Frameworks for Integration of Digital Technologies at the Roadside: Innovative Models, Current Trends and Future Perspectives.

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Abstract
The integration of technologies in the educational processes is not always an easy task, requiring from professors to study its reality and, if necessary, to adopt some model of integration. Some professors seem to know how and why to use technology, but the effective integration still eludes many of them. The key is that to work certain content we need to know it well, the technologies and the didactic way and how to use them. We don't need to follow a certain model of technology integration to use the technologies, since not all professors adapt to them and all models give the impression of a prescription that tries to define what must have more or less importance in the scenario. Whereas random practice came before the proposed models, they try to standardize what should not be standardized, that is, produce a cake recipe to be replicated.
Keywords: frameworks, technology integration, new didactics, e-resources, strategies.

1. First steps

Technology integration is not a new subject in educational domains, much less at the universities where several theses, dissertations, and papers are published – often without direct impacts on the daily routine of the institutions. The missing link seems to be in the absence of a transformational practice, institutionalized, accepted and adopted by all stakeholders to restore the role of educational space and social transformation.

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The education area is surrounded by related expressions such as “education economics” and “economics education” that represent distinct concepts, and often cause some confusion. Education economics, also known as economics of education is the study of economic issues relating to education – focuses on the economics of educational institutions – including the demand, funding and provision of education (Economics education, 2006).
On the other hand, economics education, also referred to as economic education is a field within economics that focuses on two main topics: the current state of the economics curriculum, materials and pedagogical techniques used to teach economics at all levels; and research into alternative approaches or instructional techniques, level of economic literacy and the factors that influence the level of economic literacy (Education economics, 2008).

Educational technology meets these two expressions at the same time, to the extent that it interferes with the economic aspects and at the same time in pedagogical techniques.

2. Educational technology vs. technology education

An analogous situation (involving similar expressions) can be seen with the “educational technology” and “technology education”. Educational technology is the effective utilization of

technological resources in the teaching-learning process. It refers to a wide array of tools, media, computers and networking hardware, as well as taking into account underlying theoretical perspectives for their effective application. This kind of technology is not limited to high technology. However, current digital educational technology, sometimes referred to as e-learning, has become an important part of today's society, comprising an extensive array of approaches, key elements and delivery methods (Educational technology, 2005).
On the contrary, technology education is the study of technology, where students “learn about the processes and knowledge related to technology”. This field of study covers the human capacity to change and shape the physical world to meet its own requirements through the techniques, with the handling of materials and tools (Technology education, 2005).

These concepts also get very close when the educational technologies (tools and resources – with or without ICT) are effectively used to meet the needs and expectations (of someone or some institution), through handling, adaptation and suitability of materials with these didactic and technological techniques. But the integration of these digital technologies – popularized as being of information and communication – in the educational processes is not always an easy task, requiring from professors to study its reality and, if necessary, to adopt some model of integration.

In the United States, the International Society for Technology in Education (ISTE) has established standards in technology for administrators, teachers and students of primary and secondary levels (K-12 classrooms): “Effective integration of technology is achieved when students are able to select technology tools to help them obtain information in a timely manner, analyze and synthesize the information, and present it professionally. The technology should become an integral part of how the classroom functions, as accessible as all other classroom tools” (NCES, 2002).

But all the innovation, originality, change focused on the current or future needs and even patterns and models that attempt to be established – to support the paradigm shift – seem to vanish from sight as soon as we arrived at the college level. Have you (or anyone) ever read something about amazing and contemporary universities? Something about institutions that may be considered pedagogically and technologically sound? Some examples of institutions that are not just pretentiously modern? The evolutionary or revolutionary educational practices continue excluded from universities (Roth, 2015b).

Edward Osborne Wilson (Neyfakh, 2011) paraphrased a quotation that he attributed to Arthur Schopenhauer, which may have been the first person to suggest “stages of truth”, in 1818: “All new ideas go through three phases. They’re first ridiculed or ignored. Then they meet outrage. Then they are said to have been obvious all along”.

