The future of learner-interface interaction. A vision from EdTech

El futuro de la interacción aprendiz-interfaz, una visión desde la tecnología educativa

http://dx.doi.org/10.32870/Ap.v12n2.1910

Nayiv Amin Jesus Assaf Silva*

Keywords
Human-computer interaction; learner-interface interaction; AI; EdTech; intelligent agents; tech design; covid-19

ABSTRACT

Based on Moore's three interactions of distance education, Hillman, Willis & Gunawardena, proposed a technological interaction in the instructional domain, the learner-interface interaction. Twenty-six years after their proposal, considering the high degree of technologization of educational technology due to its link to artificial intelligence, this interaction is more valid than ever. This article develops the past, present and future of this fourth interaction. The three most important technological areas related to education are presented, for the future development of the learner-interface interaction: Evaluation of technological interactions in the learning domain (Usability and user experience), Capabilities of intelligent educational agents (Artificial intelligence and natural language processing) and Scope of predictive algorithms in education (Deep learning and big data), as fundamental elements, although not the only ones, for the design of the next generation of 2D and 3D intelligent multimedia interactive interfaces for educational purposes. The need for a unified interactional model, based on the Anderson-Moore triangular interactional model, is raised, and the Anderson equivalence theorem is taken to hypothesize a possible future scenario in the short, medium and long term for highly technological education.

Palabras clave
Interacción humano-computadora; interacción estudiante-interfaz; tecnología educativa; inteligencia artificial; agentes inteligentes; diseño tecnológico; covid-19

RESUMEN

A partir de las tres interacciones de Moore de la educación a distancia, Hillman, Willis y Gunawardena propusieron una interacción tecnológica en el dominio instruccional: la interacción aprendiz-interfaz. A veintiséis años de su propuesta, esta interacción está más vigente que nunca ante el alto grado de tecnologización de la tecnología educativa por su vinculación con la inteligencia artificial. En este artículo abordamos el pasado, presente y futuro de esta cuarta interacción, y exponemos los tres rubros tecnológicos más importantes en torno a la educación para el desarrollo futuro de la interacción aprendiz-interfaz: evaluación de interacciones tecnológicas en el dominio del aprendizaje (usabilidad y experiencia de usuario), capacidades de agentes inteligentes educativos (inteligencia artificial y procesamiento de lenguaje natural) y alcance de algoritmos predictivos en educación (deep learning y big data), elementos fundamentales, aunque no los únicos, para el diseño de la próxima generación de interfaces interactivas multimedia inteligentes 2&3D con propósito educativo. Planteamos la necesidad de un modelo interaccional unificado, basado en el modelo interaccional triangular Anderson-Moore, y recurrimos al teorema de equivalencia de Anderson para hipotetizar un posible escenario futuro a corto, mediano y largo plazo de la educación altamente tecnológica.

Received: April 6, 2020
Accepted: August 14, 2020
Online Published: September 30, 2020

*PhD candidate of Educational Innovation at the School of Humanities and Education at the Technologic Institute of Monterrey, Mexico.
ORCID: http://orcid.org/0000-0002-8370-7233

INTRODUCTION

There is no educational process without interaction, mainly between the learner and the content (Moore, 1989; Anderson & Garrison, 1998; Gunawardena, 1999; Anderson, 2003; Xiao, 2017). This educational axiom, which in the interaction design area takes the form of learner-content interaction, is one of the three fundamental interactions of distance education (Moore, 1989), this is deemed to be the weak link of specialized literature regarding the research on interaction (Xiao, 2017).

The history of the learner-interface interaction, which is the means of technological and conceptual support of learner-content interaction, was very different because it had not been conceptualized until Hillman, Willis & Gunawardena (1994) proposed this fourth interaction, the first technological interaction in the discipline, to evidence the relevance and fundamental role which technology also played in the instruction through technological mediation (Danesh, Bailey & Whisenand, 2015). This interaction revealed that the quality of the interface design, and not only of the contents therein, could either significantly optimize or limit learning (Mayer, 2014).

Thus, the aspect of any technology presented to human beings and which is in contact with them is the interface. This side between two entities is called user interface in the technological field, and it is regularly defined as the place where human beings interact with digital devices (Scolari, 2018). From specialized literature, a user interface is a set of sensory controls and channels whereby a user may interact with a machine (Tidwell, Brewer & Valencia-Brooks, 2020).

Apparently, the concept and the role of the interface went unnoticed regarding education through technological mediation, classroom education included. It was not until the last decade that its relevance has been the reason of attention and concern in education (Wang & Tai, 2016). These reasons underlie, above all, in sophistication and complexity of interaction and on the answer the interface may provide the student (Luckin & Cukurova, 2019). For the contribution of artificial intelligence to education and its natural language processing capability, its approach is deemed to be relevant to be studied from the logic of educational technology (Kumar & Reddy, 2019; Doleck *et al.*, 2019).

Since the end of the eighties, Moore (1989) issued a first tripartite model of interaction in the interest of conceptualizing and operationalizing strategies, actions and scopes in the field of distance education. Moore considered that this topic was urgent and, at the same time, controversial, as he visualized indefinite spaces in the new processes which technology had available to instructors and learners. Subsequent efforts, made by Hillman *et al*. (1994) and Anderson & Garrison (1998) uncovered the fact that the interaction concept would become complex as technological advances enabled different actions in interaction models between the interface and learner-content-instructor, everything by means of using interfaces gradually with more features and benefits. Finally, Gunawardena (1999) said there was a need for a model to evaluate the facility with which interactions were performed and the quality of the learning experience.

One thing is certain, the interaction model and the role performed by the interface has not been completed to this day, and the questions posed by Moore (1989) have not been answered, upon which Gunawardena (1999) insisted and deepened:

> What kind of interaction level is essential for efficient learning? How can we achieve interaction? What is the contribution of synchronous interaction (in real time) and asynchronous (in deferred time)? What kind of interaction may be provided by new interactive technologies? Is this well worth the effort? (p. 3).

In view of the multi-directionality of the topic evolution, and in view of the prospect regarding the rapid development of technology for educational purposes, it is relevant to make a stop on the road to recapitulate on the evolution of complexity and on the role of the interface and interaction in education. The purpose of this communication is to make a historical review of the learner-interface interaction as a basic element for the conceptual development and technical advance of educational technology, which enable the provision of technological knowledge necessary to face the future of education in the short, medium and long term.

