Instructional Design in Online Education: a Systemic Approach

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Abstract

Online education is becoming more and more valid, but as a different modality from the face-to-face teaching-learning process, it has special characteristics that must be considered. Online education is much more than uploading material to a repository and using it in a linear manner. Electronic online education platforms, seen as an integral system, offer a large number of technological resources that must be used according to the educational model that is being applied. To achieve good performance, an online education model must be based on a harmonious architecture of the educational, administrative, legal and infrastructure aspects of ICT, that is, an integral model. The educational models created based on the prevailing pedagogical models - behavioral, constructivist, cognitive and connectivist - must be implemented through an instructional design, aligned with the pedagogical objectives and learning strategies, based on the proper use of the technological resources of The electronic platform. Instructional design models, such as ADDIE, ASSURE, Dick and Carey, and others, applied to online education, should take advantage of the resources of the technology platforms and the characteristics of each. These models, as a guide to instructional design processes, can also be enriched with other methodological processes, such as DevOps, which through continuous deliveries enrich and keep the educational content updated. This article proposes strategies for applying the technological resources of online learning platforms, aligned with the instructional design corresponding to the different pedagogical models.

Keywords: Online. education, models, virtual learning environments, electronic platforms, instructional design models, instructional design processes.

1. Introduction.

The creation of knowledge and education are the most important activities of the human being. Without being new, because they have always existed, although empirically in their principles, they have now become scientific and highly technical. Many theories, models, processes and technologies have been generated with the same purpose, to improve student learning, which is now not only expected to have the appropriate response to the stimulus, but also to be able to create their own solutions to real world problems.

With technological development, new possibilities have been opened for the teaching-learning process, which is no longer limited to face-to-face learning, but can also be online (e-learning), or combined (b-learning), but these technological resources have to be used in congruence with the instructional design that is being applied, in order to achieve the learning objectives set.

In this work, a structured and systemic route is used as a methodology, from a general model for e-learning to an instructional model for e-learning and the use of electronic platform resources in line with it, visiting the most important elements between both extremes through bibliographic review and own contributions resulting from the experience and other works of the authors.

2. A systemic approach to online education.

Whether a student takes a lesson or an activity and does an online evaluation are the final actions of the online teaching-learning process, but in turn they are the result of multiple previous and simultaneous processes put into operation.

The virtual learning environment (AVA in spanish), the environment in which online education is carried out, is a system composed of educational, technological, human, legal and administrative subsystems, which must be adequate and harmonized with the institution's expectations regarding the use, scope and amount of student population that you want to attend.

Thus, we must think about online education with a systemic approach that considers all the elements at stake, the function and capacity of each of them, their interrelations, and the expected performance of each and the system in general.

Integral model.

Online education is more than the repository where instructional material is stored and accessed, it requires an integral model in which educational, human, technological, legal and administrative resources are considered. The basis on which all these elements are supported is intellectual capital, the capital of knowledge, in a clear case that knowledge is required to create and give access to knowledge.

A comprehensive online learning model based on intellectual capital is proposed by Quiroz and Muñoz (2018a), which in turn follows the intellectual capital model proposed by Hubert Saint-Onge (1996), which considers intellectual capital as integration of human capital, intellectual capital and client capital. The Hubert-Saint Onge model, although it is a business model, conforms to the educational environment under the consideration that the client receives the services of the online learning system.

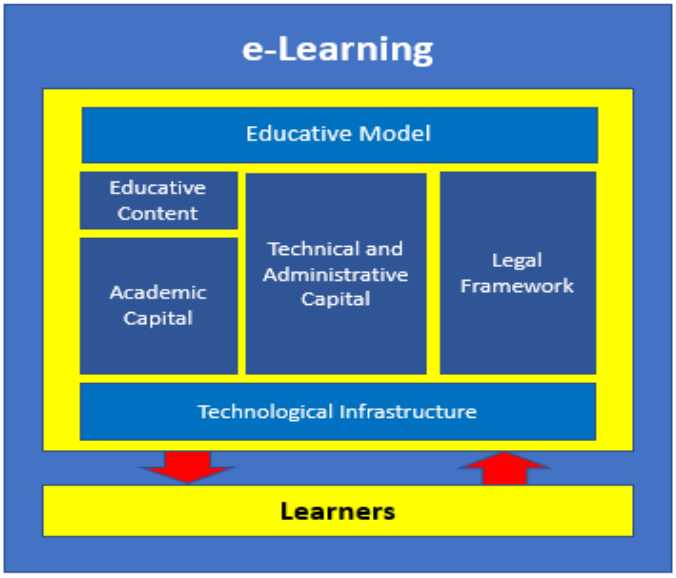

Figure 1. Integral model for e-learning.

