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DESCRIPCIÓN

La **Revista de Investigación y Evaluación Educativa (Revie)** es una publicación semestral del **Instituto Dominicano de Evaluación e Investigación de la Calidad Educativa (Ideice)**, dedicada a la difusión de investigaciones nacionales e internacionales en el ámbito educativo. Su objetivo es fomentar el análisis crítico, la innovación y la mejora continua en la educación mediante la publicación de estudios rigurosos. Revie mantiene una **política de acceso abierta** y recibe artículos que cumplan con estándares científicos, los cuales son sometidos a rigurosos procesos de arbitraje editorial. Se publica en febrero y agosto, promoviendo un espacio para el diálogo académico y la generación de conocimiento que impacte en la calidad educativa.

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RELATIONSHIP BETWEEN TECHNOLOGICAL ACCEPTANCE AND NEURO-PEDAGOGICAL DESIGN OF AN INTERACTIVE EBOOK FOR TEACHER TRAINING: AN EMPIRICAL STUDY IN MEXICO

RELACIÓN ENTRE ACEPTACIÓN TECNOLÓGICA Y EL DISEÑO NEUROPEDAGÓGICO DE UN LIBRO ELECTRÓNICO INTERACTIVO PARA LA FORMACIÓN DOCENTE: UN ESTUDIO EMPÍRICO EN MÉXICO

 

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ABSTRACT

Over the past decades, a new pedagogical approach called neuroeducation has been raised; this new knowledge area gathers psychology, pedagogy, and neuroscience into a new educational approach. As on-service teachers requested more flexible devices to be trained, an electronic book was designed, making it essential to know the acceptance level of this strategy. This study examined the relationship between technological acceptance and neuro-pedagogical design factors in an interactive eBook for teacher training in a sample of 50 teachers from the northern region of Mexico. Data was collected using a questionnaire based on the Technological Acceptance Model and the Neuro-didactic proposal. Research was conducted under a quantitative approach, following Design Based Research methodology. Data was analyzed using construct validity and a descriptive analysis using SmartPLS and SPSS software. The research used a Design-based Research methodology and an explanatory design. Its findings revealed positive relations among Technological Acceptance and latent variables Perceived Usefulness (r=.895), Perceived Ease of Use (r=.883), Neuro-educational Experience (r=.656) and Neuro-educational Content (r=.432), which validates that the neuro-pedagogical design of the e-book is suitable for teachers' training since there is a strong and positive relation among latent variables and Technological Acceptance.

KEYWORDS

Electronic Books, TAM3, technological acceptance, neuro-pedagogy, teacher's training.

RESUMEN

Durante las últimas décadas se ha planteado un nuevo enfoque pedagógico llamado neuroeducación; Esta nueva área de conocimiento reúne la psicología, la pedagogía y la neurociencia en un nuevo enfoque educativo. Dado que los docentes en servicio solicitaron dispositivos más flexibles para capacitarse, se diseñó un libro electrónico, por lo que es fundamental conocer el nivel de aceptación de esta estrategia. Este estudio examinó la relación entre la aceptación tecnológica y los factores de diseño neuropedagógico en un libro electrónico interactivo para la formación docente en una muestra de 50 docentes de la región norte de México. La recolección de datos se realizó mediante un cuestionario basado en el Modelo de Aceptación Tecnológica y la propuesta Neurodidáctica. Realizada bajo un enfoque cuantitativo, utilizando la metodología de la Investigación Basada en Diseño. Los datos se analizaron mediante el software SmartPLS y SPSS. La investigación utilizó la metodología de Investigación basada en Diseño y un diseño explicativo. Sus hallazgos revelaron relaciones positivas entre la Aceptación Tecnológica y las variables latentes Utilidad Percibida (r=.895), Facilidad de Uso Percibida (r=.883), Experiencia Neuroeducativa (r=.656) y Contenido Neuroeducativo (r=. 432), lo que valida que el diseño neuropedagógico del libro electrónico es adecuado para la formación docente ya que existe una fuerte y positiva relación entre las variables latentes y la Aceptación Tecnológica.

PALABRAS CLAVE

Libro electrónico, TAM3, aceptación tecnológica, neuropedagogía, formación docente.

1. INTRODUCTION

Existing research results regarding teachers' lack of acquisition of sufficient knowledge and domain of some regions of neuroscience demonstrate that training educators in neuroeducation provide "evidence on facilitating factors to student engagement and lasting, durable learning"(Fragkaki et al., 2022, p. 1) to improve learning quality, scientific advances in the knowledge of the functioning of the brain and the neurocognitive processes that underlie the learning process must be taken into account to improve the educational practice of in-service teachers.

In addition to the above, neuroeducation is increasingly demanding and evolving, where skills must be constantly renewed to fulfill the educational objective of teaching work. Hence, neuroeducation, as a subdiscipline of neurosciences, allows the use of neuroscientific knowledge in academic practice and requires that all educational dimensions be considered (Nouri, 2022). Likewise, there is a need to be trained in using technological tools such as eBooks, which can increase motivation to be educated in different areas.

