

Comparative Analysis of Research Skills and ICT: A Case Study in Higher Education

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Abstract: The development of research skills in relation to the use of Information and Communication Technologies (ICT) is studied in two groups of the Master of Science in Education at a public university of the State of Hidalgo, with the purpose of generating strategies to foster the development of such skills. The methodology approach is a non-experimental transactional design, in which a highly reliable questionnaire with a Cronbach's alpha of .95, was applied to evaluate seven factors. A descriptive statistical analysis of the data was carried out to compare a group of applicants to the master's program with a group of graduating students. Among the results, it was found that both groups showed a high percentage use of technology with laptops, tablets and cell phones. However, even though both groups reported having received training or having partial knowledge of the use of ICT, only a very small percentage uses these tools as a way to strengthen their research skills. It is therefore proposed to consider these results for the design of strategies that promote the development, knowledge and application of research skills supported by the use of ICT across the different courses that integrate the curriculum, in a way to ensure the best training for students while studying in the science education postgraduate program.

Key-words: Research Skills, ICT, Master's Degree, Postgraduate Program, Student Training.

1. Introduction

The University is one of the main driving forces in the 21st century society, and in front of the current scenarios of change, uncertainty, globalization and incorporation of Information and Communication Technologies (ICT) in the different fields of the life of the human being, it

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requires to make adjustments to its structure and educational model, in such a way that it responds assertively to current demands; moving from paradigms based on teaching, to paradigms oriented towards permanent learning and to the construction of knowledge, both individually and collaboratively, using the different rhythms and learning styles of each of the students.

Research as a substantive function of the University constitutes a priority axis to shift from an information society to a knowledge society, by carrying out search, identification, analysis, reflection, assessment of information, and problem-solving processes when generating new knowledge. Also, to use preexisted knowledge in a creative way, and finally, to disseminate the results of research, in print and electronic media. When working this process, higher order skills are strengthened.

For Ibarrola, Sañudo, Moreno & Barrera (2012), postgraduate research is a privileged strategy for learning, thanks to which research skills are developed and strengthened; that is, conceptual, procedural and attitudinal knowledge is oriented towards using different ways of thinking, construction of knowledge by means of the search, selection and evaluation of information, use of methods, techniques and tools, observation, analysis and interpretation of information, resolution of problems as well as decision making.

Regarding the development of research skills in graduates, there are some studies, standing among them Piña (2013), who ensures that students enter to the masters' program with different profiles, and therefore, the training process for research and developing a thesis is complex, since for several students, this would be their first experience working in such modality.

Another fact that has diversified higher education systems, as well as the development of the research processes, is the use of Information and Communication Technologies. Then it is relevant to think about Why are ICT used in master degree programs? What are they used for? Who uses them? How are they used? And in this sense, think about the research training at the master degree programs, what the current trend is from Ibero-American countries, and in which ways technologies are incorporated in the development investigative skills in the students.

Based on the previous thoughts, it is pertinent to conceptually define the term 'skills' and then to go deep specifically in the investigative skill. In a concrete way, the idea of skills in the educational field has been defined by a diversity of international authors and organizations, enriching itself over the years. OECD (2002) defines it as the skills that enable successful requirement of the demands by mobilizing social prerequisites. UNESCO (2009) affirms that this concept refers to meaningful learning, highlighting four features in its conceptualization: 1) it takes the context into account, 2) it is the result of a process of integration of knowledge, skills and attitudes, 3) it is associated with execution or performance processes, and 4) it implies a responsibility.

Perrenoud (2008, p.7) defines them as "an ability to act effectively in a defined situation, capacity that relies on knowledge, but is not limited to them". Zabala and Arnau (2007) define it as "that that any person needs to respond to the problems to be dealt along life" (p.45).

This research takes the concept of Tobón, Pimienta and García (2008) as a referent of skill, defined as "comprehensive actions to deal with activities and problems from the context, suitably and ethically, integrating ways of being, doing and knowing from a perspective of continuous improvement " (p.11). In this sense, skills are not something finished, but they are enhanced and developed throughout life, and from a systemic and complex perspective (Morín, 2007).