Source: Quiroz & Muñoz (2018a).

In this model, human capital is made up of academic, technical and administrative capital, that is, the people who execute the teaching-learning processes, operate and support the information and communications technology infrastructure, and the personnel that carry out administrative processes The structural capital is integrated by the educational model, the educational contents and the legal framework, the latter being the regulatory body, laws and regulations, which governs the operation of the distance education modality. Finally, the client's capital is the students and who finances the operation, be it a public entity, family members or the student himself.

The technological infrastructure, part of the structural capital, is the platform in which the teaching-learning processes are carried out, they are the information and communications technologies used for the interaction between teachers and students and for the creation, storage and access to educational content.

Integrated platform.

In many papers - papers, articles and books - there is talk of incorporating multimedia resources into educational processes, but this is very general and incomplete, the current online education (e-learning) and mixed education (b-learning) models require of complete ICT platforms, that is, they provide both information and communications technologies, but in the form of an integrated platform.

An integrated platform is in which computer products and communications services are complemented for the achievement of learning objectives, and although an LMS (Learning Management System) or an LCMS (Learning Content Management System) is the central application of the platform, modern online education systems require other products and services for the full development of the teaching-learning process.

Quiroz and Muñoz (2018b) propose an integrated platform model of information and communication technologies for online learning, which considers the educational application products as the core of the model, but also includes those necessary to ensure operational continuity, such as Cybersecurity and backup and recovery systems, as in any ICT platform that requires high availability and security. All this in a framework of governance and risk management that gives certainty and credibility, which, as will be seen, is one of the challenges of online education models.

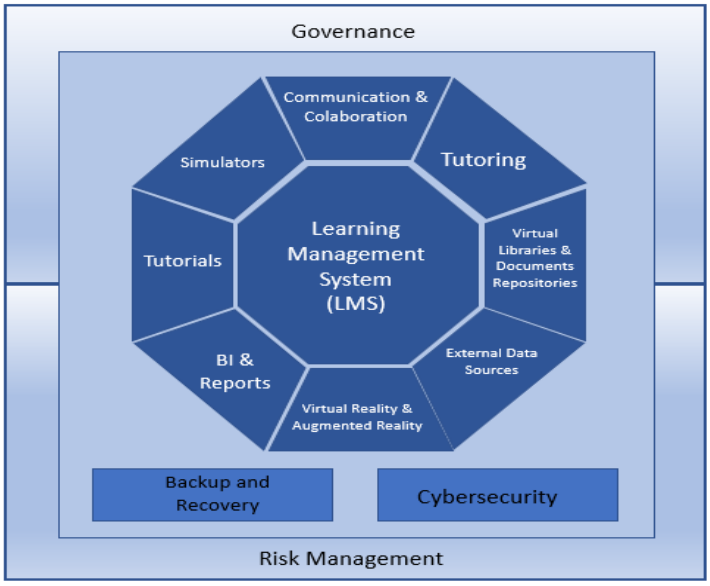

Figure 2. Integrated ICT platform model for online education.

Source: Quiroz & Muñoz (2018b).

The platform model for online education is integrated because the subsystems and products must communicate with each other, that is, none must operate isolated from the rest because it would no longer be part of the system, but it is also integral because it considers all the necessary elements to operate in an environment of operational certainty and fulfillment of the resource requirements of the instructional design derived from the applied educational model.

3. Educational contents.

Online learning is a system that brings together many elements for the fulfillment of the final objective, effective student learning. It requires a comprehensive system for its development and operation, and within it a platform with which the teaching-learning process is carried out, but also and more importantly, of the educational content, instructional materials, that the student You must assimilate to increase your knowledge and skills.