Nowadays, constructivism has reached remarkable importance in teacher training; eBooks have gained meaning as one of the most reliable didactic materials for adult training (Öztürk, 2021), especially in neuroeducation and cognitive neuroscience. In fact, after the COVID-19 pandemic, the use of technology in formal and informal education has shown a noteworthy increase. Statistics in the U.S. revealed that regarding teacher's technology efficacy during the pandemic, "about 64.2% reported high self-efficacy using digital devices, while the remaining 35.8% reported low self-efficacy" (Ogodo et al., 2021, p. 21).

E-books are flexible electronic devices that offer many advantages, making them a feasible learning object for in-service teachers' training. The possibility of constantly expanding information, flexible learning environments, and eliminating information access gaps that have been present in fixed courses and educational materials. Furthermore, digital learning environments facilitate the interactions between students and trainers and allow a more attractive experience that can be more engaging and motivating. Recent studies have shown that digital technology enables the development of complementary skills in trainees and a role change, such as switching from a passive learner to an engaged student (Fernández-Otoya et al., 2024; Turgʻunboyev, 2024).

Teaching professionalization is one of the concerns that permeate all areas, from the management of school directors to policies in state, national, and global educational institutions, such is the case of the Organization of the United Nations in the sustainable development objectives proposed for 2030 mentions the training of teachers in developing countries, as well as the increase in qualified teachers

(UN, 2015), being one of the integral axes of the development of education worldwide, training and updating teacher, which is part of the actions that countries must implement within their educational systems.

2. METHODOLOGY

The study aims to validate the curricular proposal of the neuro-pedagogical design of an interactive eBook for teacher training by examining the relationship between Technological Acceptance and Neuro-Pedagogical Design factors, analyzing the data of a questionnaire applied to 50 elementary school teachers from Durango, Mexico, who attended a professionalization program in neuroeducation and used the eBook, which was designed under the principles of Brain-Based Learning (Caine & Caine, 1990), Cognitive Modification Theory (Feuerstein et al., 2006), the Universal Design for Learning (Boothe et al., 2018), and the Neurodidactic Planning Model (Díaz-Cabriales, 2021), among other theoretical proposals such as Ríos (2019) and Rotger (2017).

The study was carried out using the quantitative approach, with an explanatory scope and an experimental design, systematized under the hypothetical deductive paradigm, under the proposal of Design-Based Research, which is compatible with the study of technological acceptance. This research analyzed the data under the partial least squares regressions methodology, which is regularly used in studies of acceptance of information technologies, in this case, the interactive eBook, using a questionnaire as an instrument, designed under the Technological Acceptance Model (TAM3) (Venkatesh et al., 2003, 2008; Venkatesh & Davis, 2000). The research was done under the quantitative method and an explanatory design, using techniques based on component analysis, such as Partial Least Squares or PLS, following the procedure proposed by Ramírez et al. (2014) , who states that:

PLS assesses a causal model that involves multiple variables with multiple observed items. This assessment is performed simultaneously on the structural model (causality between independent and dependent constructs) and the measurement model (load of the observed items with their respective constructs). Among the notable features of PLS are that it does not necessarily require a solid theoretical foundation (it supports both exploratory and confirmatory research) and is relatively robust to deviations from normality. (p. 134)

Likewise, for the development of the PLS structural equation modeling (PLS-SEM), SmartPLS 4.0.9.1 software was used. The resulting model allowed us to understand and validate the acceptance of an interactive neuro-pedagogical eBook for elementary school teachers based on the technological acceptance variables proposed by Davis (1989) in the original TAM model and its factors, which have