Particularly in this study, research skills, addressed from the view of Aguirre (2016) and Pérez (2012), imply using knowledge in an adequate way, strengthening the skills to observe, question, record field notes, experiment, interpret information, and disseminate their results, besides considering personal fulfillment and enrichment of their practice. A similar approach has been presented in Gómez (2016). According to Gayol, Montenegro, Tarrés and D'Ottavio (2008) research skills refer to the ability to mobilize conceptual, procedural and attitudinal knowledge to solve a problem in a defined context; that is, to articulate knowledge, attitudes and behaviors to integrate them into a methodology that puts them into practice.

Estrada (2014, p.180) argues that the research skill "has been conceived in higher education, both in the practical procedural and formal structural curriculum throughout the university career", although in the development of the thesis the use of scientific methodology is evident, for the identification and solution of a problem, both theoretically and practically, applying the stages of scientific research.

In a public university of the State of Hidalgo, the Master program of Science in Education establishes, knowledge, skills, attitudes, values and research skills in the admission's profile, considering the following: 1) Participate in experiences of research and generate action strategies to carry out information search, and 2) Communicate oral and written ideas in a clear, coherent and structured way to generate specialized speeches in the area of their training.

For the development of this research, we worked with a group of 11 graduating students, class 2016-2018, and a group of 17 applicants that would become the class 2018-2020. This study recovers the importance of assessing the development of research skills from the students' perception, and to develop research skills with technological resources, therefore, the following research question is proposed: What are the research skills with the use of Information and Communication Technologies with which students enter and graduate from the Master of Science in Education at a public university of the State of Hidalgo?

In order to answer this question, the following objective is considered: To conduct a diagnosis of research skills with the use of the technologies with which the students enter and graduate from the Master of Science in Education at a public university of the State of Hidalgo, to generate strategies that increase their development.

2. Method

The present research is approached from a quantitative methodology with a non-experimental transactional design (Hernández, et.al. 2010), from the construction and application of a highly reliable questionnaire, with Cronbach's Alpha .95, which was sent to the applicants digitally. The questionnaire consists of 70 items, organized into four sections: 1) General data, 2) Technology availability and Internet access, 3) Command of technological resources, 4) Research skills.

3. Results

A descriptive analysis of the results, from each of the categories established in the questionnaire is presented, from a group of applicants to the Master of Science in Education of a public university in the State of Hidalgo. In class 2018 -2020, 88% are women and 12% men, while in the class 2016-2018, 55% are men and 45% are women.

In the section Technology availability and Internet access, the Class 2018-2020 reported that 71% of the applicants own a computer while 29% does not. 94% owns a laptop, which probably covers this need in several places. 100% owns a cell phone, 65% does not own a tablet. 100% accesses the internet several times a day, which defines this is a need for the applicants; 53% accesses the internet for recreation activities, 29% for academic content from which 18% is related to art and culture. 65% has received information about the use technological resources to strengthen their research processes while 35% has not.

In the same section, Technology availability and Internet access, the Class 2016-2018 reported that 91% owns a computer while 9% does not. 100% owns a laptop, which probably covers this need in several places. 100% owns a cell phone, 9% does not have a tablet. 100% accesses to the internet several times a day; 82% accesses for recreation activities from which 18% is related to art and culture. 91% has received information about the use technological resources to strengthen their research processes while 9% has not.

In these results, when relating the Information and Communication Technologies (ICT) and the development of research skills, it was observed that the applicants, Class 2018-2020, own several electronic devices, such as laptops and cell phones; however, their use to support academic work is null.

Unlike the students of the Class 2016-2018, where 73% reported to have received information about the use technological resources to strengthen their research processes. In this sense, it is observable that not only is access to technology, but its use enhances the research they are developing.

