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The Digital Divide in the University: The Appropriation of ICT in Higher Education Students from Bogota, Colombia

La brecha digital universitaria: La apropiación de las TIC en estudiantes de educación superior en Bogotá (Colombia)

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ABSTRACT

The growth and integration of ICTs in the global economy have created conditions that profoundly affect our society, dividing communities between those who effectively appropriate these resources and those who do not, what is called the «digital divide». This exploratory study seeks to propose and validate ways of assessing this phenomenon in higher education, from the construction of a model and a comprehensive methodology that value contextual conditions, in addition to measuring access factors and motivation for use, that have been employed in previous research. To obtain indications about the behavior of this phenomenon, we developed research with students from three universities in Bogota, administering 566 surveys in four phases that would test the variables proposed in the model. The results show that the variables of the model link causally, with the strongest relations between education, attitude towards ICTs and ICT application. Although students have good access to ICTs and high levels of education, no strong relationship was found in regards to «perceived impact on production». This may be explained by a superficial appropriation of ICT, due to a context that is alien to its conditions of origin (industrialism, innovation), poor quality of education and economies not centered around R&D.

RESUMEN

El crecimiento e inserción de las tecnologías de la comunicación (TIC) en la economía mundial, ha generado condiciones que afectan profundamente a nuestra sociedad, dividiéndola entre comunidades que apropian efectivamente estos recursos y aquellos que no lo hacen, situación denominada «brecha digital». Este estudio exploratorio buscó proponer y validar formas de evaluación de tal fenómeno en la educación superior, a partir de la construcción de un modelo y metodología integral que atiendan a las condiciones de contexto, en adición a la medición de elementos de acceso y motivación de uso ya utilizadas en investigaciones anteriores. Se trabajó con estudiantes de tres Universidades de Bogotá para obtener indicios con respecto al comportamiento del fenómeno. 566 encuestas fueron administradas en cuatro fases para probar las variables propuestas por el modelo. Los resultados muestran que las variables del modelo se relacionan de manera encadenada y escalonada; la relación más fuerte se dio entre educación, actitud frente a las TIC y su aplicación. Aun cuando los estudiantes encuestados tienen condiciones óptimas de acceso y formación, no se encontró una relación fuerte con la percepción de impacto productivo; esto puede deberse a una apropiación superficial de las TIC producto de un contexto extraño a sus condiciones de origen (industrialismo, innovación), educación de calidad pobre y economías no centradas en I+D.

KEYWORDS | PALABRAS CLAVE

Digital divide, graduate education, technology appropriation, literacy, discourse, technological education, critical analysis.
Brecha digital, educación superior, apropiación tecnológica, alfabetización, discurso, tecnoculturas, análisis crítico.

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1. Introduction

The importance of technology and its relationship with economic development was synthesized by Solow (1987a) when he stated: «technology remains the dominant engine of growth, with human capital investment in second place». During the late twentieth century, radical technological changes were generated in the exchange of information, configuring a networked economy of information and knowledge. A global society with capacity for massive information exchange at low cost and accelerated innovation processes was heralded.

The promise of social change towards fairer societies and increased quality of life seemed reachable, however, a resulting paradox was also noted by Solow (1987b), «You can see the computer age everywhere but in the productivity statistics». The benefits of the computer age did not materialize as expected, or are not measured correctly; or diffusion was not accompanied by the required organizational changes for its use; or its benefits were associated with intangible assets whose absence diluted their impact (Brynjolfsson & Hitt, 2000). Measuring empirically the effects of computer technology using methodologies with reasonable reliability has proved to be an elusive task.

This research explores the complexities of measuring the impact of information and communication technologies (ICT) in a group of undergraduate students from three universities in Bogotá (Colombia), and proposes conceptual definitions that would allow measurement in an more efficient, systematic and comprehensive way, while maintaining a critical position in regards to the real effects of these technologies, to differentiate them from fashionable commercial discourse.