The delivery of instructional materials as the teaching part of the teaching-learning process begins with the determination of the learning theory or the mixture of them that the institution will use, and through various stages (see Figure 3) in which the entrance of one is the exit of the previous one, the instructional material aligned to the educational strategy and objectives established in the preceding stages is reached.

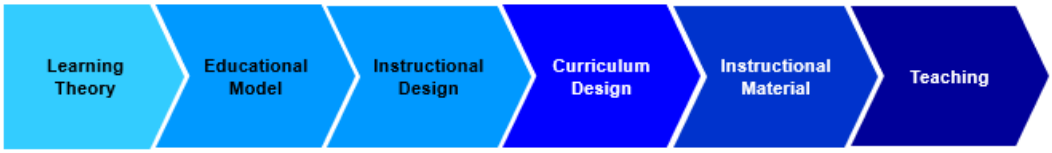

Figure 3. Process from learning theory to teaching.

Source: Self made.

The alignment between all the stages of this process is decisive in its result, as well as the omission or lack of rigor in the execution of any of them, so that from its correct and complete execution its maximum performance and correct products will be obtained and effective.

Learning theories.

Learning theories are those that try to explain the learning in the human being and consequently serve as a guide for it. Four are the dominant theories, each with different strategies, but with the same common purpose, student learning. Table 2 shows a synthesis of each theory in order of creation.

Table 1. The four dominant learning theories.

Behaviorism	Cognitivism	Constructivism	Connectivism
Learning is achieved by achieving the desired response to the given stimulus.	It is based on the acquisition of knowledge and the creation of mental structures for its organization and recovery.	It is based on providing the student with the necessary tools to develop their procedures for solving problems.	It is the integration of cognitivism with constructivism.

Current instruments of these theories are, for example, competency-based education and the flipped classroom pedagogical model that are constructivist and the MOOC (Massive Open Online Course) which and smart books that are connectivist, being the latter a true virtual learning environment of a particular subject.

The change from behaviorism to constructivism as a theory of applied knowledge as the basis for new pedagogical models seeks not only a behavioral change, but the person, in this case the student builds a new meaningful knowledge generating their own solutions to real-world problems to be presented in your area of knowledge.

Educational model

Carlos Tünnermann (2008) says that “an educational model is the creation, in pedagogical terms, of the educational paradigms that an institution professes and that serves as a reference for all the functions it fulfills (teaching, research, extension, linking and services), in order to realize his educational project.”

An educational model is constructed by choosing an educational theory or a mixture of them, and establishing the pedagogical approaches necessary to guide the development of study plans and programs and the formulation of strategies and dynamics of the teaching-learning process.

In online learning, educational models developed specifically for this modality will have to face three main challenges according to Bhavik K. Pathak (2016): improve learning effectiveness, offer personalized learning experiences and establish credibility. All this can be achieved with the appropriate use of the available technological resources so that the contents are adapted to the personal style and abilities of the students, and as long as their use is aligned with the educational model developed and the educational strategies constructed.

Instructional design

Instructional design is a systematic, planned and strategic process to achieve the effectiveness of learning, through relevant technologies and means, which is particularly applicable to online education, due to the use of electronic platforms and the resources with which they are integrated for the creation, storage and delivery of educational content.

The various models of instructional design applied to online education should consider electronic resources in their design stages and their particularities in determining strategies for delivering educational content.

Curriculum design.

Karen Schweitzer (2019) points out that the design of the curriculum is the instructional plan of the teachers, it is the way they structure the instructional blocks with the purpose of improving student learning, for which, in addition, this plan must be aligned and be complementary with the following instructional blocks. In turn, the curriculum design must be aligned with the instructional design that gave rise to it.

There are four modalities of curriculum design, the summary of what Scheweitzer mentioned in his article is shown in Table 2.

Table 2. Types of curriculum design.