Thus, in a chronological order, and upon consideration of the past (1989-2005), present (2006-2020) and future (20210-2035) stages, we will have a more accurate communication on the evolution of the link in the interaction process of education by technological mediation. We have taken the learner-interface interaction as a central axis of development, we reviewed the historical foundation, we reflected on the current standing, and projected the future of a model that would complete all the technological interactions in the

educational mastery; we, therefore, seek to answer the questions posed by Moore (1989) more than 30 years ago.

The past (1989-2005)

Interaction as the main topic in education, whether under distance or classroom mode, has been theorized at least since the times of Dewey (1916). Its relevance has been highlighted by characters such as Piaget (1971) and Vygotsky (1980). Although the adjective "disturbing" given by Moore (1989) reveals the debates which have taken place throughout time in the educational field around interaction (Jia, 2020; Anderson, 2003; Moore, 1989), its relevance lies in understanding in detail what the role of the interface is in every mediated educational process. The manner and time of the educational process are defined from the dynamics between interface and interaction, the dynamics of agents involved in the process and operational results to be achieved. These elements are essential to understand mediation in distance instruction processes (Moore, 1989; Anderson & Garrison, 1998; Gunawardena, 1999; Anderson, 2003; Akyol & Garrison, 2013; Cho & Cho, 2017; Xiao, 2017; Gunesekera, Bao & Kibelloh, 2019; Jia, 2020).

At the end of the eighties, Moore (1989) reflected on the problem of communicating concepts in distance education. He said that such terms as interaction were used in a vague and polysemic manner in the discipline. This lead to set a classification proposal consisting of three types of interaction which the community involved in distance education "should be able to distinguish and accept within their practice" (p. 1): learner-content interaction, learner-instruction interaction and learner-learner interaction.

Based on Moore's group of interactions in public domain, defined by him as dialog interactions (Akyol & Garrison, 2013) in this theory of transactional distance, Hillman et al. (1994) proposed the learner-interface interaction, a structural interaction, as a manner to extend and to improve the theories of distant education interactions in the technological domain. The so called fourth interaction (Gunawardena, 1999; Anderson, 2003; Cho & Cho, 2017; Xiao, 2017; Gunesekera et al., 2019; Jia, 2020) arises in a context where the learner interaction with the technological media was not theorized (Gunawardena, 1999; Hillman *et al.*, 1994). The main reason is that it was substituted by the learner-content interaction, which was considered to be the only thing, in the technological media, with which the learner interacted (Xiao, 2017; Gunawardena, 1999; Jia, 2020; Hillman et al., 1994). Regardless of the media type

or technology at hand (Moore, 1989), it was believed that the interface was formed by contents only.

In order to supplement the four interactions existing at the time, Anderson & Garrison (1998) proposed a second trilogy of interactions: content-content interaction, instructor-instructor interaction and instructor-content interaction, which would make the model of Moore (1989) into a symmetrical one. But this was an interactional model the conceptualization of which was difficult to make by using the technology available at the time. Because there was no other interface design than the one predetermined by the programmer in the technology applied to education then, the content-content interaction, among other limitations, could be no more than a theoretical form.

The merge of the different models of Moore (1989) and of Anderson & Garrison (1998) resulted into the Anderson-Moore triangular interactional model (see figure 1), which completed possible social interactions of distance education. However, it must be highlighted that this model along with distance education did not distinguish or contributed anything which did not require classroom education. This stage in distance education and, generally, mediated by technology, lacks a unique characterization at the epistemological level of interaction. For this reason, the theorization of Hillman *et al.* (1994) is emphasized in view of the relevance assigned to the interface as the place where they meet and the means they interact with the learner, the instructor and the content.

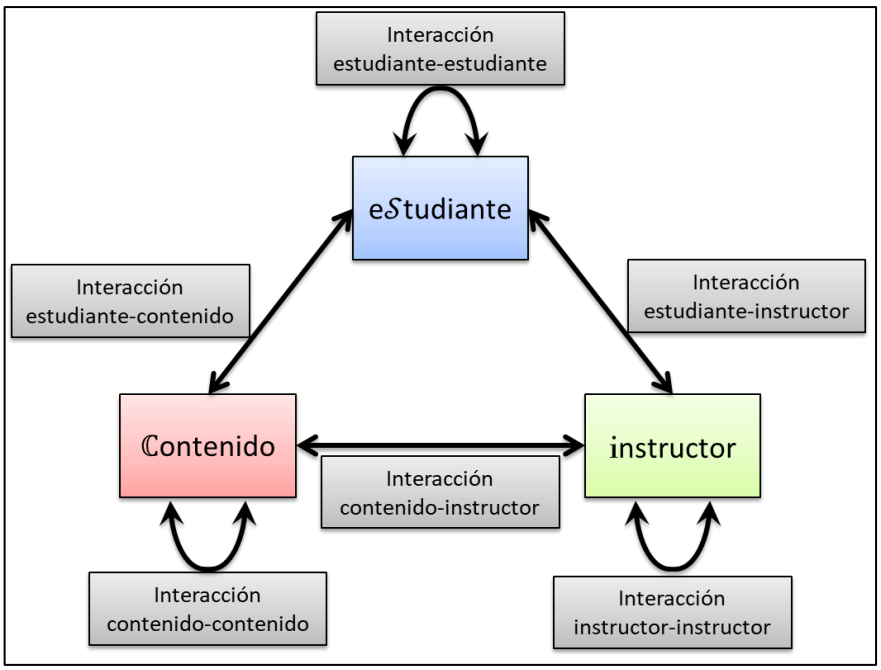

Figure 1. Anderson-Moore's interactional triangle model.

At the end of the interaction definition stage, we incorporated Anderson's (2003) equivalence theorem to the literature, which proposes and explains two forms to optimize the interrelations of Moore's (1989) interactions.

> Deep and significant formal learning is developed, provided, however, one of the three forms of interaction (learner-peer; learner-instructor; learner-content) are at a high level. The other two may exist at minimal levels, or even may not exist, without degrading the educational experience. The high levels of more than one of these three modes would probably provide a more satisfactory educational experience, although these experiences may not be so effective regarding cost and time, as less interactive learning sequences (p. 4).