Probably, the effective integration of digital technologies by universities is somewhere between the first two phases…

3. Technology integration models

Jeyaraj, Rottman and Lacity (2006); Santos (2007); Espíndola, Struchiner and Giannella (2010); Struchiner (2011); Foster, McGrier and Sheets (2011); and Rielley (2015) cite different models and theories of adoption and diffusion of innovations such as theoretical framework of integration of ICTs in educational contexts (Hall & Hord, 2006; Moersch, 1995). These works are intended to describe the main stages of adoption of ICTs and analyze the individual factors (Tabata & Johnsrud, 2008; West, Waddoups & Graham, 2007) and institutional (Shuldman, 2004) that influence the process of change (Watson, 2006), from monitoring different experiences of educational innovation.

- Theory of Reasoned Action (TRA)
The TRA refers to a model of behavioral intention prediction, covering attitude and behavior

predictions (Ajzen & Fishbein, 1980), that is, it is centered on the person's intention to behave in a certain way. It was developed at the end of the 1960s by Martin Fishbein - later expanded and revised by Fishbein and Ajzen (1975) - derived from previous research as the theory of attitude, which led to the study of attitude and behavior (Theory of reasoned action, 2005). According to Bobsin (2007), the model presents limitations: risk of possible confusion between the meaning of attitudes and norms and having an intention does not mean acting in accordance with, because there are situations – such as limited ability, time, unconscious habits, environmental or organizational variables – that may limit the freedom to act.

- Theory of Planned Behavior (TPB)
The TPB is a theory that links behavior and beliefs. This concept was introduced by Ajzen Icek to refine the predictive power of the TRA (limitations) by the inclusion of the perceived behavioral control (Ajzen, 1991; Theory of planned behavior, 2005).

- Reasoned-Action Approach (RAA)
The RAA is an integration methodology for the prediction and change of human social behavior. This theory states that attitudes regards the behavior, perceived behavioral control and perceived norms determine people's goals, while their behaviors are predicted by these intentions (Reasoned action approach, 2013). This is the latest release of theoretical ideas of Martin Fishbein and Icek Ajzen, in the wake of the earlier TRA and the TPB (Fishbein & Ajzen, 2010).

- Diffusion of Innovations (DOI)
The DOI model seeks to characterize how innovation is diffused through certain channels of communication, among members of a given social system, and by what process these individuals pass since become aware of the innovation in question until its adoption or rejection (Rogers, 2003; Diffusion of innovations, 2004; Diffusion of Innovations, 2005). The categories of adopters are the following: innovators, early adopters, early majority, late majority, laggards and leapfroggers. This theory, developed by Mitchell Everett Rogers in 1962, is one of the most ancient social science theories.

- Technological Pedagogical Content Knowledge (TPACK)
The TPACK is a framework to describe and understand the types of knowledge needed by a professor for effective pedagogical practice in a learning environments equipped with technology. The concept of pedagogical content knowledge (PCK) was initially described by Shulman and TPACK methodology was developed from these central ideas, through the inclusion of technology. Punya Mishra and Matthew J. Koehler, professors at Michigan State University (United States), developed extensive work in building the theoretical framework TPACK (Koehler & Mishra, 2008; Mishra & Koehler, 2006).

- Substitution, Augmentation, Modification, Redefinition (SAMR)
Developed by Ruben Puentedura (Puentedura, 2014) the SAMR model is similar to TPACK model, but made up of different components. Both are used for technology integration in the classroom, but SAMR helps take direct activities from the classroom and enhance them by using technology. This model focuses on the process that a professor goes through in remixing existing pedagogy content otherwise impossible without technology.

- Technology Integration Matrix (TIM)
TIM demonstrates how professors can use technology to improve students' learning. For that purpose, it incorporates five interdependent characteristics of significant learning environments: active, constructive, goal directed (that is, reflective), authentic and collaborative (Jonassen, Howland, Moore & Marra, 2003). Thus, associates five technology integration levels (entry, adoption, adaptation, infusion, and transformation) with each of the five characteristics of significant learning environments. The five levels of integration technology and the five characteristics of significant learning environments create a matrix of 25 cells. It was developed by the Florida Center for Instructional Technology, University of South Florida (TIM, 2011).

- Levels of Teaching Innovation (LoTi)
LOTI, proposed by Chris Moersch, provides an observable framework to assess technology use in the classroom and connects to higher-order thinking, engaged learning, and authentic assessment while using technology (Moersch, 1995; Rielley, 2015) – performing classroom walkthroughs according to the H.E.A.T. (2015) observation model: Higher-order thinking, Engaged learning, Authenticity, and Technology use.

