and the perceived playfulness of the CBA, determining its usefulness, interest and level of difficulty. Likewise, the content of the questions is analyzed in terms of clarity, ease of understanding, and relationship to the course content. These dimensions are specific to this model and differ from how others have treated the content. Therefore, CBAAM assumes that content will influence perceived usefulness, playfulness, goal expectancy, and intention to use, which is reflected in the following hypotheses:

- H12: The content will have a positive effect on perceived usefulness.
- H13: The content will have a positive effect on perceived playfulness.
- H14: The content will have a positive effect on goal expectancy.
- H15: The content will have a positive effect on the intention to use the CBA.

In summary, Figure 1 shows the conceptual framework of the CBAAM and the hypothesized relationships between the adopted constructs.

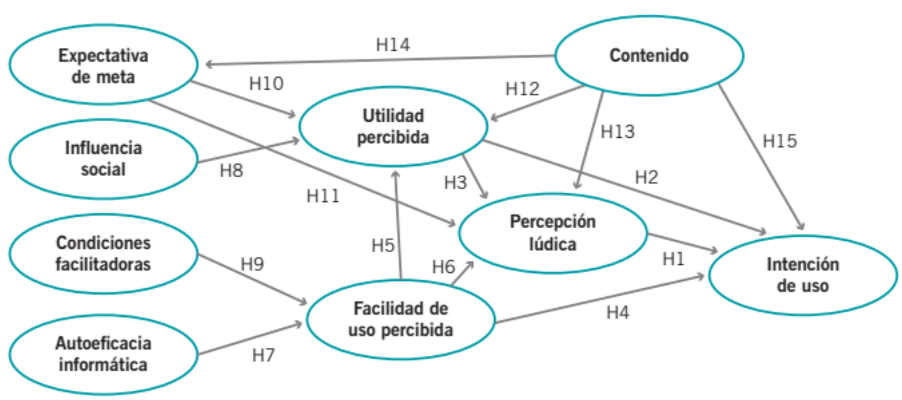

Figure 1. Research model (CBAAM).

Source: own elaboration based on the CBAAM of Terzis and Economides (2011).

METHOD

This work is a quantitative study of explanatory scope, it was carried out in a private university located in an urban area of the city of Puebla during the months of October and November 2022. The sampling was non-probabilistic, with voluntary participants, and the inclusion criteria was: being a first-year engineering student enrolled in the course of Physics Applied to Engineering. In accordance with the institution's research ethics protocol, reading and accepting the informed consent was an essential requirement to participate.

The sample was made up of 84 students, with an average age of 18.39 years (SD = 0.94) and a range of 17 to 22 years. Regarding distribution by gender, we got responses from 26 women (30%), 54 men (65%) and four people who chose not to specify their gender (5%). The procedure for data collection was divided into two main phases, the first included the administration of a computer-based exam, while the second consisted of the collection of responses corresponding to the CBAAM instrument from the students.

Phase 1. Application of computer-based assessment

The use of the evaluation system based on multiple choice questions with automatic evaluation was simple since the student only had to choose the correct answer. The exam was based on the force concept inventory (FCI) proposed by Hestenes *et al.* (1992) and lasted 30 minutes, and it had 27 questions, each with four possible answers. At the end of the exam, participants answered the CBAAM questionnaire, which is described in the next phase.

Phase 2. Application of the CBAAM instrument

The CBAAM was developed in English, so it was translated into Spanish, where the adaptation and intercultural validation of the instrument required a rigorous methodological process with the objective of achieving equivalence between the original and the translated version (Muñiz *et al.*, 2013; Sousa & Rojjanasrirat, 2011), therefore, the translation was carried out by experts in the technological adoption area and by the language center of the university itself.

Before implementing the CBAAM instrument, a pilot study was carried out with 55 engineering students who were in their first year, with the purpose of knowing their opinion about the clarity of the items and correcting the aspects that, in form or substance, made understanding difficult. These participants were informed of the reason for the test and their informed consent was requested through an electronic form.

The final instrument was administered with Google Forms so that it would be available once the students finished using the evaluation system based on multiple choice questions with automatic evaluation. The instrument had 30 items with seven response options: 1 = absolutely disagree, 2 = strongly disagree, 3 = disagree, 4 = neither agree nor disagree, 5 = agree, 6 = strongly agree and 7 = absolutely agree (see table 1).