This theorem opens the way to optimal forms of technological design and instructional design (Anderson, 2003), due to its analytical usefulness. Below is the translation into a formal language to consider future implications:

Equivalence Theorem. Be $(\mathcal{S} \rightleftarrows \mathbb{P})_i$ the Student-Peer instructional interaction; $(\mathcal{S} \rightleftarrows \mathsf{e})_i$ the Student-"instructor" instructional interaction; $(\mathcal{S} \rightleftarrows \mathbb{C})_i$ the Student-Content instructional interaction; A_f, X_e, t and \$, the factors: formal learning, educational eXperience,

time and cost. If the interaction and factor levels are optimized, then the thesis $\mathcal{T}_1$ and $\mathcal{T}_2$:

$$\mathcal{T}_1(\mathcal{S} \rightleftarrows \mathbb{P},\mathrm{e},\mathbb{C})_{i} := Max(\mathcal{S} \rightleftarrows \mathbb{P})_{i} \oplus Max(\mathcal{S} \rightleftarrows \mathrm{e})_{i} \oplus Max(\mathcal{S} \rightleftarrows \mathbb{C})_{i} \Rightarrow (A_f) \Big|_{deep}^{significan} \quad (1)$$

$$\mathcal{T}_2\ (\mathcal{S} \rightleftarrows \mathbb{P},\mathrm{e},\mathbb{C})_{i} := Max(\mathcal{S} \rightleftarrows \mathbb{P})_{i} \cdot Max(\mathcal{S} \rightleftarrows \mathrm{e})_{i} + Max(\mathcal{S} \rightleftarrows \mathrm{e})_{i} \cdot Max(\mathcal{S} \rightleftarrows \mathbb{C})_{i} + \cdots + Max(\mathcal{S} \rightleftarrows \mathbb{P})_{i} \cdot Max(\mathcal{S} \rightleftarrows \mathbb{C})_{i} \Rightarrow Max(X_e) \neq (min(t) + min(\$))$$

At this point in history, the interaction taxonomy has become a fundamental player in the guidance to design and evaluate learning interaction and experience. This theoretical link stressed on the need of Gunawardena's (1999) evaluation model and on being able to establish the difference of the dual role of learner-interface interaction, as a learner-interface interaction and as a technological discipline in the learning domain: "It's important to make a distinction between how interface is perceived as an independent fourth form of interaction, and the use of an interface as a mediating element of the whole interaction" (p. 4).

This distinction was made evident in the development of two ways that lead the way towards the construction of the term learner-interface interaction: the educational and the technological. From the educational field, we understand that the learner-interface interaction completed the group of a learner interaction with the instructor, the content and peers; Hillman et al. (1994) make it evident that it is important to theorize and to work in the making of instructional interactions with interface as a fundamental educational element. From the technological field, the interaction concept between the human being and the machine has evolved towards the learning domain, which is comprised as a discipline within the educational technology, which is a counterpart in the human-computer interaction of technology.

To exemplify how the concept of technological interaction towards learning has changed and improved, figure 2 shows a chronogram which allows understanding the evolution of the term learner-interface interaction. The two relevant conceptual lines of the evolution are: man-human-user-learner and machine-computer-device-interface. It is important to emphasize that, in spite of the fact that the learner and interface concepts have been implemented in the terminology of technological interaction since 1985, it was not until 1994 that they merged in the same interaction with a focus on learning.

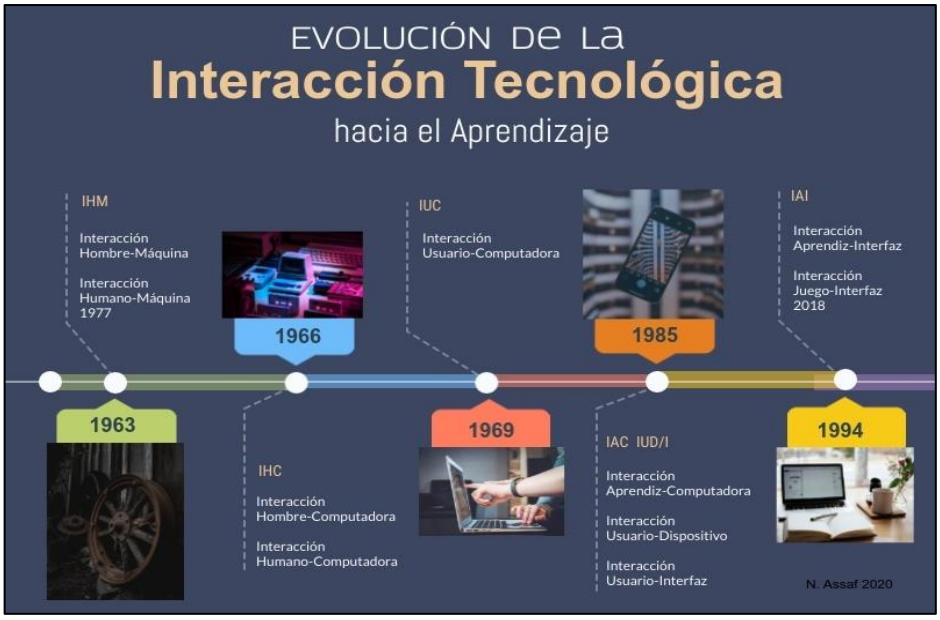

Figure 2. Evolution of the technological interaction concept towards learning domain.

The present (2006-2020)

After the emergence of Hillman's *et al.* (1994) seminal text, and a window of more than a decade with no publications on the term learner-interface interaction in specialized indexes, the text of Rautopuro, Pöntinen y Kukkonen (2006) leads a series of 17 publications that begin the present time of this interaction, and which finish with the text of Bringula *et al.* (2017). We mapped the terms in the Scopus and Web of Science (WoS) indexes until 2020 (see table and figure 3) as an illustration of the current condition of the learner-interface interaction. We selected these indexes in view of the quality of the issues they lodge devoted to the study of educational technology.