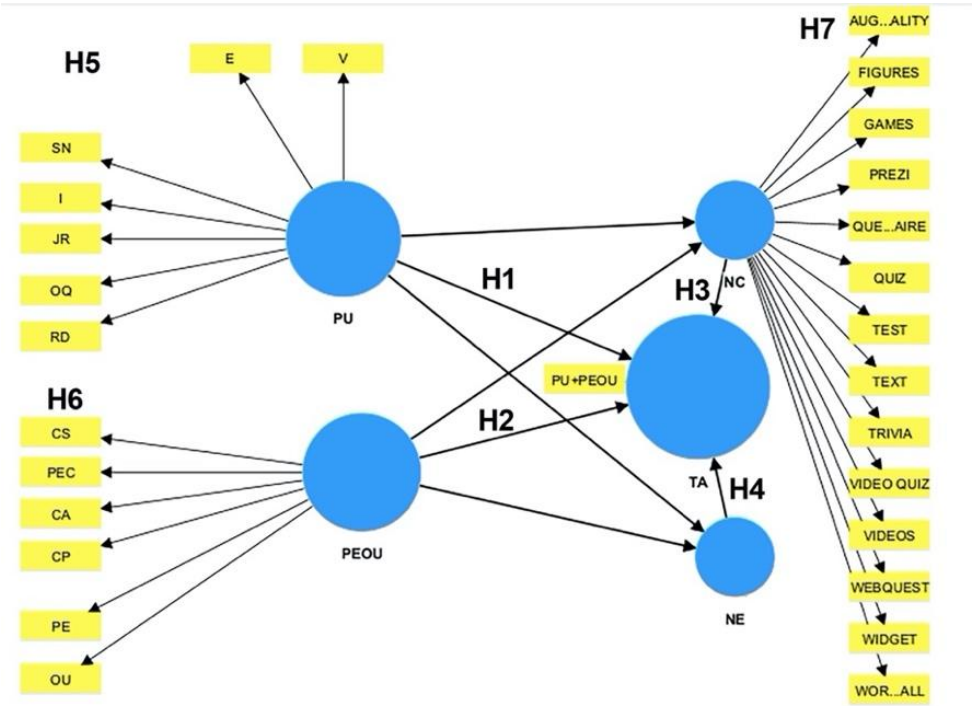
evolved to the TAM3 (Venkatesh et al., 2008), as well as the components of the neuro-pedagogical design. Allowing the understanding, if there is a relation between those components and the main variables of this study. Thus, this research proposes the following hypotheses:

- H1. Perceived Usefulness (PU) is positively associated with EBook's Technological Acceptance (TA).
- H2. Perceived Ease of Use (PEOU) is positively associated with EBook's Technological Acceptance (TA).
- H3. Neuropedagogical Content (NC) is positively associated with EBook's Technological Acceptance (TA).
- H4. Neuropedagogical Experience (NE) is positively associated with EBook's Technological Acceptance (TA).

Based on those hypotheses, it is proposed the following Expectation-Confirmation Model (ECM):

FIGURE 1.

EXPECTATION-CONFIRMATION MODEL (ECM)



Proposed ModeLData was collected using a Google Forms questionnaire directed to elementary school teachers trained in neuroeducation through a diploma program where the eBook was used. Once the data was collected and codified according to the 1-7 values (Likert Scale) in Microsoft Excel, the first validation of the data was conducted, tested using Statistical Package for the Social Sciences (SPSS), finding that Cronbach's Alpha for the instrument scored of .894, ranging from .80 to .90, which is an excellent score. Furthermore, there was no need to eliminate any element since the variation between item-correlations would not be significant.

In addition, this research was made under the Design-Based Research (DBR) methodology, under an iterative intervention process, and seeks to influence the solution of a problem through the design of effective strategies, establishing that it is essential that the methodology responds to the phenomenon of study, in the case of the application of the interactive e-Book, it is a research that is circumscribed within the research in Educational Technology, in which according to Valverde-Berrocoso (2016) quantitative studies predominate, being the most used quasi-experimental studies, with questionnaires as the most common data collection technique.

Besides that, the DBR process has two primary purposes: first, to solve the educational problem in question; second, at the end of the study, to offer research principles so that similar studies have methodological references (Escudero, 2018). As a result of this scientific investigation, some products were generated, which were tested and validated to be later published as potential solutions to the problem addressed (Chaparro et al., 2017), under the premise that these products can be both artifacts (textbooks, videos, applications, computer programs, etc.), as well as processes and procedures (methodologies, teaching plans, and other didactic strategies generated during the investigation) (De Benito y Salinas, 2016). Within this methodology, the design and development phase is essential, defined as a systematic study that extends to the assessment of educational interventions, also having the possibility of creating new theories, artifacts, and practices that positively impact teaching processes and learning in authentic contexts (Valverde-Berrocoso, 2016).

Morehead, one of the main characteristics of the DBR is the fact of producing a wide range of educational innovations, whose fundamental characteristic consists of introducing a new element to transform a situation (De Benito & Salinas, 2016) through the production of simple or complex artifacts, activities, support systems, and interventions, based on a specific theoretical foundation about teaching and learning, which reflects a greater understanding of the relationship between theory, designed artifacts, and practice, enabling the production of empirical knowledge that validates the designed intervention strategy, the constructed artifact, the correlational findings and the established theoretical proposals.

Electronic books have become a widespread way of sharing information, from the PDF format to complex digital objects such as ePUBs. It can be said that these have become a crucial tool for communication, especially in the educational field (Pinedaa et al., 2022), among the characteristics that make it applicable is the fact that it is scalable, modifiable, customizable, and, above all, easy to navigate, access and distribute (De la Peña, 2019), due the point of being able to provide the content in various formats also allows it to be inclusive.

Also, an interactive eBook is a Virtual Learning Object related to the teaching task as it is an electronic extension of the traditional book. It is enriched by the advantages of being a scalable, multiplatform multimedia material and with the possibility of incorporating the principles of the Universal Learning Design and the Theory of Structural Cognitive Modifiability, materials can be used by most of the students, regardless of the different capacities, physical or cognitive limitations that it may present. As a result, this type of material promotes inclusion and equity (CAST, 2018).