Table 1. Translation of the Computer-Based Assessment Acceptance Model (CBAAM)

Construct	Items
Perceived usefulness (PU)	PU1: Using computer-based assessment (CBA) will improve my work. PU2: Using CBA will improve my effectiveness. PU3: Using CBA will increase my productivity
Perceived ease of use (PEOU)	PEOU1: My interaction with the system is clear and understandable. PEOU2: It is easy for me to become proficient in using the system. PEOU3: The system is easy to use
Computer self-efficacy (CSE)	CSE1: I could complete a job or task using the computer. CSE2: I could complete a job or task using the computer if someone showed me how to do it first. CSE3: I can easily browse the web to find any information I need. CSE4: I was fully capable of using the computer and the internet before starting CBA.
Social influence (SI)	SI1: People who influence my behavior think I should use CBA. SI2: People who are important to me think I should use CBA. SI3: Seniors at my university have been helpful in the use of CBA. SI4: In general, my university has supported the use of CBA
Facilitating conditions (FC)	FC1: When I need help using CBA, someone is there to help me. FC2: When I need help learning how to use the CBA, the help desk is there to teach me
Content (C)	CI: The CBA questions were clear and understandable C2: The CBA questions were easy to answer. C3: The CBA questions were related to the course syllabus. C4: The CBA questions were useful for my course
Goal expectancy (GE)	GE1: The preparation of the courses was enough for the CBA. GE2: My personal preparation was enough for the CBA. GE3: My performance expectations were in line with the CBA results
Perceived playfulness (PP)	PP1: Using CBA keeps me happy doing my homework. PP2: Using CBA makes me enjoy my learning. PP3: Using CBA stimulates my curiosity. PP4: Using CBA leads to my exploration
Intention to use the CBA	IU1: I intend to use CBA in the future. IU2: I predict I will use CBA in the future. IU3: I plan to use CBA in the future

Source: own elaboration based on the CBAAM instrument by Terzis and Economides (2011).

Data analysis

To analyze the adoption model of computer-based assessment, this work used the partial least squares (PLS) based on a structural equation modeling (SEM) approach. This approach is particularly suitable for complex, exploratory models where relationships between latent variables are of primary interest. The implementation of PLS-SEM was carried out following a set of established rules and guidelines to ensure accuracy in the statistical estimation of the model, as suggested by Hair *et al.* (2016). Regarding the sample size, the minimum recommended value is defined by the two following guidelines: a) ten times greater than the number of elements for the most complex construct, and b) ten times the greatest number of independent variables that impact a dependent variable (Chin, 1998). Because this model has four independent variables that affect a dependent one (perceived usefulness), the sample of 84 participants exceeds the recommended minimum of 40.

By following the guidelines of Sarstedt *et al.* (2014), the evaluation of the PLS-SEM in this study was divided into two main phases. In the first one, measurement theory was examined, and the reliability and validity of the scales were evaluated, including composite reliability, average variance extracted (AVE) to evaluate convergent validity, and the correlation of latent variables for discriminant validity. Additionally, it was ensured that each reflective item had significant loadings on its corresponding construct. Once the measurement model was validated, we proceeded to the second phase, focused on the structural model, where the strength and significance of the structural relationships was evaluated using the coefficient of determination (R^2) for the endogenous variables, the values of the effects of the routes and their statistical significance. Also, an analysis of the indirect and total effects was performed to better understand the interrelationships between the latent variables.

RESULTS

Measurement model

For the analysis of the model, this study used the SmartPLS 4.0 software. Convergent validity is the degree to which the indicators used to measure the same latent variable agree (Bagozzi & Yi, 1988; Garson, 2016) and can be demonstrated through three measures: 1) item reliability of each measure through the use of factor loading (>0.7), 2) composite reliability of each construct (>0.7) and 3) the average variance extracted (>0.5). Table 2 shows evidence of convergent validity. The factor loadings of the measurement model elements indicate acceptable levels and, similarly, the composite reliability and the average variance extracted have adequate values.