Type of curriculum design	Pros	Cons
Focused on the topic.	This type of curriculum focuses more on the subject than on the student. The advantage would be the depth and extent with which the subject is treated.	That is not student centered. It is designed without taking into account the student's learning style.
Student-centered.	Take into account the goals, needs and interests of the students. The instructional plan is differentiated, giving you the opportunity to select subjects, learning experiences or activities.	It is labor intensive for the teacher or for those who prepare the instructional material, since they must prepare appropriate material for each type of student.
Focused on the problem.	It focuses on the student to identify a problem and propose ways of solution. The advantage is that it exposes the student with real problems and that helps him develop skills that he can put into practice in the real world.	It does not always take into account the student's learning style.

Instructional material

Instructional material, educational material, are the lessons, activities and tests developed as a result of instructional design and curriculum design. It is the content that will be delivered to students enrolled in the programs, or to those who participate without being enrolled, and therefore without the possibility of receiving records, in the MOOCs.

In online education this material must be in electronic format for loading and access on the platform, but the resource that best suits the type, structure and dynamics of the material should be used.

Instruction

The development of the learning session, either face-to-face or online, requires the deployment of the planned strategy for the delivery of educational material to students. The effective development of the class requires that the planned conditions be met, either for the lesson or the planned activity. A simple example, in a case of online education, the prerequisites are that the class is prepared and set up in the repository and that the system is accessed from the date and time announced.

The learning sessions must have clearly defined their purpose and objectives, scope, development and closing activities. In this regard, there are also models that support the effective development of the sessions, one of them is proposed by Gagné, Briggs and Wager (1992), which provide an instructional model for the development of learning sessions that in turn They require procedures to achieve the objectives of each stage and the general objective, which is student learning.

The Gagné, Briggs and Wager model consists of nine instructional events: obtaining the attention of students, informing students of the objectives, stimulating a reminder of previous learning, presenting content, providing guidance in learning, achieving performance through practices, provide feedback, evaluate performance and improve retention and transfer. This instructional model offers a dynamic that aims to achieve student interest, while bridging the sessions and using the various levels of learning in the Dale pyramid.

There are other models of instruction, or the teacher himself creates his own dynamics, but in any case the important thing is to propose a strategy of effectiveness of the instruction, apply it, evaluate it and adjust it until obtaining the best performance in a dynamic of continuous improvement.

Instructional design.

Instructional design is key in the teaching-learning process to achieve pedagogical and performance objectives. The history and evolution of instructional design is long, even before it was called by this name, but with pedagogical and technological advances it has to be kept updated for the full use of them.

Instructional Design Concepts.

There are many concepts of instructional design, among the most important are the following:

For Smith and Reagan (2005), instructional design is "the systematic and reflective process of translating principles of learning and instruction into plans for instructional materials, activities, information resources and evaluation."

Reiser & Dempsey (2007) say that "instructional design is a systematic procedure in which educational and training programs are developed and constructed with the intention of achieving a substantial improvement in learning."

Branch & Kopcha (2014) say “instructional design is intended to be an iterative process of planning outcomes, selecting effective strategies for teaching and learning, choosing relevant technologies, identifying educational media and measuring performance.”

It is to be considered that all concepts agree that instructional design is a process, and as such concepts and methodologies such as process architecture, process engineering and process optimization are applicable, all of which result in its effectiveness.

Models of instructional design.

A model in instructional development is a guide for its planning, execution and evaluation. Serhat Kurt (2015) said: “An instructional design model provides guidelines to organizing appropriate pedagogical scenarios to achieve educational goals. Instructional design can be defined as the practice of creating instructional experiences to help facilitate learning most effectively.”

There are many models of instructional development, but ADDIE, ASSURE and Dick and Carey stand out.

ADDIE is the most widely used model and from which others are derived. The name of this model is composed of the initial letters of the name of each stage. ADDIE is the acronym for Analyze, Design, Develop, Implement and Evaluate. Robert Maribe (2009) describes this model as a product development concept, in this case instructional material. The terms correspond to the stages of the process of generating effective instructional material. It is a reflective, planned, strategic, operational and evaluated process to ensure the effectiveness of the development of instructional material. ADDIE is an

iterative model, which means that from one stage you can return to any other, and the result will be the input of the next stage.

Table 3. Stages of the ADDIE model.