In the same matter, interactive e-books allow real-time, virtual models, or b-learning or blended learning work, which provides versatility in their application that not only puts the teacher's cognitive abilities at stake but also develops superior executive functions such as self-regulation. One of the most critical aspects of the eBook is that by its own nature, it is not a finished artifact; it must remain in constant change so that both publishers and educators can customize the designs with interactive formats and animation components depending on the resources with those who count (Lim et al., 2020) because much of the effectiveness of eBooks depends on factors such as design, interactivity, richness of content, and students' perception, the benefit students get or can get from using eBooks (Almekhlafi, 2021).

In the case of the eBook, the interface is characterized by its dynamism, which promotes the active participation of students, awakening in them an essential aspect of the learning process, such as motivation; all this is derived from the diversity of resources present in electronic books such as videos, sounds, and animations produce a greater interest in the user (Bermeo & Cajamarca, 2017), because the variety in the design styles that have emerged as the eBook itself has evolved to incorporate elements such as personalization, and the possibility that the teachers themselves begin to produce their eBooks from the printed books they use in class, in an exercise that does not mean a significant investment for teachers (Lim et al., 2020).

As a result, the need to measure the degree of acceptance of the eBook within the training process led to the review of several methodological proposals for instruments to measure this variable; hence, it is observed in the literature that Davis (1985) proposes the Technological Acceptance Model, which is based on the Theory of Reasoned Action (TRA) (Cabero et al., 2016) since it managed to adapt the generic design of this theory to the particular context of information systems or as we know them in the information and

communication technologies. Currently, the TAM model is widely used in research. However, it maintains its validity, particularly in areas of education. (Wannapiroon et al., 2021)

The objective of TAM is to provide a theoretical model that the determining factors that influence the adoption of ICTs (Davis, 1989) . The model, particularities include adapting the causal relationship belief-attitude-intention-behavior and base acceptance on two particular beliefs; perceived usefulness and perceived ease of use these beliefs determine the user's intention to use a technology, and, therefore, their actual use of it (Sastre & Blasco, 2018).

Regarding the Perceived Ease of Use, Davis considered that it refers to the degree to which a person contemplates that using a particular system will be effortless (Davis, 1989); this concept was built after Albert Bandura's Theory of Perceived Self-efficacy, which is defined as the judgments about how a person can execute the necessary courses of action to overcome specific situations. (Bandura, 1997). The relationship between the perceived ease of use refers to the fact that self-efficiency beliefs and procedural knowledge, as well as the management of experiences and the execution of skills required, influence (Venkatesh et al., 2008).

TAM has its origin both in the Theory of Reasoned Action proposed by Fishbein and Ajzen in 1975 and in the Theory of Planned Behavior the researcher Ajzen proposed in 1985, both coming from cognitive psychology, sharing the purpose to investigate the process by which an individual adopts a conclusive behavior (Terán, 2019), basic aspect to know the behavior of acceptance of the eBook that is proposed for teacher training.

Venkatesh and Bala proposed the TAM3 (2008), adding some determining variables to the perceived ease of use. These are four anchor variables or determining factors: computational self-efficiency, perception of external control, computational anxiety, and computational entertainment. The second group of determining factors are the so-called adjustments, which are made up of the aspects of perceived enjoyment and objective usability; with the above, the TAM3 is complemented so that it can take into account the external factors that can influence the measurement and behavior of the two main variables; perceived usefulness and perceived ease of use, both related to self-efficacy, understood as:

One’s belief is in one's ability to control one's motivation, behaviors, and social environment. The concept originates from social cognitive theory and refers to the degree of one’s belief regarding one's ability to accomplish given tasks and objectives in particular circumstances. (Widiantoro et al., 2022, p. 1235)

Nowadays, Neuroeducation allows educational agents to bring knowledge related to the brain and learning that helps them understand what the process is like for students with different problems

(D'Addario, 2019) because they reveal the role of individuality as a determining factor of learning; according to empirical evidence, the urgency of a new teacher training that is based on neurosciences is a latent need (Acta, 2019), since it has already been possible to evolve from a constructivist model to a connective model with the benefits and restrictions that this entails (Rojas-Londoño & Díaz-Mora, 2020), now teacher training institutions must join this neuro-educational trend in which existing didactic programs are integrated and where all the benefits for learning that arise from the interrelation of all its elements are used (Codina et al., 2022, p. 125) from a new holistic perspective.

Regarding neuro-didactics, it is essential to note that as a new discipline, it is trying to influence education, learning, neuroscience, teaching, and gamification (De la Peña, 2019). This provides a framework to establish that the existence of design-based research and the possibility of producing not only an intervention strategy but also a pedagogical proposal are other factors that make this study viable. In addition to helping to solve the educational problem, neuro-didactics is also trying to transform educational practices.