Table 2. Results for the measurement model

Latent variable	Average	Standard deviation	Indicator	Factor loading	Cronbach's Alpha	Composite reliability	Average variance extracted
Computer Self-Efficacy (CSE)	6.349	1.018	CSE1	0.895	0.843	0.886	0.663
			CSE2	0.663			
			CSE3	0.852			
			CSE4	0.827			
Content (C)	5.337	1.046	C1	0.611	0.724	0.827	0.547
			C2	0.734			
			C3	0.813			
			C4	0.785			
Facilitating conditions (FC)	5.640	1.172	FC1	0.846	0.759	0.888	0.799
			FC2	0.939			
Goal Expectancy (GE)	4.698	1.193	GE1	0.866	0.630	0.786	0.564
			GE2	0.839			
			GE3	0.488			
Perceived Ease of Use (PEOU)	6.054	1.188	PEOU1	0.917	0.915	0.946	0.854
			PEOU2	0.928			
			PEOU3	0.927			
Social influence (SI)	5.343	0.926	SI1	0.534	0.659	0.758	0.444
			SI2	0.617			
			SI3	0.746			
			SI4	0.744			
Intent to use (IU)	6.039	1.003	IU1	0.928	0.927	0.953	0.872
			IU2	0.950			
			IU3	0.923			
Perceived playfulness (PP)	5.506	1.002	PP1	0.871	0.885	0.919	0.740
			PP2	0.903			
			PP3	0.829			
			PP4	0.836			
Perceived usefulness (PU)	5.829	0.736	PU1	0.726	0.749	0.857	0.669
			PU2	0.903			
			PU3	0.815			

Discriminant validity

To evaluate discriminant validity, the Fornell and Larcker (1981) criterion was applied, considered one of the most relevant measures in this area. In this method, the square root of the average variance extracted (AVE) is evaluated for each latent variable. The recommended guideline is that the square root of the AVE for each latent variable should be greater than its correlation with any other latent variable (Garson, 2016). The bold text on the diagonal of Table 3 represents the square root of the AVE of each of the latent variables. The results show that, in all latent variables, the square root of the AVE is greater than the correlations with other variables (the numbers below the diagonal), confirming that discriminant validity is adequately established in the study.

Table 3. Discriminant validity of the measurement model

Constructo	AI	C	CF	EM	FDUP	IS	IU	PL	UP
AI	0.814								
C	0.174	0.740							
CF	0.465	0.427	0.894						
EM	-0.035	0.720	0.402	0.751					
FDUP	0.601	0.536	0.409	0.171	0.924				
IS	0.336	0.467	0.336	0.565	0.342	0.666			
IU	0.339	0.444	0.275	0.239	0.594	0.383	0.934		
PL	0.234	0.439	0.202	0.404	0.569	0.478	0.610	0.860	
UP	0.386	0.383	0.430	0.307	0.551	0.531	0.408	0.536	0.818

Structural model and hypothesis testing

To examine the structural model, it is essential to investigate the statistical significance of the relationships in the model (t value) of the research hypotheses (path estimates) at the 0.05 level, as well as the coefficient of determination (R2) for the endogenous variables of the research. The model shows 47% variation in the intention to use. The total effects of PP (0.389), PEOU (0.543) and C (0.141) are important for the explanation of intention to use. Furthermore, GE (0.403), CSE (0.303), PEOU (0.579) and PU (0.225) account for 47% of the variance in perceived playfulness. On the other hand, PEOU (0.468), CSE (0.245), SI (0.366) and GE (0.100) explain 44% of the variance in perceived usefulness. CSE (0.524) and FC (0.166) account for 38% of the variance in perceived ease of use. Finally, content (0.72) explains 51% of the variance in goal expectancy. Figure 2 and Table 4 summarize the results of the hypotheses.

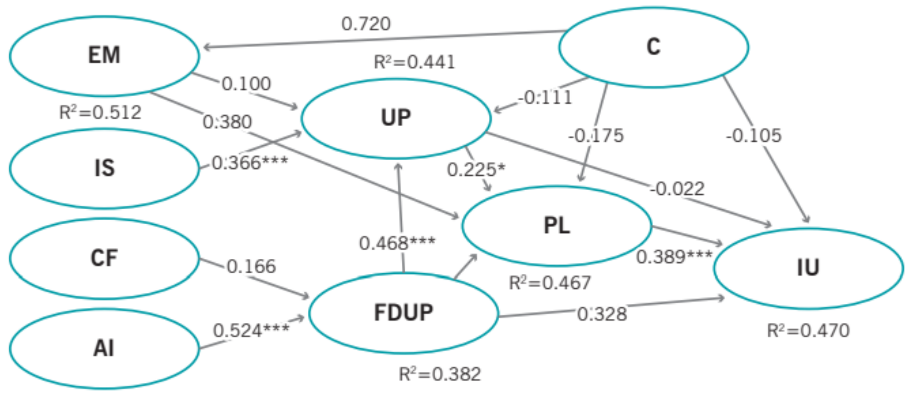

Figure 2. Path coefficients of the research model (CBAAM).