Stage	Description
A (Analyze).	It consists primarily of identifying the target student, determining instructional goals, determining human and technological requirements, and creating the project management plan.
D (To design).	Based on the elements obtained in the design stage, the strategies for the other stages are determined, instructional objectives, performance objectives, test instruments and performance metrics are generated.
D (Develop).	Generate learning resources and validate their performance.
I (Implement).	Prepare teachers, students, and in the case of electronic learning prepare electronic platforms to ensure their continuity and performance.
E (Evaluate).	Rate the quality and performance of instructional products based on the criteria and metrics that have been established in the design stage.

In ADDIE each stage is developed through specific procedures, how many and which depends on the complexity of the environment and the resources that the organization can put into practice. The model is also applicable to online learning, but it requires that in each of its stages the resources and strategies be considered to achieve the proper use of electronic platforms in the creation and delivery of instructional resources.

Heinich, Molenda, Rusell and Smaldino (1999) proposed the ASSURE model, similar to ADDIE but with the fundamental purpose it ensures the effective use of the means in the instruction. The ASSURE model is based on the constructivism and part of the characteristics of the student, whose identification is made in the first stage of the process.

Table 4. Stages of the ASSURE model.

Stage	Description
A (Analyze student characteristics).	It is the identification of the characteristics of the students to guide the development of instructional material according to those characteristics.
S (Set standards and objectives).	It is the specification of what students should be able to do as a result of instruction.
S (Select strategies, technology, media and materials).	It is the ideal selection of these elements to achieve the learning objectives.
U (Use technology, media and materials).	It is the planning and use of resources to engage the student with the material that is being delivered.
R (Require student response).	It consists of planning how to achieve student and group participation in the learning process, given all the previous stages.
E (Evaluation and Review).	The impact of teaching on students is assessed, determining whether the learning objectives were achieved. The results are used to review all the elements involved, strategies, technology, media and materials.

The model of Dick, Carey and Carey (2015) opens the process to ten stages. The essence of this model is the relationship that is built between the stimulus and the response, the stimulus being the didactic materials and the response the learning of these materials by the student, and the stages create the conditions for that relationship to be established.

Table 5. Dick, Carey and Carey model.

Stage	Description
Instructional goals.	Determination of instructional goals, what the student is expected to learn.
Instructional analysis.	It is the identification of the skills and abilities that the student must have to learn what they want to teach.
Initial behaviors and student characteristics.	It is the determination of which of the skills that were determined as necessary really possesses.
Performance objectives.	The goals and objectives of the lesson become explicit through statements of what the student should achieve.
Elements of evidence crossed against criteria.	It is the construction of tests according to the performance objectives that the students reach.

Instructional strategy.	It is the determination of the strategy of the development of the materialized class through a plan to achieve the performance objectives.
Instructional materials.	Development and selection of instructional materials.
Design and development of the formative evaluation.	It is the evaluation of the development of the lesson and if the objectives of the lesson were achieved.
Design and development of summative evaluation.	It is the overall evaluation of the execution of the model, determining what worked, what did not and what can be improved.
Review of the instruction.	At this stage the data of the formative evaluation are used to reexamine the validity of the instructional analysis and the assumptions about the initial skills and characteristics of the students. These results are used to make revisions to the process.

Thus, although all models of instructional design are processes that have the same purpose, they differ in the emphasis they make on some of the stages and in the theory they use as a basis. The instructional designer must select the most appropriate model according to the selected educational theory and the educational model built on it.

4. Instructional design in online learning.

Eliana Patricia Londoño (2019) makes a bibliographic review of the instructional design in virtual education, in which she points out that according to Luzardo (2004), cognitivism and constructivism are the learning theories that best accommodate the educational models of online education, to from this and given that connectivism makes use of the two, it can be affirmed that both cognitivism, as well as constructivism and connectivism are ideally applicable in electronic learning.

Instructional design as a process should not only consider the use of electronic platforms, but the use of the resources of those platforms that are appropriate for the educational model in accordance with its principles of operation and functionality. Thus, for example, the use of the hypertext feature of web pages makes web education a suitable medium for models based on constructivist theory, while blogs and wikis are suitable for collaborative learning, also used in constructivist models. In the connectivist models all technological resources are adequate, guiding the development of the material with an instructional design that takes advantage of those resources.