Neurodidactics field has been established as a new area within neuroscience that deals with the study of the brain and how it works to be able to propose improvements in the pedagogical dynamics of current teachers (D'Addario, 2019); its foundation is based on some principles proposed by García-Valdecasas et al. (2022) who suggest inverting the traditional classroom mode, group learning, frequent use of new technologies and flexibility of schedules and use of various methods. In these strategies, the student plays the leading role, being active in the learning process, considering his needs, emotional character, way of studying, reasoning, and understanding.

2.1 NEURO-PEDAGOGICAL DESIGN

The neuro-educational design proposal of the eBook is based on some main theories, such as brain-based learning (Caine & Caine, 1990), the Universal Design for Learning (CAST, 2018), the theory of Structural Cognitive Modifiability (Feuerstein et al., 2006) , and the Neurodidactic Planning Model (Díaz-Cabriales, 2021), all of them are proposals that are aligned with the knowledge of how the brain learns, to provoke metacognitive processes in the learner, that facilitate the significance of the new learning objective achieved (Noguez, 2002), promoting in the student some learning criteria that are indicated by Reuven Feuerstein such as the feeling of competence, the regulation and control of behavior, the act of sharing, individualizing and psychological differentiation, challenging behavior, the human being as changing entity, and the optimistic alternative.

The proposal is established as a multidimensional and multisystemic pedagogical model with contents in different formats (audios, videos, quizzes, interactive activities, augmented reality, etc.)

converge to promote multimodal learning (Edjidjimo, 2022), in which both cerebral hemispheres work together, but rather take into account the eight systems of organized learning proposed by Subirats (2022) which are: biological, procedural, conditional, cognitive, expressive-creative, emotional-volitional, social and mental, as an integral proposal that achieves a technologically rich resource in which motivation and the intention to examine the benefits of technology in the educational context are present (Lee, 2018).

The eBook design aims not only for teachers to be trained in this science but also to achieve a meta-cognition process in which they exercise control over their learning processes under a self-regulation scheme for their emotions (Codina et al., 2022). Therefore, based on the previously mentioned theories, some guidelines were established so that the e-book complied with a neuro-pedagogical design by brain-based learning theories:

- Open the range of possibilities for the student to complete the task, taking into consideration that the main objective is not the acquisition of content but rather the development of functional cognitive structures so that the student can, at some point, become self-manager of the content through self-regulation; we must leave open how the student wishes to achieve the objective, always taking into account that the mediation of the teacher will be one of the core points for the correct development of the activity.
- Understand the different learning needs when the brain, through the Ascending Reticular Activating System (ARAS), identifies the stimuli as irrelevant and not necessary for its survival or that it does not have a history where there was an experience where serotonin was produced; it will simply discard it. That is why the teacher must present the contents in a significant way for the student, and that, if they are not an apparent learning need, become one from the correct stimulus and the awakening of epistemic curiosity.
- Recognize the strengths and weaknesses of students; this aspect is common to the UDL since any didactic planning method, no matter how traditional it may be, has taken these aspects into account. Otherwise, it could hardly be classified as a correct planning process.
- Use of technologies.
- Build an appropriate learning environment.
- Choice of form of expression: At this point, there must be an opening for the student to express the learning they are acquiring in the way they deem most convenient.
- Present the material in different formats.

3. ANALYSIS AND RESULTS

Once the course was finished and the instrument was applied to the teacher, some measurements were made to validate the obtained data. Instrument analysis obtained a KMO of .771, which does not reach the "meritorious" category, although it obtains an average score that still allows us to work with the instrument. Regarding the factorial analysis, it was forced onto two components or factors as indicated by the theory (Davis, 1989), assessing the significant Bartlett sphericity test at .000, for which reason proceeded to perform a factorial analysis of the correlation matrix and found that the commonalities of the dimensions exceeded the value of .3. For that reason, they are considered acceptable, integrated into two components calculated by the varimax rotation method that explain 55% of the total accumulated variance.

The second validity test was conducted through SEM-PLS on SmartPLS software, finding that all the variables scored Chronbach's Alpha above 7.0 "to determine the reliability of a variable, which refers to an indicator's consistency or stability." There is also a need for Rho-A and Rho-C should be greater than 0.7 (Pinedaa et al., 2022). In Table 1, we can see that those requirements are fulfilled by all the latent variables of the study, except for the average variance extracted, which has to be greater than 0.5. In this case, only PEOU reached an acceptable score of .612. Meanwhile, NC scored .328. PU scored .467 nonetheless since the theoretical support has strong validation, and due to high scores on Rho-A and Rho-C, it is concluded that the results are acceptable (Lam, 2012).

About Cronbach's Alpha, scores should be greater than 0.7, Rho-A should be greater than 0.7, and composite reliability should be greater than 0.7. Then, convergent validity and construct reliability are assumed to be dependable for structural equation modeling. Meanwhile, the average variance extracted (AVE) should be greater than 0.5 (Pinedaa et al., 2022, p. 59), requirements that are fulfilled as shown in Table 1.

TABLE 1.