Variable	Class 2016-2018		Class 2018-2020	
	Mean * (N=17)	Standard Deviation	Mean * (N=11)	Standard Deviation
Use of computer software (Word, Power Point, Excel).	17 3.36	.67	3.29	.84
Use of email (Gmail, Hotmail, Yahoo).	3.63	.50	3.47	.87
Use de browsers (Internet Explorer, Google Chrome, Firefox, Opera, Safari).	3.63	.50	3.47	.71
Resources to share imagery and video (Flickr, Slide Share, YouTube).	2.81	1.16	2.00	1.11
Resources for collaborative edition (Wikis, Google drive).	2.81	.75	1.88	1.16
Social media (Facebook, Twitter, Instagram, Snapchat).	3.54	.68	2.94	1.08
Blogs.	2.45	1.29	1.29	.98
Communication tools (Messenger, Skype, Hangouts, WhatsApp).	3.27	1.00	3.41	1.00

Table 1. Command of technological resources

*Answers organized as follows: 0 (never),1(occasionally), 2 (one or two 2 times a month), 3 (several times a week), 4 (daily). Source: Authors.

According to the analysis of Table 1, the mean's response for class 2018-2020 students was 2.71, and 3.18 for the class 2016-2018, which indicates that the applicants use these technological resources several times a week. The least used resource is "Blogs", and the most used are email and internet browsers. In their answers, some applicants referred to have never used certain resources, while others stated to use all the resources on a daily base.

These results indicate the need to train and encourage understanding of ICT and the development skills for research, since it is one of the objectives of the program in Science Education.

Variable	Class 2016-2018		Class 2018-2020	
	Mean * (N=11)	Standard Deviation	Mean * (N=17)	Standard Deviation
Used concepts and key words to search for information in the	3.54	.52	3.41	.79

internet.				
Used internet advanced search with Boolean terms	1.90	1.30	1.58	1.32
Use of search engines and meta search engines (Google, Yahoo, AltaVista, Excite).	3.45	.68	2.58	1.22
Use of digital libraries (UNAM, ILCE, Biblioteca Digital Mundial, Biblioteca Digital Hispánica).	3.18	.75	2.47	.94
Use of high impact factor electronic journals (JCR, Scopus, Indexed in: Redalyc, Latindex, Scielo, MIAR, DOAJ, ORCID).	3.00	1.26	2.41	1.06
Use of reference managers (Mendeley, Zotero, Endnote, RefWorks).	1.54	.93	1.00	.93
Use of ICT for document and file storage (Dropbox, Pocket, One Drive, iCloud).	2.90	.94	2.29	1.26
Data base search (Eric, Dialnet, Ebsco Host, Google Académico, Latindex, Redalyc).	3.00	1.00	2.11	1.31
Use of thesaurus for information search (VOCED, ERIC, TESE, UNESCO, OIT).	1.18	1.07	.94	1.08

Table 2. Research-inquiry skill.

*Answers are organized as follows: 0 (never), 1 (rarely), 2 (sometimes), 3 (almost always), 4 (always). Source: Authors.

This research is supported by a process stems from the need to estimate the content validity of a test, as noted above, it has carried out an expert opinion. To do this we have collected information systematically, following the steps pose Escobar-Pérez and Cuervo-Martinez (2008):

Mean for the class 2018-2020 is 2.23 against 2.63 of the class 2016-2018, a closer response to the occasional use of these resources totally related to activities or the development of research products and inquiry, to a degree that most of the participants answered that they have never used them, as they do not know or need them. The skill that they have most developed was the use of keywords for information search, which indicates that this skill is limited, with the need to develop it, as it is essential to inquiry and research.

Among the lowest scores in this category are the use of Boolean operators with 1.90 in the class 2016-2018 and 1.58 in the 2018-2020. Also, reference managers as well as the use of thesauri for information search presented a low percentage. In this sense, it is important to think about the

level of research inquiry skill that both applicants and students of the master program possess. If adequate strategies were generated for information search, it would be possible to advance deeply in the object of study; otherwise valuable time is lost in the search and use of unintelligent information, increases the number of sources with limited scientific validity.