2. Inequalities in the network economy and the information society

The impact of ICT is uneven between different communities or organizations (Davenport, 1999). Brynjolfsson proposed that effects can be categorised under two types: 1) those particular to each organization, or distinctive uses; and 2) those common to almost all organizations, or stereotyped uses (Brynjolfsson & Hitt, 2000). To achieve the first type of effects, we need actions that go beyond the mere application of ICTs (DeLone, 1988). These actions include training, organizational restructuring, process redesign and attitude change. Effects are expressed in long-term intangibles, within multi-faceted and multivariate areas that include context, the system, information, the individual, the collective, intention, emotion and action (Delone, 2003).

Following Brynjolfsson (Brynjolfsson & Hitt, 2000), organizational behaviors associated with the creation of added value and differentiation when applying ICTs imply autonomy, empowerment, investment in training and incentives for collective performance. Organizations with labor that is skillful in R&D in societies that support and consume products with high levels of added value, tend to have profiles that result in a positive digital disposition (Dutta, Lanvin, & Paua, 2004). However, in organizations within contexts different to these, the beneficial effects of ICT can be reduced, disappear or even become negative (Avgerou, 2001; Brynjolfsson & Hitt, 2000).

Organizations synergic with ICTs tend to invest more in information technologies, permanently making their management more sophisticated and rapidly differentiating themselves from their competitors. In non-industrial contexts, non-computerized societies and organizations maintain more traditional routines, because they simultaneously face the absorption of techniques and instruments, while copying their pre-existing idiosyncrasies, environments and routines (Avgerou, 2003). In these cases change is perceived as expensive, time-consuming and risky, producing sentiments that facilitate phobic, indifferent or stereotyped attitudes towards technology.

The digital divide is part of a global evolving pattern of techno-economic dependence whose dominant centers are the Western industrialized metropolises (Perez, 2001), those that commanded the evolution from Gutenberg's print to the Internet. This center-periphery structure (Prebisch, 1986), maintains technologies that revolutionize the market sheltered in the industrial metropolises, exporting them to the «periphery» when they reach saturation points in their own market, but restricting their source codes. Initially a novelty in the host societies, the process of expansion and saturation is repeated there, while the metropolis evolves to the next innovation, creating a renewed bond of dependence (De-la-Puerta, 1995).

The technological transference involves semiotic elements that act as a DNA that reproduces organizational routines (Hodgson, 2002), market symbolism (Bourdieu, 2000) and social isotopies (Blikstein, 1983), creating an administrative common sense (Perez, 2012). All these sociotechnical dynamics conform what Gille has referred to as the Technological System (Gille, 1999), a structure that transforms social life by connecting technologies and everyday productive routines. If the technological system adopted by the com-

munity is inconsistent or non-competitive, the host is limited by these gaps and builds an inefficient technical rationality.

For these reasons, communities from developing territories end up producing superficial changes in their tortuous transition to the new ICT paradigm, unable to keep up the pace in developing computer skills. The problem is not just access to tools; it includes the construction of a compatible social, cultural and economic logic (Avgerou, 2003), that, due to the resistance to change from some of the local stakeholders, turns into a complex and slow process. It involves sacrificing some of the distinctive particularities of the community, with no clear perspective about the future benefits of such actions.

Under this scenario, the digital divide must be redefined as a multidimensional problem of politics, economics, culture, access, skills and incentives (Cho, De Zuniga, Rojas, & Shah, 2003; Norris, 2001; Warschauer, 2004), complemented with access limitations, economic hardship, fragile infrastructure, weak education and regulation shortage, all of them typical conditions in developing countries (Chinn & Fairlie, 2007). Those with a less effective technology will be unable to extract the benefits from the system. Those with educational, language or context restrictions will not be able to decode the information and integrate it constructively. All social, cultural and context differences between developed and excluded communities are significant, therefore it cannot be assumed that the critical elements for ICT appropriation are the same (Venkatesh & Sykes, 2013).