As already mentioned, MOOCs and smart books, but especially the latter, make use of the flexibility and interactivity of resources. There are other resources that do not have flexibility or interactivity, such as videos, but the lessons, demonstrations and tutorials that can be developed with them can have a high impact on learning. Otherwise they are the simulators, that just what they offer is the interactivity, so that the student simulates actions that in the real world can be expensive, dilated, insecure or that cannot be returned to initial conditions again and again to test the model With different strategies and scenarios.

Thus, each resource of the platforms of the virtual learning environments has characteristics that must be known to take full advantage of the teaching-learning processes.

It should also be considered that new technologies such as artificial intelligence are already present in several educational products, for example, in some LMS, and in others that may be part of the integrated platforms, such as business intelligence applications that allow voice consultations, that is, the recognition of natural language, which is one of the branches of artificial intelligence. The knowledge and use of new incoming technologies, will allow things such as personalization of content according to the diagnoses made by the system about student performance and the type of difficulties encountered.

The potential that new technologies open in education only has as a limit the vision and knowledge that they have of them for their use in current pedagogical models and those that are explicitly constructed for them. Instructional design will also have to quickly and effectively incorporate these technologies into their process, because they will surely have a high impact on students' educational performance.

5. Final thoughts and recommendations.

Instructional design should not be considered as an isolated entity, as the last link in the chain or just as a resource for planning classes, it is part of a teaching-learning system that must be comprehensive, integrated and harmonized. Integral because it must have subsystems for all aspects involved, integrated because all subsystems must be articulated and

harmonized because each subsystem must have the necessary scope, capacity and performance to provide the appropriate resources that the other subsystems require in order to operate at full capacity and achieve maximum performance.

The instructional design for online education currently employs models developed for face-to-face education, but they are applicable to it as long as electronic resources and their characteristics are taken into account at all stages of the model. However, specific instructional models for online education are being developed based on the characteristics of electronic resources, that is, their flexibility, impact on different levels of learning and their access to vast available information and knowledge resources on the internet, such as electronic libraries, databases and databases in the form of open data and online simulators. These new models of instructional design will make more effective use of electronic resources and therefore achieve the optimum performance of their use in the teaching-learning processes.

The use of technological resources with full knowledge of their characteristics and capabilities, allows their adaptation to the educational models derived from the different learning theories. The architecture of the academic content must be aligned with the strategy of its delivery to the student, an example could be to structure the material in a linear, tree-like or network way, possible modalities with the combination of the characteristics of the repositories and the websites.

Technological platforms incorporate recent technologies, some that have not yet been extended, such as virtual reality and augmented reality, and despite this there are already products that use others, even more modern, for example, some LMS already incorporate artificial intelligence and machine learning, and soon we will see deep learning based on neural networks as a support tool for both the teacher and the student.

Online education systems due to their systemic characteristics can incorporate not only technologies, but also methodologies for system development in general, agile methodologies such as Scrum are already in practice to respond quickly to the new requirements for the creation of careers and courses in line, DevOps is also applicable, the methodology of continuous deliveries, to enrich and update the academic content continuously, without causing interruptions, taking advantage of the characteristics of electronic platforms.

The future is in the personalization of the content according to the interests, abilities, capacities and learning style of the student. This imposes an important challenge for instructional designers as well as for instructional material developers, but it opens a very encouraging perspective for the future of online education given the levels of effectiveness that can be achieved.

Due to its dual, pedagogical and technological nature, the development of instructional material for online education is multidisciplinary, so educators and computer and design professionals must work in a coordinated manner to generate quality products, which will be the end result of the collaborative, reflective and aligned work of this variety of specialists.

Being information systems, and information and communication technologies, a very dynamic world, it is necessary to keep up to date to quickly and effectively incorporate new resources into online education systems. The instructional design must take full advantage of the technological resources and methodologies of available and upcoming systems, which requires that they be known, used and used properly to achieve the central objective of education, student learning.

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