Source: own elaboration based on the CBAAM of Terzis and Economides (2011).

Table 4. Hypothesis testing results

Hypothesis	Path	Trajectory coefficient	t-*values*	p-*values*	Empirical evidence
H1	PL->IU	0.389***	2.648	0.008	Accepted
H2	UP->IU	-0.022	0.134	0.893	Rejected
H3	UP->PL	0.225	1.764	0.078	Rejected
H4	FDUP-	0.328**	2.261	0.024	Accepted
H5	FDUP-	0.468***	2.791	0.005	Accepted
H6	FDUP-	0.474***	2.953	0.003	Accepted
H7	AI-	0.524*	1.749	0.080	Rejected
H8	IS->UP	0.366***	2.920	0.004	Accepted
H9	CF-	0.166	0.835	0.404	Rejected
H10	EM-	0.100	0.454	0.650	Rejected
H11	EM-	0.380**	2.025	0.043	Accepted
H12	C->UP	-0.111	0.431	0.666	Rejected
H13	C->PL	-0.175	0.716	0.474	Rejected
H14	C->EM	0.720***	10.537	0.000	Accepted
H15	C->IU	0.105	0.883	0.377	Rejected

Note: *p < 0.10, **p < 0.05, ***p < 0.01.

DISCUSSION

The purpose of this study was to explore and identify the influencing factors on students' attitude towards the use of CBA in higher education. All contributions to this area of research help institutions have a successful implementation of CBA. According to the literature and previous studies such as that of Terzis *et al*. (2013), factors such as perceived usefulness, perceived ease of use, perceived playfulness, and perceived importance are crucial for the intention to use CBA.

The results of the study indicate that perceived playfulness directly impacts the intention to use. On the other hand, it was identified that perceived usefulness, perceived ease of use, computer self-efficacy, social influence, facilitating conditions, goal expectancy and content have indirect impact on the intention to use (see table 5).

Table 5. R^2 and direct, indirect and total effects

Dependent variable	R^2	Independent variable	Direct effect	Indirect effect	Total effect
Intention to use	0.470	Perceived playfulness	0.389	0.000	0.389***
		Perceived usefulness	-0.022	0.088	0.066
		Perceived ease of use	0.328	0.215	0.543***
		Computer self-efficacy	0.000	0.284	0.284
		Social influence	0.000	0.024	0.024
		Facilitating conditions	0.000	0.090	0.090
		Goal expectancy	0.000	0.155	0.155
		Content	0.105	0.036	0.141
Perceived playfulness	0.467	Perceived usefulness	0.225	0.000	0.225*
		Perceived ease of use	0.474	0.105	0.579***
		Computer self-efficacy	0.000	0.303	0.303
		Social influence	0.000	0.082	0.082
		Facilitating conditions	0.000	0.096	0.096
		Goal expectancy	0.380	0.023	0.403**
		Content	-0.175	0.265	0.090
Perceived usefulness	0.441	Perceived ease of use	0.468	0.000	0.468***
		Computer self-efficacy	0.000	0.245	0.245
		Social influence	0.366	0.000	0.366***
		Facilitating conditions	0.000	0.078	0.078
		Goal expectancy	0.100	0.000	0.100
		Content	-0.111	0.072	-0.039
Perceived ease of use	0.382	Computer self-efficacy	0.524	0.000	0.524*
		Facilitating conditions	0.166	0.000	0.166

Goal expectancy	0.518	Content	0.720	0.000	0.72***

Note: *p < 0.10, **p < 0.05, ***p < 0.01.