- Concerns-based Adoption Model (CBAM)
The CBAM is an analytical tool used to understand the cognitive concerns of professors and students by providing a framework to anticipate future needs associated with the adoption of change (Hall & Hord, 2006).

- Learning Adoption Trajectory (LAT)
The LAT is a refinement of CBAM developed by Sherry and Gibson (2002) based on their research work on change in education.

- Apple Classrooms of Tomorrow (ACOT)
Project developed in the 80s in five public schools in the United States through a partnership between universities, public schools and Apple Computer, Inc. (Ringstaff, Yocam & Marsh, 1997; Sandholtz, Ringstaff & Dwyer, 1997).

- Social Cognitive Theory (SCT)
The SCT started in the 1960s by Albert Bandura as the Social Learning Theory (SLT). The theory turned into SCT in 1986 and postulates that learning occurs in a social context with a dynamic and reciprocal interaction of person, environment and behavior (Bandura, 1986). It starts from the idea that people do not learn only through what they do by affective way but also by observing the action of others (SCT, 2006).

- Technology Acceptance Model (TAM)
The TAM is one of the most influential extensions of the TRA of Martin Fishbein and Icek Ajzen (Ajzen & Fishbein, 1980). Developed by Fred Davis and Richard Bagozzi (Davis, 1989; Davis, Bagozzi & Warshaw, 1989), this model suggests that when users are presented with a new technology, many factors influence their decisions about how and when they will use it. According to Davis (1989), people tend to use or not to use certain technologies in order to improve their performance at work - perceived usefulness. However, even if this person understands that a particular technology is useful, its use could be compromised if the user finds it difficult to use such technology, so that the effort does not compensate the use - perceived ease-of-use (Technology acceptance model, 2003). TAM has expanded into two major updates, TAM 2 (Venkatesh, 2000; Venkatesh & Davis, 2000) and the Unified Theory of Acceptance and Use of Technology (UTAUT), (Venkatesh et al. 2003). In addition, a TAM 3 was proposed in the context of e-commerce, with the inclusion of the effects of trust and perceived risk on system use (Venkatesh & Bala, 2008; Venkatesh, V., n.d.).

- Unified Theory of Acceptance and Use of Technology (UTAUT)
The UTAUT, formulated by Venkatesh et al. (2003) is a technology acceptance model. It has as purpose to explain the user intentions to use an information system and the subsequent use behavior. This theory is supported by four key constructs: performance expectancy, effort expectancy, social influence and facilitating conditions. The first three are direct determinants of usage intention and behavior, and the fourth a direct determinant of usage behavior (Unified theory of acceptance and use of technology, 2008).

- Perceived Characteristics of Innovating (PCI)
Aichholzer (2004) states that the five perceived characteristics of innovating (PCI) of Moore and Benbasat (1991) are based on the theory of diffusion of innovation (DOI) of Rogers (1995) – which is often used in information systems research to explain the adoption of technological innovations by users - and of literature on the diffusion of innovation. Larsen and McGuire

(1998) refer to these attributes or characteristics such as universal attributes to innovation adoption studies. These five perceived attributes (relative advantage, compatibility, complexity, observability and trialability) formed the basis of the work by Moore and Benbasat (1991). They developed a general instrument to be used when you want to assess the various perceptions that an individual can have about the usage characteristics of an innovation and have introduced three new attributes: image, voluntary use and income statement. Furthermore, they adapted the original attributes of complexity and observability that were denominated, respectively, ease of use and visibility (Perez & Zwicker, 2010).

- Diffusion and Infusion Model
Initially proposed by Kwon and Zmud (1987) the diffusion model was further modified by Cooper and Zmud (1990) that proposed a six phase model of information technology (IT) implementation, necessary to achieve the objectives of diffusion and infusion. These six-stages include: initiation, adoption, adaptation, acceptance, use and infusion. To really innovate with the use of the technologies an organization must achieve the level of infusion, which is the degree of integration of an IT innovation to existing processes and normal practices of an organization, providing users with the innovative use of technology.