Table. Mapping of the term learner-interface interaction

Reference	Appears in	In Scopus	In WoS	Year
Hillman, Willis & Gunawardena	Title and abstract	✓	×	1994
Rautopuro, Pöntinen & Kukkonen	Abstract	✓	×	2006
Bray, Aoki & Dlugosh		✓	×	2008
Chang		✓	×	2009
Alsharif & Roche		✓	×	2010
Şimşek, Atman, Inceoğlu & Arikan		✓	×	
Chou, Peng & Chang		✓	✓	
Cho		✓	×	2011
Martin, Parker & Deale		✓	×	2012
Luo & Lei		✓	×	
Mladenova & Kirkova		✓	×	2014
Wang, Rush, Wilkerson & Van Der Merwe		✓	✓	
Hsiao & Huang		×	✓	
Lee		✓	✓	2015

Bringula, Basa, De la Cruz & Rodrigo	Title and abstract	✓	✓	2016
Bringula, Álvarez, Evangelista & So		✓	✓	2017
Jancheski	Abstract	×	✓	

Source: made with information taken from Scopus and WoS (2020).

Unlike the vision of Hillman et al. (1994), the 16 subsequent surveys propose the learner-interface interaction in an operational form, only focused on the metrics, like the number of clicks, the time of response and use. A likely reason for this interpretation is that the learner-interface interaction never was integrated to the Anderson-Moore model; this means that the social sphere of mediated education by technology has not been unified with the technological sphere, a guild division prevailing thus far (Clark, 2020).

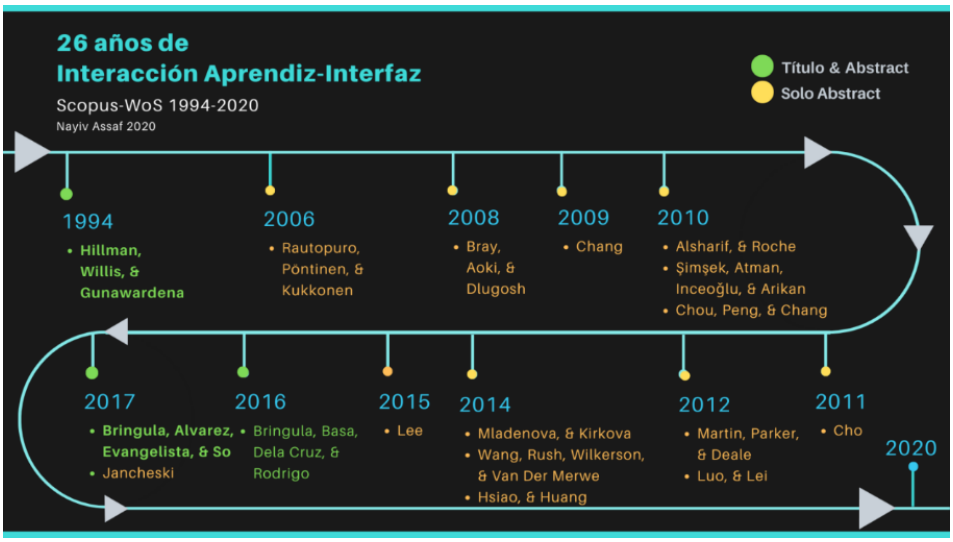

Figure 3. Chronogram of the term learner-interface interaction in the indexed literature of Scopus 1994-2020.

Absence of the learner-interface interaction of theoretical models may be interpreted in a number of manners; mainly, it denotes a conceptual void in the operation of the interface as a technological mediation and as the foundation in technological mediated

instruction. Therefore, we conclude that this has not been assimilated by current instructors or education technologists, as has been warned by Hillman *et al.* (1994) and Gunawardena (1999) more than two decades ago.

The above remark speaks of the fundamental scarcity of the presence and contribution of educational technology in the future of educational interfaces, which are their main object of study, in addition to the absence of contributions to instructional topics from education. This is due to the trend of current technological evolution towards intelligent interfaces with educational purposes, as no human instructor has been set up, because the human educator has been substituted by the interface itself, with some form of configured artificial intelligence as intelligent agents, avatars, virtual tutors or conversational bots (Cope, Kalantzis & Searsmith, 2020; Garg, 2020; Longo, 2020; Nappi & Cuocolo, 2020; Rampton, Mittelman & Goldhahn, 2020; Ricco, Guetarni & Kolh, 2020; Villegas-Ch, Arias-Navarrete & Palacios-Pacheco, 2020; Walsh, 2020; Yang & Bai, 2020), based on the concentration of technological identification concepts for complex patterns and on processing natural language (Luckin & Cukurova, 2019; Doleck et al., 2019).

An example of the application of combined teaching-learning strategies considered as ostensibly human capabilities applied in a formal manner in educational interfaces, is learning based on tutorships and on an inverted classroom, where the intelligent interface asks the human learner to guide it and teach it (Luckin & Cukuroca, 2019). These instructional and technological developments are the beginning of the agenda expected for education, educational technology and artificial intelligence (Alexandru *et al.*, 2015); however, this absolutely does not imply, nor shall this be done in future decades, substitution of the instructor in front of the group, although it is possible in face-to-face instructional processes, provided, however, that the learner does not interact in an instructional mode in the learning process. In other words, the educational and artificial intelligence technology, for the time being, requires an ideal learner, focused and engaged in what is being taught.

This technological and educational evolution involves a new role of the interface in the present, in addition to the previous conceptualization as a means of support of contents and as a technological medium of interaction. It is now considered as an technological medium of instruction, which transforms the

instructional learner-interface interaction $(\mathcal{S} \rightleftarrows \ddot{\imath})_{\dot{\imath}}$; into a new instructional goal-interaction instructional learner-interface $\langle \mathcal{S} \leftrightarrow \ddot{\imath} \rangle_{\dot{\imath}}$; an instructional interaction of instructional interactions that comprises the learner-instructor interaction $(\mathcal{S} \rightleftarrows \mathrm{e})_{\dot{\imath}}$; into the instructor-instructor interaction $(\mathrm{e}^2)_{\dot{\imath}}$; and the instructor-content interaction $(\mathrm{e} \rightleftarrows \mathbb{C})_{\dot{\imath}}$ into a single analytically expressed interaction as: $\langle \mathcal{S} \leftrightarrow \ddot{\imath} \rangle_{\dot{\imath}} = (\mathcal{S} \rightleftarrows \mathrm{e})_{\dot{\imath}} + (\mathrm{e}^2)_{\dot{\imath}} + (\mathrm{e} \rightleftarrows \mathbb{C})_{\dot{\imath}}$

The development of deep study of the instructional technological interaction and of instructional interfaces, such as the jurisdiction of the educational technology and not of technology or education, opens the road to a vision of a future that involves a turning point in radical direction, which is marked and formalized by the sudden and necessary educational change which entailed the closing of schools at a global scale (Kennepohl, 2020), which had its peak during the first five days of April 2020, and which left more than 91% of the world enrolment out of the classroom (UNESCO, 2020).