It is interesting that the content construct, used for the first time in this model, did not show a direct impact on the intention to use, in contrast to what was suggested in the initial hypothesis. Only one hypothesis of the ones proposed was also confirmed in relation to the content: it has a direct effect on perceived usefulness, perceived playfulness and goal expectancy, which indicates an indirect influence on the intention to use. Regarding goal expectancy, which was also used for the first time in this model, it was shown that students find a playful CBA when they have good expectations of the system. Likewise, the positive effect of social influence on perceived usefulness provided by TAM2 was supported by this model.

It can be argued that significant gaps still exist despite the substantial effort and attention that has been devoted to research on ICT adoption. The work of Terzis and Economides (2011) represents one of the few studies focused on developing a model to understand the adoption of e-assessments. It identifies and demonstrates the key constructs that influence students' willingness to use CBA, providing significant insight into the field of e-assessment. Table 6 summarizes the results of this research and aforementioned authors, show the 15 hypotheses and whether or not they were supported by the model. Data obtained from this study concludes that students are more likely to use a system if it is playful, which confirms the findings of previous studies. Likewise, a CBA is more likely to be perceived as playful when it is easy to use.

Table 6. Summary of the results of this research and those of Terzis and Economides (2011)

Hypothesis	Path	Results from Terzis and Economides (2011)	Results of this research
H1	PP- > IU	Accepted	Accepted
H2	PU- > IU	Rejected	Rejected
H3	PU- > PP	Accepted	Rejected
H4	PEOU- > IU	Accepted	Accepted
H5	PEOU- > PU	Accepted	Accepted
H6	PEOU- > PP	Accepted	Accepted
H7	CSE- > PEOU	Accepted	Rejected
H8	SI- > PU	Accepted	Accepted
H9	FC- > PEOU	Accepted	Rejected
H10	GE->PU	Accepted	Rejected
H11	GE-> PP	Accepted	Accepted

H12	C- > PU	Accepted	Rejected
H13	C- > PP	Accepted	Rejected
H14	C- > GE	Accepted	Accepted
H15	C- > IU	Rejected	Rejected

CONCLUSION

In this work, a study was carried out on the factors that influenced students' behavior in the intention to use a computer-based assessment in higher education. The tested model and measurement were supported by collected data. The results of this research demonstrate that perceived playfulness has a direct effect on the intention to use CBA, which agrees with what Terzis and Economides (2011) stated and with previous research on the adoption of other technologies (Wang *et al.,* 2009; Ong *et al.,* 2004; Landry *et al.,* 2006). However, it was found that: a) facilitating conditions and computer self-efficacy do not have a direct effect on perceived ease of use, b) goal expectancy and content do not have a direct effect on perceived usefulness, and c) perceived usefulness and content do not have a direct effect on perceived playfulness. These relationships contradict Terzis and Economides (2011) results.

A major challenge facing the implementation of CBE is the lack of research that aims to identify a comprehensive list of behavioral constructs linked to its adoption. Various studies opt for different theoretical approaches regarding technological innovation, but few have established a bridge between the most prominent innovation adoption models and the CBA adoption process. This study has practical implications, since it provides an instrument with evidence of reliability and validity for measuring the use and acceptance of CBA in a Mexican educational context. In addition, it allows us to know the ways in which students perceive the use of ICT specifically applied to the evaluation process.

On the other hand, from a theoretical perspective, as it is an adaptation of an instrument already published in another language and in another context, it allows us to compare observable constructs and indicators, since one of the most important limitations of this type of study is that specific samples of students are used to express their beliefs. This is one of the possible reasons why it was found that certain hypotheses were validated in one of the models, but not in the other. At the same time, it should be considered that the time in which the studies were carried out could have significantly influenced the results, because familiarity and predisposition towards technology have evolved over time.

This study concludes that a system is more likely to be used by students if it is playful, and that CBA tends to be perceived as playful when it is useful and easy to use. Finally, the acceptance model studied for the CBA explains approximately 47% of the variance in the intention to use CBA, so it is recommended to investigate other variables that affect the intention to use and apply the model in other contexts for further confirmation.

ACKNOWLEDGMENTS

This work was carried out with the support of a Conacyt grant 769631.