- Tri-Core Model of Innovation
Swanson (1994) proposed a model of three cores to identify the cores of expertise that contribute to the development of organizational information systems (IS) innovations. The tri-core model is composed by an administrative core, a technical core and an information systems core. This model suggests that a deficiency in one or more cores can cause failures in different types of IS innovations.

- Actor-Network Theory (ANT)
The ANT is a stream of research in social theory that originated in the field of studies of science, technology and society in the 1980s from the studies of Michel Callon, Bruno Latour, John Law, Madelaine Akrich, and others (Freire, 2006). Technically it can be described as a material-semiotic method, meaning that it maps relations that are, at the same time, materials (among things) and semiotic (between concepts). Thus it assumes that many relations are both material and semiotic. This theory is also called sociology of translation, which is one of the important concepts used by the authors. This sociological study aimed to explain the birth of scientific facts. The ANT is also used to explain the new communication paradigms that began into existence with contemporary culture.

- Institutional Perspective
With different impacts, the adoption of IT is also influenced by coercive pressures from both trading partners as their parent companies. The coercive pressures are considered by Teo Wei and Bensbasat (2003) as a construct made up of three sub-constructs: perceived dominance of supplier adopters, perceived dominance of customer adopters and conformity with parent corporation’s practices. The last sub-construct was found to have a stronger impact on the intention to adopt than the pressures from suppliers and customers, “probably because their performance and tenure are subject to evaluation by the parent corporation’s executives” (Teo, Wei & Bensbasat, 2003, p. 40). The adoption of technologies is also influenced by competitors. Mimetic pressures are a construct formed by the extent of adoption by the competitors and their perceived success of adoption and were found to be significant only when innovation was perceived as being highly complex.

- Integration Model of ICT into the School Curriculum (MITICA)
The MITICA consists of five main axes that in a concept of Fundación Gabriel Piedrahita Uribe (FGPU) must meet any educational institution that wants to achieve significant changes in the integration of technologies into their educational processes: institutional direction: refers to the administrative, pedagogical and technical leadership required from administrators of educational institutions and the necessary changes in its structure and organizational culture; ICT infrastructure: meets the proper technological resources: hardware, software (operating system and other basic applications), connectivity and technical support; ICT coordination and

teaching: deals with the roles they should play within the institution both the computer science coordinator and the professors of this subject; professors from other areas: refers to the skills that they should have to be able to integrate ICTs in teaching their subjects; digital resources: meets the availability and proper use of software and Web resources (MITICA, 2011).

- Pedagogical Projects of the Classroom (PPA)
The pedagogical projects of the classroom for the integration of ICTs – possibilities and scenarios for the use of ICTs in education – was proposed by the Universidad del Cauca, taking them as a strategy to build experiences that leverage the mediation of ICTs both to stimulate the reflection on teaching practice and to enrich the educational and didactic proposals that surround them (Chaustre et al. 2010; Pino et al. 2011).

- MICEA Model
The interdisciplinary methodology based on learning teams (MICEA) was proposed by Velandia (1990), “an interdisciplinary construction methodology of knowledge as a team, and through practice, and can complement each other with new information and communication technologies” and the dynamic classroom, based on social cybernetics and triadic proportionalism, proposed by Gregory and Volpato (2002). Velandia C. (1990) proposes that MICEA addresses the need to streamline the student presentiality in a participatory manner, critical, committed and operative. It responds to the requirement of teamwork; the efficient use of technology in constant growth and innovation; to the progressive transit from face-to-face classroom towards to that develops in cyberspace, where the student may also find himself with the knowledge (Mora, 2005).

Santos (2007) reports that it is also possible that in environments with strong institutional symbolism, new technologies will supplant the older ones even though the latter have not yet been exploited to its full potential. This possibility is sustained by the theory of fashions and fads (Abrahamson, 1991).

Did I forget something? For sure. The goal was not to compile, sort, or even compare everything that exists, often only theorized by those who do not practice or live the day-to-day realities. Regardless of what is proposed and theorized, the key is that to work with a particular content of educational manner and through technologies, we need to know the content, the technologies and the pedagogical way to using them. The rest is just idle talk, nonsense, individual attempts of standardization that does not get consensus, much less are adopted as standard by some supralegal body or evolved jointly by the community – nonprofits. In all areas, including the proposition of models and theories, there is always a competition in search of credits, dividends, a place in the sun and, perhaps, recognition...