Variable	Class 2016-2018		Class 2018-2020	
	Mean * (N=17)	Standard Deviation	Mean * (N=11)	Standard Deviation
Save a webpage when relevant for the research Favorites in Internet Explorer or bookmarks in Mozilla Firefox).	3.7273	.46710	2.94	1.19742
Use social marks to save and classify the information found on the internet (tags).	2.1818	1.07872	1.52	1.23
Saved the information in managers (Zotero, Mendeley, End-Note).	1.0000	1.00000	.76	.97
Save information found in my computer using 'save as'.	3.6364	.92442	3.05	1.19
Review the history in my computer to identify information previously found.	2.6364	1.43337	2.76	1.30
Organize the information found in themes, levels or categories.	3.0909	1.04447	2.17	1.18
Use technological tools appropriately to cite in a requested style (APA, Harvard, Chicago and others).	2.5455	1.21356	2.23	1.09

Table 3. Organizational research skill

*Answers are organized as follows:0 (never),1(rarely), 2 (sometimes), 3 (almost always), 4 (always). Source: Authors.

The mean for the organizational skill (Table 3) for the Class 2018-2020 is 2.04 against 2.68 for the Class 2016-2018, which indicates that they sometimes use ICT to organize the information required. This is probably related to the first results in which they referred the use of ICT for recreation or cultural purposes; however, to do research, it is necessary to organize, recover and store the necessary information.

After information searching, selection is one of the most meaningful characteristics for someone who is training in research. The results obtained are remarkable in the limited use that both students and applicants have of technological tools such as reference managers, which is a resource that favors the organization of information, as well as its classification in

categories and subcategories, enabling a macro, mesa and micro view of the documents that have been reviewed.

Variable	Class 2016-2018		Class 2018-2020	
	Mean * (N=11)	Standard Deviation	Mean * (N=17)	Standard Deviation
Qualitative data analysis of information with specialized software (Nud.ist, Atlas.ti, Aquad, Ethnograph).	2.18	1.16	.88	1.05
Quantitative data analysis of information with specialized software (SPSS, SAS, BMPD, STADISTICA).	1.90	1.44	1.05	1.34
Use of plagiarism check software (PlagScan, Turnitin, Paper rater, Plagium, Plagiarism Cheker).	.45	.82	.23	.66
Use of software for visual data (Cmaptools, Hohli, WriteMaps, Diagramly, Google Chart Tool).	1.45	1.03	.47	1.06

Table 4. Analytical research skill *Answers are organized as follows:0 (never), 1(rarely), 2 (sometimes), 3 (almost always), 4 (always). Source: Authors.

The mean for the analytical research skill for the Class 2018-2020 is .66 compared to 1.49 in the Class 2016-2018, which indicates that participants never or rarely use this skill. Although their answers range from never (0) to always (4) about the use of specialized software for the analysis of qualitative or quantitative data, the low mean's response indicates a need to attend it, especially with the class 2018-2020, since the use of these software is fundamental to get to precise results during research.

The use of specialized software for both quantitative and qualitative analysis are resources that facilitate the organization of data and do deep in terms of the reflection around them; however, on one hand, it requires technological understanding of the software used, as well as clarity of what, how and why is to be analyzed, to achieve greater consistency in the results obtained, to reduce time for analysis, to represent information in a variety of formats, and well as to consolidate their work.

Variable	Class 2016-2018		Class 2018-2020	
	Mean * (N=17)	Standard Deviation	Mean * (N=11)	Standard Deviation
Use of Google Drive, Dropbox, OneDrive to share and create documents.	3.63	.67	2.76	1.34
Use of groups and chat to ana-	2.36	1.02	2.17	1.33

lyze, share and discuss information.				
Work in the virtual platform.	2.09	1.30	1.70	1.44
Use of Wikis to create collaborative knowledge.	1.45	1.12	.52	1.12

Table 5. Collaborative research skill

*Answers are organized as follows:0 (never), 1(rarely), 2 (sometimes), 3 (almost always), 4 (always). Source: Authors.