RELIABILITY OF LATENT VARIABLES

	CHRONBACH'S ALPHA	COMPOSITE RELIABILITY (RHO_A)	COMPOSITE RELIABILITY (RHO_C)
Neuroeducational Content (NC)	.857	.876	.857
Perceived Ease of Use (PEOU)	.873	.883	.904
Perceived Usefulness (PU)	.808	.824	.858

Discriminant validity is a testing procedure that "ensures that a reflective construct holds the strongest correlation with its indicator." (Widiantoro et al., 2022, p. 1239) therefore, it is essential to analyze the correlation between all the latent variables in order to visualize the effect that has one with another on table 2 we can find the correlations between the three latent variables of the study.

TABLE 2.

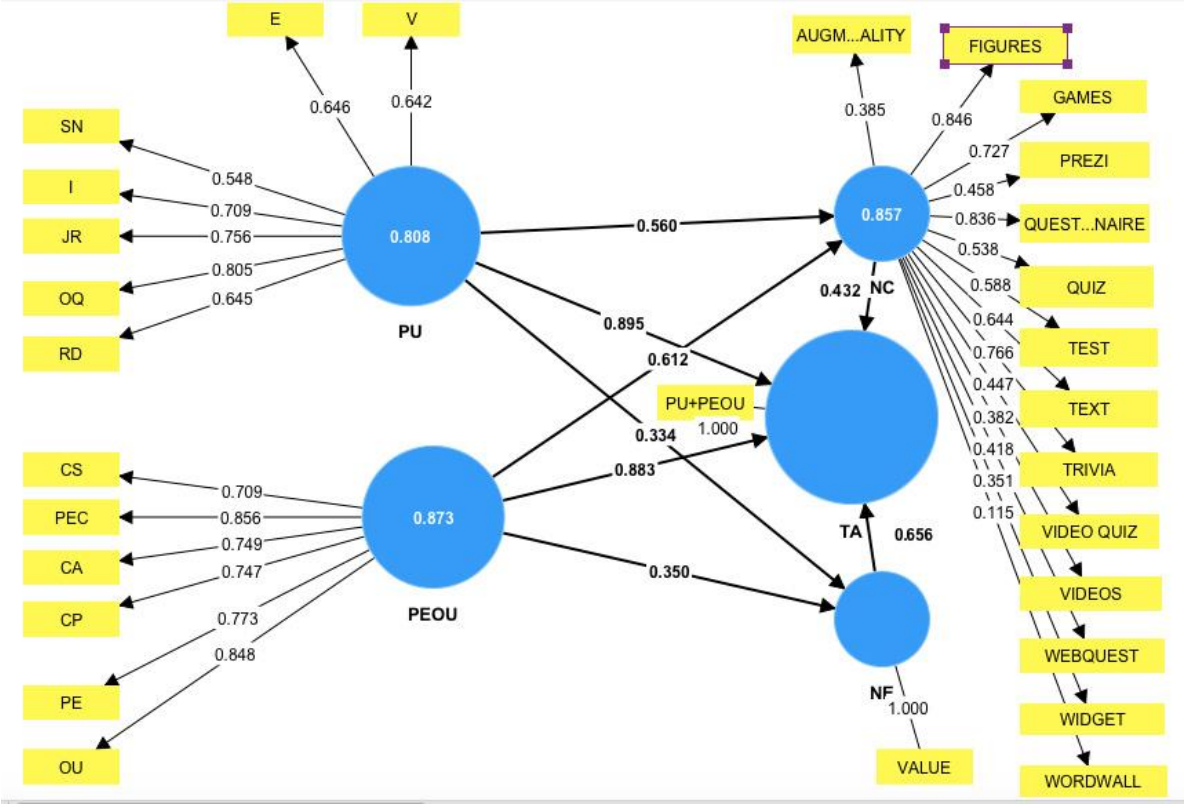
VARIABLES CORRELATION

	NC	NE	PEOU	PU	TA
NC	1				
NE	0.761	1			
PEOU	0.612	0.350	1		
PU	0.560	0.334	0.833	1	
TA	0.533	0.289	0.883	0.895	1

The research aims to validate the design of the eBook through the TAM application; to follow the process established by Ramírez et al. (2014), a model description was built using SmartPLS software, showing the significance and relation score between latent variables and its technological factors in the case of PU and PEOU (TAM3), and also between the Neuro-pedagogical Components in the case of NC, as shown in the figure 2.

FIGURE 2.

MODEL CORRELATIONS



It is shown that PU is positively related to TA (H1), with a strong score of .895 (p-value), in agreement with the results of Widiantoro et al. (2022) establishing the relationship between perceived usefulness and acceptance of e-learning systems such as the interactive eBook. PEOU relates positively with TA (H2), scoring .883, which represents a high correlation and is in line with the findings of Mizher & Alwreikat (2023, p.160) , who observed a "significant effect of PEOU on PU towards adoption of e-textbooks," as well as Zhang et al. who found that PEOU enhances PU, and contribute to "individuals' beliefs that the technology will improve their performance and help them achieve their goals."