Communities from developing territories end up producing superficial changes in their tortuous transition to the new ICT paradigm, unable to keep up the pace in developing computer skills. The problem is not just the access to tools; it includes the construction of a compatible social, cultural and economic logic (Avgerou, 2003), that, due to the resistance to change from some of the local stakeholders, turns into a complex and slow process. It involves sacrificing some of the distinctive particularities of the community, with no clear perspective about the future benefits of such actions.

2.1. Digital divide: A clash of epistemologies and cultures?

For McLuhan (1969) as media are extensions of human perception, new media technology creates radical changes in the sensitive conscience of mankind. Within this logic, we need to review technology features, content and context. It is necessary to exceed the instrumental level to accompany the complex behavior that technological appropriation entails (Berrío-Zapata, 2005). ICTs act as media, content and context. Its techno-informational paradigm is the expression of the Western mind built on the Fordist and post-Fordist model (Day, 2001). Oral tradition lost its leading role and those communities based on it were marginalized by the dominant grafocentrism of the industrial world (Serres, 2003).

Charles Kenny contends that the biggest problem of poor and marginalized populations is the differences in culture and economies from Western traditions and habits (Kenny, 2002). Due to their location, population density, economy and idiosyncrasies, the Web structure provides certain incompatibilities with them. Globalization marginalizes populations that are not close or compatible with its interests and ICTs follows such inclination. Kenny proposed building information systems and knowledge networks from the tradition of these fringe worlds, with technologies that would be economically viable, structurally possible and socio-culturally acceptable.

In management literature we still talk about information systems as a synonym for computer systems. The first pre-exist the latter as an economic structure of organizational knowledge. «Peripheral» communities have non-digital information systems. Merle calls them «knowledge economies of poverty», based on «non-informatic men-ware systems» (Merle, 2005). Information systems, including computing, are better understood from an epistemological perspective of

auto-eco-regulation (Morin, 2001) and self organization (Foerster, 1997), associated with ecological models of information (Davenport, 1999; Nardi & O'Day, 2000) that can be applied to the digital divide. This implies reassessing many of the characteristics attributed to organizational systems. Some of these features are (Berrío-Zapata, 2005):

• System Rationality: meaning and significance dominate over technical rationality. The intuitive, emotional, symbolic, cultural and institutional prevails. Media and content are significance and significant at the same time. The emphasis falls on tacit knowledge. Optimization rules the logic of the system.

• Content Function: Content exceeds and complements the formal and technical structure through informal communication and organization.

• Relationship with the User and Context: Systems integrate with the community and environment in an adaptive dialogue that affects the collective and the individual recursively, producing holographic effects (Morin, 2001). The informational routines behave as organizational DNA that reproduces a rationality of content, media and process (Hodgson, 2002). It is a dialectical spiral of epistemological and ontological impact on the organizational knowledge system.

• System Control: Computers generate butterfly effects, subtle routines that evolve autonomously and create exponential impact over time by force of repetition and multiplication. Self-organization prevails; the formal system conveys informal exchanges whether compatible or not with its productive logic.

This epistemological perspective of information systems is the basis of this work and its methodology for assessing the impact of ICT.

3. Field of study: Colombia and the higher education sector

The education sector is a turning point for social change and that is why it was chosen as the niche for this research. Education is directed at building generic skills that will be the basis for the development of distinctive skills in citizens. As computer literacy is a generic competence in the networked economy, universities are an ideal space for observing the process of technological appropriation and the elements that modulate the process. In Colombia, until 2001, the fastest growing IT infrastructure in the country was in universities (DANE, 2003). The Alvaro Uribe governments (2002-06 and 2006-10) continued a policy started by former president Andres Pastrana (1998-2002) regarding the appropriation of ICTs in higher education, continuing to implement a digital master plan called «Agenda Conectividad» and articulating it with its educational policy «Revolución Educativa» (Ministerio de Educación Nacional de Colombia MEN, 2003). In addition to these two policies, the previous Ten-Year Educative Master-plan also included ICTs for higher education as a strategic priority (Ministerio de Educación Nacional de Colombia MEN, 1996). The Uribe government, who reassigned these programs from presidential level to ministerial level, dividing them between the ministries of Telecommunications and Education, reduced the initial impulse of Pastrana's ICT policy. However, Colombia followed the international tendency of building ICT policies and virtual education during the decade of 2000 (Facundo, 2002; Sunkel, 2006).