The future (2021-2023)

In the coming fifteen years, research programs shall be performed on education and educational technology aimed to analyze the educational effects and technological implications of the sudden change of the digital format applied during the first months of 2020 (Schlegelmiclch & Douglas, 2020), and research areas shall be developed of new forms of mediated education, as a short, medium and long term strategy (Nacu, Martin & Pikard, 2018) with the purpose of preventing critical situations like the one that resulted in world confinement due to the global pandemic of Covid-19.

Also, future works shall be linked to the forms, topics and applications already in existence operationally, on educational technology in at least three items of the main development that will have an impact on educational understanding and practice:

- Assessment of technological-instructional interactions under the learning domain: as a basis in the development of usefulness of instructional evaluation methods and user-learner experience aimed to determine the level of technological instructionality of interfaces developed with an educational purpose ((Nathoo *et al*., 2020; Nahar, Sulaiman & Jaafar, 2020; Raees & Ullah, 2020).
- Capabilities of intelligent educational agents: as a basis for the developments of complex pattern determination algorithms, natural language processing for communication between the human and the machine, and emulation of human tasks under

teaching domain (Dwivedi et al., 2019; Mohan et al., 2019; Koola, Ramachandran & Vadakkeveedu, 2016).

- Scope of massive and predictive algorithms in education: as a basis to process large volumes of complex data with deep learning predictive algorithms for education (Baykal, Bulut & Sahingoz, 2018; WBIS, 2018).

In a future scenario as is seen, the learner-interface interaction, as a discipline and interaction, becomes one of the central topics of educational technology, and this, in turn, into a central sphere of education, and education into a discipline only behind medicine, and even ahead of economy, as one of the basic milestones to face a world contingency.

In order to guide the dynamics of interactions in the near future, it is necessary to extend the interactional model developed throughout the last 30 years, which enables management of the large number of instructional interactions that have become evident by the increase on the use of technology which mediates the teaching-learning process (Morgan, 2020). A unified and basic interactional model is proposed (see figure 4) which covers basic technological instructional interactions: technological (1-6), social (7-10), and metacognitive (11-15), that are not present in the current learner-interface instructional models for mediated education.

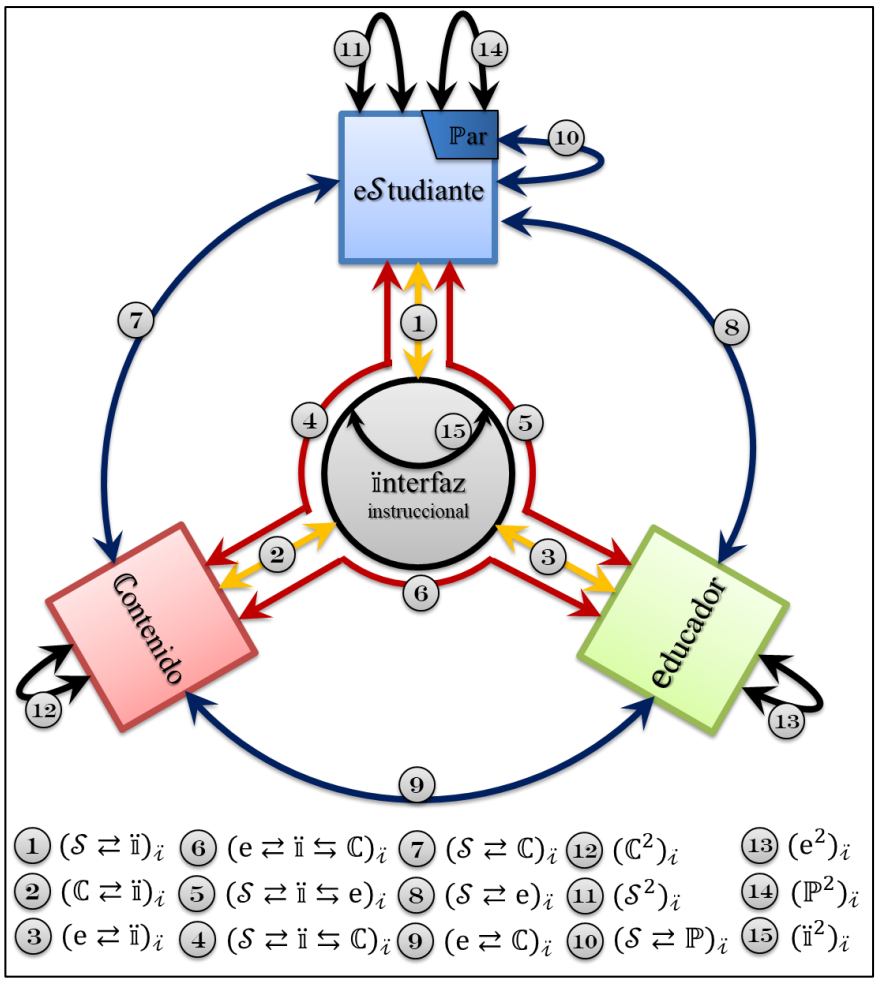

Figure 4. Basic and unified interactional model.