NC shows a positive relation with TA (H3) with a moderate score of .432, and even when the score is not very high, an essential influence of neuro-pedagogical components on technological acceptance is observed, showing that individuals willingness to use technology is related to conditions where the device is implemented (Efiloğlu Kurt & Tingöy, 2017), in this case, the neuro-pedagogical design of the eBook enhances accessibility, improving using conditions. Pinedaa et al. (2022) establish that improving the acceptance of the eBook requires a better perception of benefit for the user, so the applicability of the

curricular contents of the proposal should be reviewed to improve the acceptance of the neuro-pedagogical interactive eBook as a training proposal for teachers.

NE shows a positive relation with TA (H4) with a high score of .656, which states that the general perception of the eBook affects the acceptance of it, showing the advantages of using electronic books as virtual learning resources for training in mixed environments (Miao et al., 2020), because technology acceptance promotes positive emotions and enhances technological self-efficacy (An et al., 2022). Meanwhile, the neuro-pedagogical experience trains teachers in learning and teaching using brain-based methodologies.

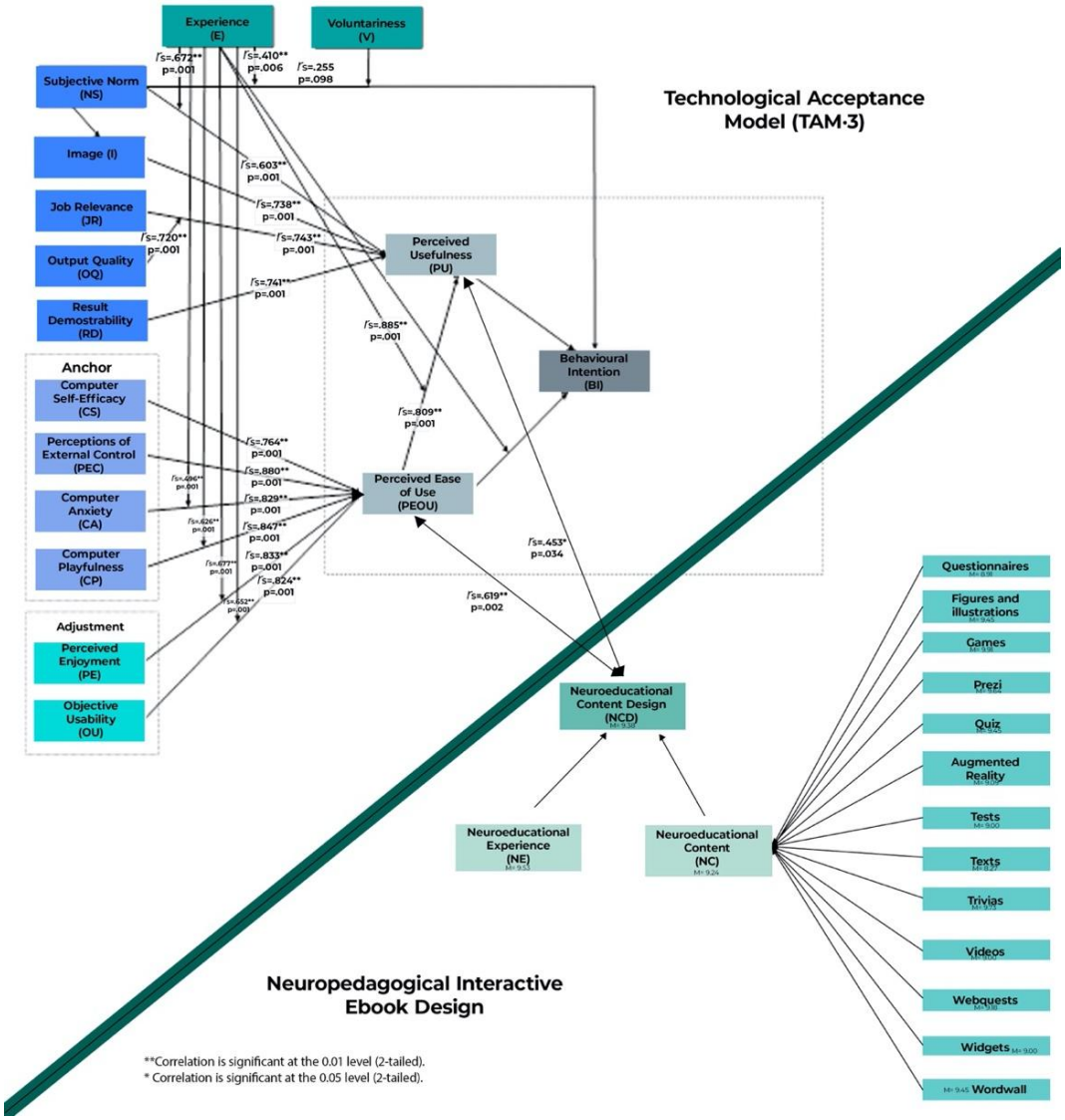
It is also observed that technological factors have a positive relation with PU, scoring: .642 with Voluntariness (V), .646 with Experience (E), .548 with Subjective Norm (SN), .709 with Image (I), .756 with Job Relevance (JR), .805 with Output Quality (OQ) and .645 with Result Demonstrability (RD), as concluded by some other researches such as Sastre and Blasco (2018), Davis (1989), and Venkatesh et al. (2003). Regarding technological factors influence on PEOU, it is observed a positive relation among them, scoring .709 with Computer Self-efficacy (CS), .856 with Perceptions of External Control (PEC), .749 with Computer Anxiety (CA), .747 with Computer Playfulness (CP), .733 with Perceived Enjoyment (PE) and .848 with Objective Usability (OU).