At the time Colombia was described in international reports as a country with significant advances in digital inclusion and infrastructure investment, although its «ICT shopping basket» prices were not the best (ITU, 2012; Stats, 2012). High expectations were held in regards to the enabling action of the ICT context in Colombian and its appropriation by the university population.

4. Towards a holistic methodology for measuring the appropriation of ICT

Investigating whether Internet improves educational productivity has been sought repeatedly, but research has suffered from varied methodological problems (Benoit, Benoit, Muyo, & Hansen, 2006):

• Small population samples.

• Tenuous relation between measurement and educational objectives.

• Non quantifiable measurements.

• Failures in the control of variables.

• Extensive use of self-reported data.

• Use of single-variable indicators rather than multivariate scales.

• Scales without any reported statistical reliability.

This research has tried to overcome these flaws by formulating a methodology that would encompass endogenous and exogenous variables, while integrating theoretical models that could articulate a comprehensive view of the subjects in their own environment. This structure is described in the following section.

4.1. Areas of measurement: endogenous, exogenous and appropriation constraints

Methodologies that study the effects of ICTs are usually based on the subject's perception about how they impact their lives (Lopez, 2013; Venkatesh, Thong, & Xu, 2012): the endogenous. This is just a

part of the equation. This research drew on exogenous indicators in order to triangulate the impact of ICTs, integrating three tools of strategic analysis: (1) PEST analysis (Johnson, Scholes, & Whittington, 2006), (2) the Systemic Competitiveness Analysis (Esser, Hillebrand, Messner, & Meyer-Stamer, 1995), and (3) the Core Competencies Model (Le Deist & Winterton, 2005). Thus it was possible to verify what the subject reports against environmental indicators.

To define the endogenous variables analysis, we used the Technology Acceptance Model (TAM) (Davis & Venkatesh, 2000) complemented with the Expectations Model (Vroom & Deci, 1982) and the Motivation-Hygiene Model (Herzberg, 1966). In the absence of appropriate instrumental conditions for a behavior, in this case technological appropriation, motivation towards the behavior tend to decline despite the perceived usefulness.

Endogenous and exogenous factors were organized in pyramidal style (figure 1), inspired in the Hierarchy of Needs but replacing the structure of «floodgates» with the probabilistic principle proposed by Herzberg. It is expected that the instrumental or exogenous elements act as hygienic factors that reduce the probability of ICT appropriation when they are not satisfied. In addition, conditions such as a facilitating social context (Venkatesh, 2000) would act as facilitators (i.e. positive attitude towards ICT from peers and family).

In this model the existing knowledge structure would mediate the ability to understand, use and articulate a technology and the information that such technology makes available for everyday life, reducing knowledge gaps (Bonfadelli, 2002).

The third pillar includes restrictive factors to technological appropriation, a concept employed by Argyris who contends that the key to knowledge management lays in eliminating the barriers to learning (Argyris, 1999).

Resistance to change was operationalized employing Limiting Mental Models and System Thinking (Senge, Cambron-McCabe, Lucas, Smith, & Dutton, 2012). Due to risk aversion and the anxiety suffered during the process (V. Venkatesh, 2000), communities and organizations can get stuck in traditions that represent successful practices of the past but inadaptive behaviors of the present, (Denrell & March, 2001). They can act as «organized anarchies» characterized by problematic preferences, scarce technological clarity and low participative exchange. In this case ICTs would become a stereotypical alternative taken from the collection of «fashion solutions».