The first direct result in the short-term future shall be the amendment of the equivalence theorem, thesis $\mathcal{T}_1$ in (1) would be the same, but $\mathcal{T}_2$ in (2) could very well be:

(3)

$$\mathcal{T}_2\ (\mathcal{S} \rightleftarrows \mathbb{P},\mathrm{e},\mathbb{C})_{\dot{\imath}} := Max(\mathcal{S} \rightleftarrows \mathbb{P})_{\dot{\imath}} \cdot Max(\mathcal{S} \rightleftarrows \mathrm{e})_{\dot{\imath}} + Max(\mathcal{S} \rightleftarrows \mathrm{e})_{\dot{\imath}} \cdot Max(\mathcal{S} \rightleftarrows \mathbb{C})_{\dot{\imath}} + \cdots + Max(\mathcal{S} \rightleftarrows \mathbb{P})_{\dot{\imath}} \cdot Max(\mathcal{S} \rightleftarrows \mathbb{C})_{\dot{\imath}}\ Max(X_e) \cdot \big(min(t) + Max(\$)\big)$$

This means that, in order to achieve formal learning, only one of the three interactions should be maximized, due to higher costs, $\mathcal{T}_1$ in (1), and that the times involved in technologically mediated

education would be very short in view of the functionality of technologies involves, $\mathcal{T}_2$ in (3). This could change in the future in the medium and long term, which means that $\mathcal{T}_1$ in (4) would be extended to more than one simultaneous interaction and $\mathcal{T}_2$ in (2) for technological mediated education and for educational technology would be incorrect, which implies that formal learning maximization would be developed in the shortest time and at a minimum cost, $\mathcal{T}_2$ in (5).

$$\mathcal{T}_1(\mathcal{S} \rightleftarrows \mathbb{P},\mathrm{e},\mathbb{C})_{\dot{\imath}} := Max(\mathcal{S} \rightleftarrows \mathbb{P})_{\dot{\imath}} + Max(\mathcal{S} \rightleftarrows \mathrm{e})_{\dot{\imath}} + Max(\mathcal{S} \rightleftarrows \mathbb{C})_{\dot{\imath}} \Rightarrow (A_f)\Big|_{profundo}^{significativo} \tag{4}$$

(5)

$$\mathcal{T}_2\ (\mathcal{S} \rightleftarrows \mathbb{P},\mathrm{e},\mathbb{C})_{\dot{\imath}} := Max(\mathcal{S} \rightleftarrows \mathbb{P})_{\dot{\imath}} \cdot Max(\mathcal{S} \rightleftarrows \mathrm{e})_{\dot{\imath}} + Max(\mathcal{S} \rightleftarrows \mathrm{e})_{\dot{\imath}} \cdot Max(\mathcal{S} \rightleftarrows \mathbb{C})_{\dot{\imath}} + \cdots + Max(\mathcal{S} \rightleftarrows \mathbb{P})_{\dot{\imath}} \cdot Max(\mathcal{S} \rightleftarrows \mathbb{C})_{\dot{\imath}} \Rightarrow Max(X_e) \cdot (min(t) + min(\$))$$

An implication in the loss of validity of the equivalence theorem, within educational technology, is that one ought to be developed within the context of education performed by using artificial intelligence. This development would be based in the operationalization of the goal-interaction learner-interface and the intelligent instructional interface, along with standards both *de facto* and *de jure*, that would require a multimedia interactive design and the evaluation of 2D and 3D graphic interfaces designed with an educational purpose. This implies that the need will be produced in the population, generally, of a basic learning knowledge level, but mainly with artificial intelligence (Wong *et al.*, 2020).

CONCLUSIONS

The purpose of our work is to emphasize the role which learner-interface interaction has had as a discipline and interaction within educational technology, and to underscore the predominant function it can or should be able to fulfill in the future of technologically mediated education, as well as to highlight its application in times of crisis, such as the one suffered worldwide in 2020. This application may determine the difference in the short term between the worldwide educational system by means of mediated technology which, at least, is at the same level as its classroom education predecessor, or one that would produce

stagnation and drawback on global education. Reversing these processes may take decades to world governments.

Most of technological and educational challenges that have been discussed fall under the jurisdiction of educational technology, which turns the education technologist into a disciplinary professional with authority to work formally in terms of the interaction, which is relevant to the management of the relationship Instructionality ⇄ Interaction Learner Interface ⇄ Educational technology. This, in turn, to the education technologist implies an endless number of technical, economic and social challenges to conciliate the future of two worlds: the technological and the educational, towards educational technology as a subject with its own motivations and problems, differentiated and independent from its two initiating disciplines.

In this sense, the education technologist is in the position to mutually measure the educational and technological organizations on technological implications in the educational field and instructional implications in the technological area, such as the fears of instructors on the substitution of the instructor for artificial intelligence, or, to determine the manner in which technologists ought to apply the instructional design in the design of technology with an educational purpose.

One of the biggest mutual implications currently existing is the incursion which the technological field has had on the educational field in the way of educational artificial intelligence technology. Success in this incursion requires an interdisciplinary combination of all the experts involved. Technologists already are progressing on this path with an unstoppable dynamic; it is instructors, and specifically, educational technologists who ought to assume the organizational role pertaining thereto in the formation of a disciplinary field of educational artificial intelligence technology as a study domain.

In this regard, the role of education professionals is to participate in this technological advance, to give rise to and contribute with theories that would explain cognition processes and teaching-learning research processes and content design, and that they report and formalize the technical development of designing highly technological educational interfaces, which is to be done by technology professionals. The role of educational technology professionals is to merge the vision of both worlds and to answer the question: How instructional is educational artificial intelligence

technology as a technology itself? The above, based on the evaluation of the interaction level which educational artificial intelligence technology may reach with its user learners.

Educational technology, as a stronghold of education, as it is mutually supported on the road to a technologized future, will have to work, more than ever, on theoretical and practical models that would operationalize the ways in which humans learn from, with, in between and by technology. The foregoing requires that a specific research program be developed, within educational technology, for the learner-interface interaction that would be the way to enter the future of an extensive world of intelligent technology applied to education. It is also necessary that the place and the authorities pertaining to each person be defined in the complex educational orchestra. Should these lines succeed in creating awareness of the educational community and educational technology on the dimension of the technological future of education and of their role, then their purpose would have been achieved.

REFERENCES

Akyol, Z. & Garrison, D. R. (2013). *Educational communities of inquiry: Theoretical framework*. Research and practice. Information sciences reference, IGI Global.

Alexandru, A.; Tîrziu, E.; Tudora, E. & Bica, O. (2015). Enhanced education by using intelligent agents in multi-agent adaptive e-learning systems. *Studies in Informatics and Control, 24*(1), 13-22. http://doi.org/10.24846/v24i1y201502

Alsharif, N. Z. & Roche, V. F. (2010). Promoting key interactions in a distance medicinal chemistry course. *Currents in Pharmacy Teaching and Learning, 2*(2), 114-125. http://doi.org/10.1016/j.cptl.2010.01.003

Anderson, T. (2003). Getting the mix right again: An updated and theoretical rationale for interaction. *The International Review of Research in Open and Distributed Learning, 4*(2).