4. The other side of the coin

Neither the educational technologies (related or not to ICTs), nor the technological integration models can be considered as a solution to all the problems of education. The integration of technology is not a panacea and for it to be successful in the learning process, professors need to demonstrate how and why it can be used in a meaningful way. It is not a unique approach to all cases in which professors do the same thing for their students or possess the same specific skills to be competent technology users (Wepner, Tao & Ziomek, 2006). Professors need to know how and why to use technology in meaningful ways in the learning process for technology integration to work. Some professors seem to know how and why to use technology in the processes, but the effective technology integration to support and enhance teaching and learning in the classroom still eludes many of them (Plair, 2008).

We don't need to follow a certain model of technology integration to use the recent or even archaic technologies, since not all professors adapt to them and all models give the impression of a prescription that tries to define what must have more or less importance in the scenario. And this does not work. Whereas random practice came before the models, they try to

standardize what should not be standardized, that is, produce a cake recipe to be replicated.

The reversal of the traditional paradigm of educational technology (making teaching first, technology second) the need for an increasingly diverse student population and geographically dispersed (Penn State College of Education, 2015), but this would be virtually impossible, these days – without frustrating the new generations – if the use of technologies (new and not so new) was to be left to chance in an apparent return to the past...

In the post “Push My Thinking: TPACK or SAMR or?” from “EdTech Coaching” blog by Krista Moroder, she starts the discussion arguing “why I don’t use TPACK”. What appeared to be a post related to the use (or not) of the methodologies, “evolves” (or, should I say, “regresses”?) to the rhetoric discussion of education with or without technology (Moroder, 2013):

D! says: “I tend to disagree. In my view, the only variable that changes anything in educational methodology, is advances in technology. For example, the printing press and the humble pencil changed pedagogy. The internet and accompanying hardware are simply next in line. Great teaching is always influenced by available tools. Tech therefore deserves an equal circle if not a bigger one.”

However, some resilients agree with the author...
maa says: “Great teaching should not be the case be influenced by available technological tools. It’s with a great teacher’s common sense of knowing how they become the right tools for teaching to enhance learning.”
And Anne Leftwich @anneleftwich, suggests: “Focus on learning. Don’t use technology as a Trojan Horse to change pedagogy”.

As William Shakespeare said “Life is a stage, and we are the actors” (Felter, 2012). According to Galvão (2007), “We staged moments, we rehearse our dreams, and we debut on stage, sometimes successfully, but sometimes with total shame...” In this sense, and adapting to the context, each actor (or author) seeks to interpret in his own way the effectiveness or the non-viability of a certain model, theory or even technology – successfully or with total shame...

This “resistance” shows a salutary, a mistaken and a dated side. The salutary side is not bowing down, not even to established truths, without questioning, without discussing, not to be seduced. The mistaken side is to try, at this stage of the game, ignoring the role of new technologies with the argument that good or great professors do not need them. “Good” or “great” professors, it is an adjectival expression, used in the wrong way, probably referring to those who still give lectures, although nothing is so didactically incorrect nowadays as the action of giving a presentation and have the pretense of holding the knowledge, not committing to a program previously approved, which included content to be developed, methods and forms of assessment (Roth, 2013). The sages on the stage ignore the technological possibilities and the current needs for fear of exposing their own weaknesses. They are overcome with fear of the new and unknown. For them it is much easier to stay in their comfort zone rather than learning new lessons.

Moroder (2013) claims that didactics should have more importance. That may be true. But which didactics is she talking about? An updated didactics or the traditional that has stopped in time?
A current didactics is not shy of exploring new ways to evolve the standard focused on the professor, to later ones, focusing respectively centered on the student and on the relationship between professor-student(s) and among students.

Many professors considered “good” or even “great” do not have any didactics. They learned from their masters how to give lectures and remained at this evolutionary stage. They tend to reproduce the kind of teaching that they have received and never innovate in their didactic practices. They refuse to learn new lessons or even dream with the hypothesis that they are not knowledge holders. In fact, they deceive themselves into thinking that they only teach and

others just learn. This *modus operandi* (method of operation) is not pedagogical, or even something that can be considered “good” or “great”. Everything that exists is the feeling or even a false tradition of refuse to change the way things should be done, an evident desire to stay in their comfort zone, the *status quo* represented by the current situation that has prevailed in the institutions and that keeps them tied to the past, entrenched, oblivious to the world that evolves around them...