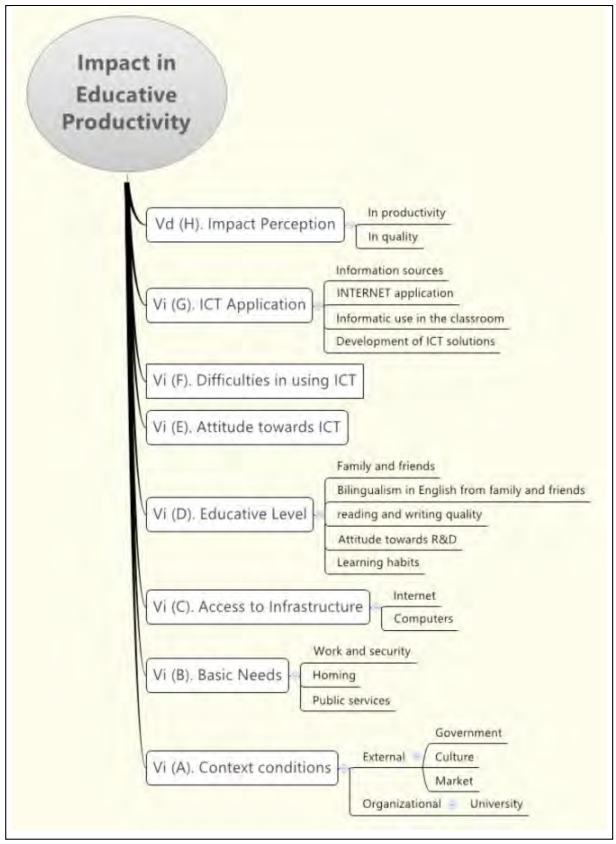

Figure 1: Variables defined for the study.

Educational productivity was defined as an improved relation between quantitative and qualitative production of learning and the effort invested in the process, measured with respect to the goals set by the educative institution, the available resources and the needs from the environment.

4.2 Variables

The variables of the study (figure 1) were divided into Endogenous, Exogenous and Restrictions to Appropriation. It was assumed that the variables in the base of the scale would define probabilistically the possibility of moving up to the variables at the top. As we move up in the structure, access to the following levels of the scale should become more limited. Therefore, the distribution of these variables in the population would have the form of a pyramid: more people at the base and gradually or drastically reducing as you ascend through the variables necessary to reach the top. The steepness of the pyramid would reflect the magnitude of the digital divide. For example (figure

2), applying Colombian statistics from the year 2008, 99.4% of the urban population had access to electricity, 22.8% to a computer, and 12.8% to the Internet; 10.3% of the population in ages between 20 to 34 had five or more years of education (DANE, 2008). Articulating these data a pyramid form naturally where each level is necessary but not sufficient to reach the next level; this incomplete example (it does not include all the seven stages of the model) helps to represent the articulation of IT with everyday life and a context resulting in information impact regarding productivity. Figure 2 shows only four levels but serves to illustrate this new way of visualizing the digital divide. The probability of having an impact on productivity in the population with ICTs would be the product of the combined probabilities of all levels. This research focused on testing this structure of variables and relationships, looking to improve the methodological options required to verify them empirically.

4.3. Instruments and population sample

The instrument used was a survey that included seven dimensions representing the variables in the proposed model. The survey included 25 multiple choice questions adopting a Likert-type format.

The surveys were administered four times between 2006 and 2008, and in each iteration the survey was improved to obtain a final questionnaire. The face validity of the instrument was evaluated using external peers and feedback from the respondents in the initial iterations, the reliability of the scales was assessed via Cronbach's Alpha. We worked in Bogota with a convenience sample of 566 undergraduate students from three private universities. Data collection was made via email including advice on how to answer the questionnaire and control over incomplete answers.