Lastly in reference to neuro-pedagogical content formats, it has been found a positive relation with NC, scoring .385 with augmented reality, .846 figures, 727 with games, .458 with prezi presentations, .836 with questionnaires, .538 with quizzes, .588 with tests, .644 with texts, .766 with trivia, .447 with video quizzes, .382 with videos, .418 with webquests, .351 with widgets and .115 wordwalls, as implied by other research results that establish any information format that allows the enhancement of the educational process will generate better learning environments (Gallo et al., 2019), responding to training needs in a context where technology is constantly present, being able to establish strategies with the potential to be replicated in groups of teachers with similar features (Escalante et al., 2019) in order to develop skills that go beyond those exclusively disciplinary; the need to offer training programs in co-design strategies, and design of digital educational resources in educational institutions, to respond to current transformations (Diez-Martínez & Morales-Velasco, 2020).

As an exercise to validate the findings through the SEM analysis, it was performed a linear regression analysis on SPSS shows that the beta coefficients of technological factors are statistically significant at a 1 percent significance level ($p<0.01$), scoring: .092 (PU), .237 (SN), .359 (V), .267 (I), .163 (JR), .137 (OQ), and .197 (RD) for PU. Moreover, scoring .192 (CS), .203 (PEC), .187 (CP), .219 (CA), .131 (CE), and .128 (CU) for the PEOU variable, demonstrating that both variables affect the intention to use e-books, as found in (Ann, 2022).

FIGURE 3.

TAM3 + NEURO-PEDAGOGICAL MODEL RELATIONS



It was also found that PU is positively related to all TAM3 model influential factors, scoring rs=.603 (p.001) with Subjective Norm, rs=.738 (p.001) with Image, rs=.743 (p.001) with Job Relevance, which at the same time relates positively with Output Quality scoring between JR and OQ rs=.720 (p.001), and finally PU relates positively with Result Demonstrability, scoring rs=.741 (p.001). Besides, the second TAM3 variable Perceived Ease of Use (PEOU) holds a positive relation with all its factors as well, scoring: rs=.764 (.001) with Computer-Self Efficacy, rs=.880 (p.001) with Perceptions of External Control, rs=.829 (.001) with Computer Anxiety, rs=.847 (p.001) with Computer Playfulness, rs=.833 (p.001) with

Perceived Enjoyment, and rs=.824 (p.001) with Objective Usability. The data demonstrates that the experience of using the eBook has a more vital acceptance due to the more substantial and more positive relation of the variable PEOU with its technological factors (rs max. .743, rs min. .603), in comparison with the scores of PU and its factors (rs max. .880, rs min. .824).

In the case of the factor Experience, the data analysis shows that it correlates positively with NS (rs=.672, p.001), CA (rs=.496, p.001), CP (rs=.626, p.001), PE (rs=.677, p.001), and OU (rs=.652, p.001). The only factor that has no relation with the other predictors is Voluntariness, which scored (rs=.255 p.098).

4. DISCUSSION AND CONCLUSIONS

Both Instrument and SEM analysis produced similar results and supported the curricular proposal of the neuro-pedagogical design of the interactive eBook for teacher training by finding positive relations among the latent variables and their influential factors and neuro-pedagogical components. The empirical evidence demonstrates the technological acceptance of the interactive eBook and validates all the hypotheses of this study.

Based on the empirical information and the analysis carried out, it is concluded that the acceptance of the neuro-pedagogical eBook is influenced by the perceived usefulness and the perceived ease of use, as well as by the neuro-educational design of the eBook and the multiformat contents that were included in it; the neuro-pedagogical design.

Therefore, it is established that incorporating electronic books as a pedagogical means of training must follow the principles of brain-based learning to give the learner a holistic educational experience. In addition, the fundamental aspects of navigability, design, accessibility, and content must be considered to succeed in any e-book proposal.

It is also established that the neuro-educational design of the electronic book contributes to the technological acceptance of this virtual learning object since it provides a different user experience through multiformat content.

5. FINANCING

CONAHCYT postgraduate studies scholarship.

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