Barton and Nettheim (2015) have defined this situation in just one sentence: “I’m an analogue man in a digital world... I’m redundant.”

Finally, the dated side, related to the age or even the lifetime of the resilients (or should I say resistants, or even redundants). The new professors were born in a technological world, in which the use of the internet is not a differential, but a common place. Considering that they are the future and who controls the world is always a dated issue – we all have a life limit – this difficulty will soon be outdated (Roth, 2015a).

“When you look through the years and see what you could have been, oh what might have been if you'd had more time. So when the day comes to settle down, who's to blame if you're not around?” (Davies & Hodgson, 1979/1978, track 6).

Certainly it is possible to do education these days without the latest technologies. It would also be possible to write this article by hand or using outdated technologies like a typewriter or even computers of the first generations. The fact that we use the latest means and methods does not imply better quality, but responds to the expectations of stakeholders. And this reduces frustrations (Roth, 2014).

But to truly utilize in an unarmed way the many possibilities offered by the “force” of the internet – as a support for the contemporary education (pedagogically and technologically sound) – perhaps we should follow the lessons from Jedi Master Yoda to the young Luke Skywalker: “No! Try not. Do... or do not. There is no try” (Kurtz & Kershner, 1980; Quotes for Yoda, n.d.).

There is also the need to venture, get out of the common place and look for something unexpected, unusual, carrying the practices beyond the small horizons.

5. Integration of digital technology in business

The methodologies perceived and described previously are normally related to the question of professor-school-technologies, that is, focused on the school setting. They imply that a certain theory or model are needed to assist the integration of technologies into teaching practices – which is not always true, although there is always a process, even if unconsciously or unplanned. But this approach is not limited to educational institutions. The companies also use the technology integration not only in their training courses (internal or external), but also in their processes of administration, production, sale and post-sale, which includes institutional or functional websites and presence in social networking sites (SNSs) that could be used as innovative tools for teaching (Harris, 2012; Duncan & Baryzck, 2013; O’Brien & Glowatz, 2013).

In the European Union (EU) this aspect is perceived through the Digital Economy and Society Index (DESI), prepared by the European Commission (EC) – through five main dimensions: connectivity, human capital, use of internet, integration of digital technology and digital public services (DESI, 2015). Denmark, Sweden, the Netherlands and Finland are the countries with the highest performance. They are not only ahead in the EU, but they are the leaders of the digital world. Outside EU, Norway and Iceland also show performances that would place them in this high performance group.

Final thoughts

Dockstader (1999) stated that, “Technology integration is having the curriculum drive technology usage, not having technology drive the curriculum”. Generally speaking, the curriculum drives the use of technology and not vice versa (Edutopia, 2005; Edutopia, 2007; Technology integration, 2005).

At the Ca' Foscari University of Venice (UNIVE) the only reference found related to a technology integration model, refers to the TPACK in an introductory essay by Banzato and Baschiera (2012, p. 24) – through a quote from Holton (2012): “But faculty can be aided by some training or assistance in course design, technology, and teaching and learning to develop technological, pedagogical content knowledge (TPACK). Teaching should be treated as a design science, more like engineering than just an art or craft that we all think we can intuitively do well”. That is, no text of own authorship of some professor or researcher was located on the context. The references found are limited to the behavioral models and are treated theoretically. This does not mean that this institution does not perform any “technology integration”, although nothing has been perceived in this sense. But for sure, this university does not practice and does not even theorize any of the best know models (TPACK, SAMR, TIM and LoTi).

This process is urgent and can no longer be ignored. By the end of the 20th century such arguments were still admitted that the use or even integration of technologies “that came to stay”, should be something slow and gradual, taking into account the wishes of the *status quo*. However, even the “big” dinosaurs had their heyday and subsequent extermination, naturally (catastrophic) or even induced by pseudo-gods (Ancient Aliens, 2008) that here decided to conduct experiments “that came to stay”, created in his image and likeness...

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