The exogenous characterization was developed on the base of secondary sources, official documents collected from the government, multilateral agencies, NGOs and press news between 2006 and 2009 from two of the highest circulating newspapers in the country: El Tiempo and Portafolio. This information was triangulated with the survey into a section devoted to items asking about how organizational, institutional, economic and sociocultural contexts facilitated or hindered the productive use of ICT. In this way we sought to balance the effect of self-reporting.

5. Results

The endogenous analysis showed the following trends (figure 3):

A statistically significant (0.01) and strong association ($\beta > 0.3$) between (D) Education Level (E) Attitude towards ICTs and (G) Application of ICT. The explanatory power of these variables reached 'R' values between 24.1% and 53.2%.

All respondents agreed that ICTs are useful, but the (H) Perception of productive impact did not have a strong relationship with the other variables at the base of the pyramid. This can be interpreted in two ways:

a) There are conceptual problems in the definition of «productive impact». Achieving a valid and reliable way of measuring this phenomenon is a long-term challenge.

b) Students have access to the instrumental conditions associated with the use of ICTs, but they do not explore their productive applications, as their social context does not value or reward knowledge management and innovation neither socially nor economically.

c) The different independent variables that affect the perception of productive impact act by stages, and share a correlation based in contiguity. This correlation is reduced as variables become more distant. Each variable is a necessary step but not sufficient to advance forward to the productive impact of ICTs. Inadequate conditions in any level of the pyramid do not prevent moving to the next level, but reduce the chance of reaching the top. These findings were consistent with the results of the analysis of the exogenous context in four levels:

- Meta-economic: During the period studied Colombian society did not yet have a clear perception

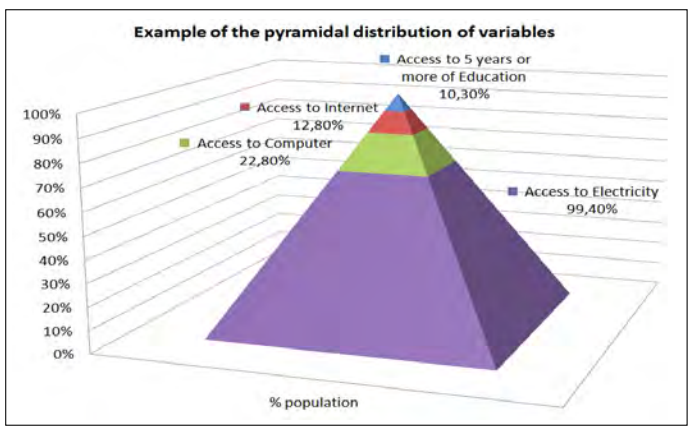

Figure 2 Example of distribution of variables in the proposed model, with data obtained from Colombian urban population, year 2008 (DANE, 2008).