REFERENCES

Al-Qdah, M. & Ababneh, I. (2017). Comparing Online and Paper Exams: Performances and Perceptions of Saudi Students. *International Journal of Information and Education Technology*, *7*(2), 106-109. https://doi.org/10.18178/ijiet.2017.7.2.850

Bagozzi, R. P. & Yi, Y. (1988). On the evaluation of structural equationmodels. *Journal of the academy of marketing science*, *16*(1), 74-94. https://doi.org/10.1007/BF02723327

Chau, K. Y.; Law, K. M. & Tang, Y. M. (2021). Impact of Self-Directed Learning and Educational Technology Readiness on Synchronous E-Learning. *Journal of Organizational and End User Computing (JOEUC)*, *33*(6), 1-20. https://doi.org/https://doi.org/10.4018/JOEUC.20211101.oa26

Chin, W. W. (1998). The partial least squares approach to structural equation modeling. *Modern methods for business research*, *295*(2), 295-336. http://www.researchgate.net/publication/232569511

Compeau, D. R. & Higgins, C. A. (1995). Computer self-efficacy: development of a measure and Initial test. *MIS Quarterly*, *19*(2), 189-211. https://doi.org/10.2307/249688

Davis, F. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, *13*(3), 319-340. https://doi.org/10.2307/249008

Fornell, C. & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing research*, *18*(1), 39-50. https://doi.org/10.2307/3151312

Garson, G. D. (2016). *Partial least squares: Regression and structural equation models*. Statistical Associates Publishers.

Granic, A. & Marangunic, N. (2019). Technology acceptance model in educational context: A systematic literature review. *British Journal of Educational Technology*, *50*(5), 2572-2593. https://doi.org/10.1111/bjet.12864

Hair, J. J. F.; Hult, G. T. M.; Ringle, C. & Sarstedt, M. (2016). *A primer on partial least squares structural equation modeling (PLSSEM)*. Sage Publications.

Hestenes, D.; Wells, M. & Swackhamer, G. (1992). Force concept inventory. *The Physics Teacher*, *30*(3), 141-158. https://doi.org/10.1119/1.2343497

Imtiaz, A. & Maarop, N. (2014). A Review of Technology Acceptance Studies in the Field of Education. *Jurnal Teknologi*, *69*(2), 2180-3722. https://doi.org/doi:10.11113/jt.v69.3101

Joint Information Systems Committee (JISC). (2007). Effective practice with e-assessment: An overview of technologies, policies and practice in further and higher education. https://people.cs.vt.edu/shaffer/cs6604/Papers/eAssessment.pdf

Jordan, S. (2013). E-assessment: Past, present and future. *New Directions*, *9*(1), 87-106. https://oro.open.ac.uk/38536/3/SEJ%20New%20Directions%202013%20d3.pdf

Kundu, A. & Bej, T. (2021). Experiencing e-assessment during covid-19: an analysis of Indian students' perception. *Higher Education Evaluation and Development*, *15*(2), 114-134. https://doi.org/10.1108/heed-03-2021-0032

Landry, B. J.; Griffeth, R. & Hartman, S. (2006). Measuring student perceptions of blackboard using the technology acceptance model. *Decision Sciences Journal of Innovative Education*, *4*(1), 87-99. http://dx.doi.org/10.1111/j.1540-4609.2006.00103.x

Mo, D. Y.; Tang, Y. M.; Wu, E. Y. & Tang, V. (2022). Theoretical model of investigating determinants for a successful Electronic

Assessment System (EAS) in higher education. *Education and Information Technologies*, *27*(9), 12543-12566. https://doi.org/10.1007/s10639-022-11098-1

Moon, J. y Kim, Y. (2001). Extending the TAM for a world-wideweb context. *Information and Management*, *38*(4), 217-230. https://doi.org/10.1016/S0378-7206(00)00061-6

Muñiz, J.; Elosua, P. & Hambleton, R. K. (2013). Directrices para la traducción y adaptación de los tests: segunda edición. *Psicothema*, *25*(2), 151-157. https://doi.org/10.7334/psicothema2013.24

Nikou, S. A. & Economides, A. A. (2017). Mobile-based assessment: Investigating the factors that influence behavioral intention to use. *Computers and Education*, *109*, 56-73. https://doi.org/10.1016/j.compedu.2017.02.005

Ong, C. S.; Lai, J. Y. & Wang, Y. S. (2004). Factors affecting engineers' acceptance of asynchronous e-learning systems in high-tech companies. *Information & Management*, *41*(6), 795-804. http://dx.doi.org/10.1016/j.im.2003.08.012