Anderson, T. & Garrison, D. R. (1998). Learning in a networked world: New roles and responsibilities, en *Distance Learners in Higher Education: Institutional responses for quality outcomes*. Madison, Wi.: Atwood.

Baykal, S. I.; Bulut, D. & Sahingoz, O. K. (2018, April). Comparing deep learning performance on BigData by using CPUs and GPUs, en *2018 Electric Electronics, Computer Science, Biomedical Engineerings' Meeting (EBBT)* (pp. 1-6). IEEE.

Bray, E.; Aoki, K. & Dlugosh, L. (2008). Predictors of learning satisfaction in Japanese online distance learners. *International Review of Research in Open and Distance Learning, 9*(3).

Bringula, R. P.; Álvarez, J. N.; Evangelista, M. A. & So, R. B. (2017). Learner-interface interactions with mobile-assisted learning in mathematics: Effects on and relationship with mathematics performance, en *K-12 STEM Education: Breakthroughs in Research and Practice* (pp. 305-321). IGI Global.

Bringula, R. P.; Basa, R. S.; De la Cruz, C. & Rodrigo, M. M. T. (2016). Effects of prior knowledge in mathematics on learner-interface interactions in a learning-by-teaching intelligent

tutoring system. *Journal of Educational Computing Research, 54*(4), 462-482.

Chang, Y. (2009). An action research of integrating computer technology in academic writing for undergraduates. *World Academy of Science, Engineering and Technology, 37*, 981-984.

Cho, M. H. & Cho, Y. (2017). Self-regulation in three types of online interaction: A scale development. *Distance Education, 38*(1), 70-83.

Cho, T. (2011). The impact of types of interaction on student satisfaction in online courses. *International Journal on E-Learning: Corporate, Government, Healthcare, and Higher Education, 10*(2), 109-125.

Chou, C.; Peng, H. & Chang, C. (2010). The technical framework of interactive functions for course-management systems: Students' perceptions, uses, and evaluations. *Computers and Education, 55*(3), 1004-1017. http://doi.org/10.1016/j.compedu.2010.04.011

Clark, R. C. (2020). *Evidence-based training methods: A guide for training professionals*. American Society for Training and Development.

Cope, B.; Kalantzis, M. & Searsmith, D. (2020). Artificial intelligence for education: Knowledge and its assessment in AI-enabled learning ecologies. *Educational Philosophy and Theory*. http://doi.org/10.1080/00131857.2020.1728732

Covid-19 Impact on Education (2020). UNESCO. Recuperado de https://en.unesco.org/covid19/educationresponse

Danesh, A.; Bailey, A. & Whisenand, T. (2015). Technology and instructor-interface interaction in distance education. *International Journal of Business and Social Science*, *6*(2).

Dewey, J. (1916). *Democracy and education: An introduction to the philosophy of education*. Macmillan.

Doleck, T.; Lemay, D. J.; Basnet, R. B. & Bazelais, P. (2019). Predictive analytics in education: A comparison of deep learning frameworks. *Education and Information*

Technologies, 1-13. http://doi.org/10.1007/s10639-019-10068-4

Dwivedi, Y. K.; Hughes, L.; Ismagilova, E.; Aarts, G.; Coombs, C.; Crick, T. & Galanos, V. (2019). Artificial intelligence (AI): Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy. *International Journal of Information Management*, 101994. https://doi.org/10.1016/j.ijinfomgt.2019.08.002

Garg, T. (2020). Artificial intelligence in medical education. *American Journal of Medicine, 133*(2), e68. http://doi.org/10.1016/j.amjmed.2019.08.017

Gunawardena, C. (1999). The challenge of designing and evaluating 'interaction' in web-based distance education, en *WebNet World Conference on the WWW and Internet* (pp. 451-456). Association for the Advancement of Computing in Education (AACE).

Gunesekera, A. I.; Bao, Y. & Kibelloh, M. (2019). The role of usability on e-learning user interactions and satisfaction: A literature review. *Journal of Systems and Information Technology, 21*(3), 368-394

Hillman, D. C.; Willis, D. J. & Gunawardena, C. N. (1994). Learner-interface interaction in distance education: An extension of contemporary models and strategies for practitioners. *American Journal of Distance Education, 8*(2), 30-42.

Hsiao, E. L. & Huang, X. (2014). Promoting interactivity in a distance course for nontraditional students. *RealLife Distance Education: Case Studies in Practice*, 235.

Jancheski, M. (2017). *Interaction in distance education*, en 11th International Conference on Technology, Education and Development (INTED) Location: Valencia, SPAIN: INTED2017: 11th international technology, education and development conference Book Series: INTED Proceedings, pp. 7643-7652

Jia, J. (2020). *Educational stages and interactive learning: From kindergarten to workplace training*. Information sciences reference, 437. IGI Global.

Kennepohl, D. (2020). Editorial. *International Review of Research in Open and Distributed Learning, 21*(2), i-iii. https://doi.org/10.19173/irrodl.v21i2.4812

Koola, P. M.; Ramachandran, S. & Vadakkeveedu, K. (2016). How do we train a stone to think? A review of machine intelligence and its implications. *Theoretical Issues in Ergonomics Science, 17*(2), 211-238.

Kumar, S. G. & Reddy, G. H. (2019). Prediction of education performance using deep learning. *International Journal of Innovative Technology and Exploring Engineering, 8*(7), 361-364

Lee, M. K. (2015). Effects of mobile phone-based app learning compared to computer-based web learning on nursing students: Pilot randomized controlled trial. *Healthcare Informatics Research, 21*(2), 125-133. http://doi.org/10.4258/hir.2015.21.2.125

Longo, L. (2020). *Empowering qualitative research methods in education with artificial intelligence*. http://doi.org/10.1007/978-3-030-31787-4_1

Luckin, R. & Cukurova, M. (2019). Designing educational technologies in the age of AI: A learning sciences-driven approach. *British Journal of Educational Technology, 50*(6), 2824-2838.