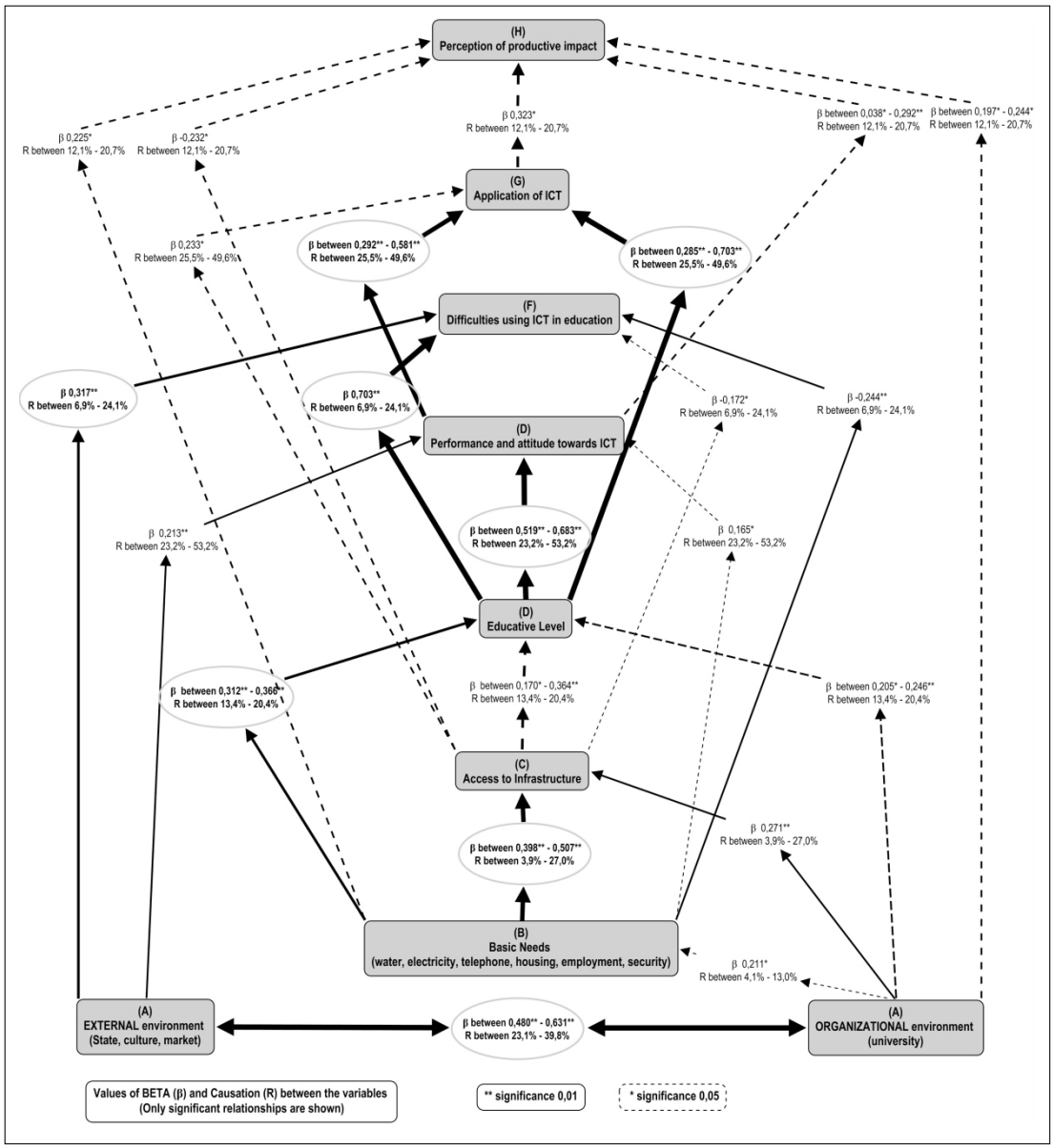

Figure 3: Results in correlation, significance and predictive capacity among the proposed variables.

of the importance of ICTs as a tool for productive development. IT tools still were seen as objects of fashion and status. There was no visible link between education, industry, ICT policies and the development of R&D, and in the community studied and their context that articulation was not considered as something to be encouraged.

• Macro-economic: The situation of Colombian society in terms of consumption capacity was not good. Despite the improvement in some economic indicators and the rapid lowering of IT costs, these technologies were still a luxury for most people and therefore, alien to their living environment. Such effect was not noted in the community studied except for the rates of broadband access. Due to their socio-economic profile, the samples taken from private universities had the first three levels of the pyramid granted.

• Meso-economic: the country had a rapid advance in the political and regulatory infrastructure concerning the informatic. However, the disarticulation of these policies and norms with the social and economic reality did not allow the creation of a critical mass to shake up the traditional productive array. High rates of growth in access to infrastructure were the result of

the country's lacking state of digitalization before year 2000. A poor educational infrastructure coupled with an economy focused on the exploitation of natural resources where R&D is almost nonexistent, made ICT flawed as a generator of significant productive progress and led higher education towards a scheme of technical training geared towards the production of basic goods rather than the creation of knowledge and the generation of innovation skills. In this context ICTs had a significant loss of power.