Sarstedt, M.; Ringle, C. M.; Smith, D.; Reams, R. & Hair, J. F. (2014). Partial least squares structural equation modeling (PLS-SEM): A useful tool for family business researchers. *Journal of Family Business Strategy*, *5*(1), 105-115. https://doi.org/10.1007/978-3-319-05542-8_15-2

Scherer, R.; Siddiq, F. & Tondeur, J. (2019). The technology acceptance model (TAM): A meta-analytic structural equation modeling approach to explaining teachers' adoption of digital technology in education. *Computers & Education*, *128,* 13-35. https://doi.org/10.1016/j.compedu.2018.09.009

Smith, P. J.; Murphy, K. L. & Mahoney, S. E. (2003). Towards identifying factors underlying readiness for online learning: an exploratory study. *Distance Education*, *24*(1), 57-67. https://doi.org/10.1080/01587910303043

Sousa, V. D. & Rojjanasrirat, W. (2011). Translation, adaptation and validation of instruments or scales for use in cross-cultural health care research: A clear and user-friendly guideline. *Journal of Evaluation in Clinical Practice*, *17*(2), 268-274. https://doi.org/10.1111/j.1365-2753.2010.01434.x

Tang, Y. M.; Chen, P. C.; Law, K. M. Y.; Wu, C. H.; Lau, Y. Y.; Guan, J.; He, D. & Ho, G. T. S. (2021). Comparative analysis of Student's live online learning readiness during the coronavirus (covid-19) pandemic in the higher education sector. *Computers & Education*, *168*. https://doi.org/10.1016/j.compedu.2021.104211

Terzis, V. & Economides, A. A. (2011). The acceptance and use of computer based assessment. *Computers & Education*, *56*(4), 1032-1044. https://doi.org/10.1016/j.compedu.2010.11.017

Terzis, V.; Moridis, C. N. & Economides, A. A. (2012a). How student's personality traits affect Computer Based Assessment Acceptance: Integrating BFI with CBAAM. *Computers in Human Behavior*,*28*(5), 1985-1996. https://doi.org/10.1016/j.chb.2012.05.019

Terzis, V.; Moridis, C. N. & Economides, A. A. (2012b). The effect of emotional feedback on behavioral intention to use computer based assessment. *Computers & Education*, *59*(2), 710-721. https://doi.org/10.1016/j.compedu.2012.03.003

Terzis, V.; Moridis, C. N. & Economides, A. A. (2013). Continuance acceptance of computer based assessment through the integration of user's expectations and perceptions. *Computers & Education*, *62*, 50-61. https://doi.org/10.1016/j.compedu.2012.10.018

Timmis, S.; Broadfoot, P.; Sutherland, R. & Oldfield, A. (2016). Rethinking assessment in a digital age: opportunities, challenges and risks. *British Educational Research Journal*, *42*(3), 454-476. https://doi.org/10.1002/berj.3215

Venkatesh, V. & Davis, F. D. (1996) A Model of the Antecedents of Perceived Ease of Use: Development and Test. *Decision Science*, *27*, 451-481. https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1540-5915.1996.tb00860.x

Venkatesh, V.; Morris, M. G.; Davis, G. B. & Davis, F. D. (2003) User Acceptance of Information Technology: Toward a Unified View. *MIS Quarterly*, *27*, 425-478. https://doi.org/10.2307/30036540

Wang, Y. (2003). Assessment of learner satisfaction with asynchronous electronic learning systems. *Information & Management*, *41*(1), 75-86. https://doi.org/10.1016/S0378-7206(03)00028-4

Wang, Y. S.; Wu, M. C. & Wang, H. Y. (2009). Investigating the determinants and age and gender differences in the acceptance of mobile learning. *British journal of educational technology*, *40*(1), 92-118. https://doi.org/10.1111/j.1467-8535.2007.00809.x

HOW TO CITE

Torres Kauffman, J. G.; Olmos Pineda, I. y González Calleros, J. M. (2024). Aceptación y uso de la evaluación basada en computadora en estudiantes universitarios. *Apertura*, *16*(1), 40-55. http://doi.org/10.32870/Ap.v16n1.2476