Luo, H. & Lei, J. (2012). Emerging technologies for interactive learning in the ICT age. *Educational stages and interactive learning: From kindergarten to workplace training* (pp. 73-91). http://doi.org/10.4018/978-1-4666-0137-6.ch005

Martin, F.; Parker, M. A. & Deale, D. F. (2012). Examining interactivity in synchronous virtual classrooms. *International Review of Research in Open and Distance Learning, 13*(3), 228-261.

Mayer, R. E. (ed.) (2014). *The Cambridge handbook of multimedia learning*. Cambridge University Press.

Mladenova, M. & Kirkova, D. (2014). Role of student interaction interface in web-based distance learning, en *ACHI 2014 -7th*

International Conference on Advances in Computer-Human Interactions (pp. 307-312).

Mohan, S.; Ramea, K.; Price, B.; Shreve, M.; Eldardiry, H. & Nelson, L. (2019). *Building Jarvis-A learner-aware conversational trainer*. IUI Workshops on User-Aware Conversational Agents in conjunction with ACM Intelligent User Interfaces 2019, Los Angeles, California.

Moore, M. G. (1989). Editorial: Three types of interaction. *The American Journal of Distance Education, 3*(2).

Morgan, H. (2020). Best practices for implementing remote learning during a pandemic. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas, 93*(3), 135-141. https://doi.org/10.1080/00098655.2020.1751480

Nacu, D.; Martin, C. K. & Pinkard, N. (2018). Designing for 21st century learning online: A heuristic method to enable educator learning support roles. *Educational Technology Research and Development, 66*(4), 1029-1049. http://doi.org/10.1007/s11423-018-9603-0

Nahar, L.; Sulaiman, R. & Jaafar, A. (2020). An interactive math braille learning application to assist blind students in Bangladesh. *Assistive Technology* (en prensa). https://doi.org/10.1080/10400435.2020.1734112

Nappi, C. & Cuocolo, A. (2020). The machine learning approach: Artificial intelligence is coming to support critical clinical thinking. *Journal of Nuclear Cardiology, 27*(1), 156-158. http://doi.org/10.1007/s12350-018-1344-2

Nathoo, A.; Bekaroo, G.; Gangabissoon, T. & Santokhee, A. (2020). Using tangible user interfaces for teaching concepts of internet of things. *Interactive Technology and Smart Education* (en prensa). https://doi.org/10.1108/ITSE-09-2019-0061

Piaget, J. (1971). *Genetic epistemology*. Norton & Co Inc.

Raees, M. & Ullah, S. (2020). THE-3DI: Tracing head and eyes for 3D interactions. *Multimedia Tools and Applications, 79*(1-2), 1311-1337.

Rampton, V.; Mittelman, M. & Goldhahn, J. (2020). Implications of artificial intelligence for medical education. *The Lancet Digital Health, 2*(3), e111-e112. http://doi.org/10.1016/S2589-7500(20)30023-6

Rautopuro, J.; Pöntinen, S. & Kukkonen, J. (2006). Towards the information society - the case of Finnish teacher education. *Informatics in Education, 5*(2), 285-300.

Ricco, J.; Guetarni, F. & Kolh, P. (2020). Learning from artificial intelligence and big data in health care. *European Journal of Vascular and Endovascular Surgery*. http://doi.org/10.1016/j.ejvs.2020.01.019

Schlegelmilch, J. & Douglas, C. (2020). Initial covid-19 closure strategies adopted by a convenience sample of US school districts: Directions for future research. *Disaster Medicine and Public Health Preparedness,* 1-4. http://doi.org/10.1017/dmp.2020.147

Scolari, C. A. (2018). *Las leyes de la interfaz: diseño, ecología evolución, tecnología* (vol. 136). Editorial Gedisa.

Şimşek, Ö.; Atman, N.; Inceoğlu, M. M. & Arikan, Y. D. (2010). Diagnosis of learning styles based on active/reflective dimension of Felder and Silverman's learning style model in a learning management system, en *International Conference on Computational Science and Its Applications* (pp. 544-555). Springer, Berlin, Heidelberg. http://doi.org/10.1007/978-3-642-12165-4-43

Tidwell, J.; Brewer, C. & Valencia-Brooks, A. (2020). *Designing interfaces: Patterns for effective interaction design* (3a. ed.). O'Reilly Media, Inc.

Villegas-Ch, W.; Arias-Navarrete, A. & Palacios-Pacheco, X. (2020). Proposal of architecture for the integration of a chatbot with artificial intelligence in a smart campus for the improvement of learning. *Sustainability (Switzerland), 12*(4). http://doi.org/10.3390/su12041500

Vygotsky, L. S. (1980). *Mind in society: The development of higher psychological processes*. Harvard University Press.

Walsh, K. (2020). Artificial intelligence and healthcare professional education: Superhuman resources for health? *Postgraduate Medical Journal, 96*(1133), 121-122. http://doi.org/10.1136/postgradmedj-2019-137132

Wang, C. & Tsai, W. (2016). Elucidating how interface design and cognitive function affect learning performance in the enterprise resource planning (ERP) software system. *Journal of Testing and Evaluation, 44*(1), 31-46. http://doi.org/10.1520/JTE20140044

Wang, H.; Rush, B. R.; Wilkerson, M. & Van Der Merwe, D. (2014). Exploring the use of tablet pcs in veterinary medical education: Opportunity or obstacle? *Journal of Veterinary Medical Education, 41*(2), 122-131. http://doi.org/10.3138/jvme.1013-145R1

WBIS (2018). Proceedings -2017 international workshop on big data and information security, en *Proceedings - WBIS 2017: 2017 International Workshop on Big Data and Information Security*.

Wong, G. K. W.; Ma, X.; Dillenbourg, P. & Huen, J. (2020). Broadening artificial intelligence education in K-12: Where to start? *ACM Inroads, 11*(1), 20-29. http://doi.org/10.1145/3381884

Xiao, J. (2017). Learner-content interaction in distance education: The weakest link in interaction research. *Distance Education, 38*(1), 123-135.

Yang, S. & Bai, H. (2020). The integration design of artificial intelligence and normal students' education. *The Journal of Physics: Conference Series, 1453*(1). http://doi.org/10.1088/1742-6596/1453/1/012090

HOW TO CITE

Assaf Silva, Nayiv Amin Jesús. (2020). The learner-interface interaction´s future, a vision from EdTech. *Apertura*, *12*(2). http://dx.doi.org/10.32870/Ap.v12n2.1910