• Micro-economic: Universities had the lead in infrastructure but privileged the development of technological instrumental and operational capabilities rather than creative skills. With a focus in tuition revenue and not in R&D, the higher education sector provided the tools but did not encourage a strategic appropriation. ICTs became devices for basic or hedonic uses, not a booster for information management, knowledge and innovation.

6. Conclusions

The lack of a strong correlation between the variables in the base of the model and the Perception of Productive Impact can be explained by the lack of articulation between technological tools, the economic profile of the country and the idiosyncrasy of users. Students use ICTs but given their formation and education, they do not appropriate them beyond basic production possibilities or recreational uses. These results confirm the critique of the instrumental and motivational focus when discussing the digital divide. Technological appropriation is an individual but also collective phenomenon, which includes political, economic and cultural factors that must be analyzed together. It is possible to supplement endogenous models like TAM with exogenous models for competitive and economical analysis to have a contextual view.

The theories of Mental Models can assist in understanding the rationale of technological appropriation. Tradition, culture and power structures associated with conventional information architectures are part of the conflict that is generated in front of any new alternative, irrespective of the benefits that the technology on offer may include. Productive rationality is just a part of these processes. Strong social inequalities and tensions in developing regions stimulate the action of extra technical elements, widening the gaps that limit communities to build computer and information literacy.

The internet is the natural environment of developed communities of the West, those who built the Networked Economy. This environment spilled into a productivist epistemology that does not reflect the dimensions of organic information systems, their ecological complexity and logic. The impact of ICTs has been such that its ontology had been naturalized within discourse about development. But developing countries do not fit into this logic. In these places the actors and dynamics that restrict the ability to access and control Internet are different.

If ICTs are to be the engine of improvement for the world population, we cannot start from the assumption that the world is digital, because two thirds of the planet do not inhabit that paradigm. Although the digital order dominates economically, under its dominion many informational architectures and vernacular technical rationalities remain, representing the diversity of a «peripheral» humanity. Ignoring these risks implies a loss of valuable informational heterogeneity, identity and adaptability, as well as the waste of resources that happens when trying to implement non-negotiated technologies that become forced semiotic conversions.

To tackle poverty and exclusion through ICTs, it is necessary to investigate better the relationship between the local informational architectures, their technology and the economic, socio-cultural, institutional and political systems articulated therein. Developing countries are concentrated on the production of basic goods and services of low added value, so their conditions do not facilitate compatibility with the regime of the Innovation Economy. The social milieu must change if ICTs are to be intelligent technologies.

This research tried to overcome the limitations of preceding studies. That was not achieved in some aspects:

• The size of the samples is still a restraint.

• Although the concept of educational productivity was linked to the educational goals, the results could not be triangulated with other variables such as student performance and class grades.

• Surveys were distributed and controlled via e-mail, a practice that created problems for people with low computer literacy, or limited resources to access a computer or Internet.

• Control of variables within the population samples is still not satisfactory. Given the size of the sample and the limited resources it is difficult to introduce stratified sampling.

However, it was possible to improve other aspects:

• Balancing the structure of self-report with exogenous sources of information.

• Defining countable results with reliable scales tested with Cronbach Alpha.

• The application of statistical correlation and multivariate analyses to test the proposed scales.

• Correlations, reliabilities and predictability of the model worked with a significance of 0.05.

The challenge for future research will be to test these results in populations of wider variability. Working with university students in an educational environment within one country introduces associated variables of socioeconomic nature that limit a better testing of the instrument capabilities.

Finally, it is also necessary to rethink the definition of «productive impact» of ICTs, as there are multiple connotations in the rationality of «the productive», which tend to bias the research towards a technical reductionist discourse that measures the degree of acculturation of the host population. Without the proper care researchers may end up making a justification of what is being criticized: the presumption of universality of a production order that given its technical power and dominant position, this confuses such power with the capacity of producing welfare and human development in every latitude of the globe.

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