Regarding the collaborative research skill, the Class 2018-2020 obtained a mean's response of 1.79 compared to 2.38 of the Class 2016-2018, which tends to indicate that the applicants sometimes use this skill; some of them have never used it, and others, to a lesser extent, always do. When these resources derived from ICT facilitate network communication to develop group activities for research activities or products, with all the benefits of quality, flexibility, time and economy in many cases.

The development of collaborative work in the society of the 21st century is one of the priority activities, both in the academic and professional fields, and of course in the scientific field. Since collaborative networks are currently generated to do institutional and inter-institutional research nationally or internationally, training in research requires the development of collaborative processes since their earliest stages, to lead to the construction of learning communities where each one of its members have something to learn, and something to contribute to their colleagues.

Variable	Class 2016-2018		Class 2018-2020	
	Mean * (N=17)	Standard Deviation	Mean * (N=11)	Standard Deviation
Use of technological tools to present results (Glogster, Infografía, Prezi, Emaze).	2.3636	1.12006	1.41	1.46
Interchange of experiences in discussion forums and chats.	2.0000	1.00000	1.35	1.11
Participation in virtual congresses.	.8182	.75076	.41	.71
Member or collaborator in a research network.	1.0909	1.44600	.52	.94
Creation of online profiles (Google Academic, ResearchGate, ORCID).	1.1818	1.60114	.64	1.05

Table 6. Communicative research skill

*Answers are organized as follows:0 (never),1(rarely), 2 (sometimes), 3 (almost always), 4 (always). Source: Authors.

Regarding the communicative research skill, the Class 2018-2020 obtained a mean's response of 1.05, compared to 1.49 for the Class 2016-2018. This suggests that they seldom use this skill, as they have almost never participated in virtual congresses nor have they been members or collaborators in research networks. This might be a characteristic of some universities in which research is scarce and students are rarely involved in research activities or encouraged to participate in virtual congresses.

The use of this skill allows students to present partial or global progress of their research, both orally and in written form, and in some cases, receive an opinion or point of view from experts in the field; and in this way, expand the vision of object of study from several theoretical positions, as well as empirical experiences resulting from their research work.

Variable	Class 2016-2018		Class 2018-2020	
	Mean * (N=17)	Standard Deviation	Mean * (N=11)	Standard Deviation
Assessment of electronic sources (textual and non-textual documents, multimedia documents, hypertexts).	3.00	1.26	1.94	1.59
Use of technological tools to organize hierarchically main and secondary ideas (cmaptools, imindmap, freemind, mindomo, infographics).	1.36	.92	1.23	1.43
Argumentation using diverse electronic sources.	3.18	.87	2.29	1.53
Establishment of a personal position upon reflection on the electronic sources.	3.18	.98	2.47	1.23
Reflection on the different positions of the authors found in the electronic documents.	3.09	1.13	2.82	1.18

Table 7. Reflective research skill

*Answers are organized as follows: 0 (never), 1 (rarely), 2 (sometimes), 3 (almost always), 4 (always). Source: Authors.

Participants of the Class 2018-2020 obtained a mean's response of 2.15 compared to 2.76 of the Class 2016-2018 (Table 7). This suggests that sometimes they use the reflective research skill. In postgraduate studies, this skill requires high levels of cognitive activity and functions, such as analysis, reflection, decision-making, interaction and generation of new knowledge supported on electronic, valid and reliable sources and resources.

With the use of technological tools such as cmaptools, imindmap, freemind, mindomo and infographics, students explore diverse ways to

present information obtained when reviewing different references and electronic sources. Therefore, this skill implies not only the use of the technological tool, but the development of a higher order cognitive process that exceeds the technological instrumentation as well as the use of information as the base for meaningful construction of knowledge.

4. Conclusions

In This study lead to the identification of the main research skills that both applicants and students of the Masters of Science in Education from in a public university of the State of Hidalgo use. Coincidences in a more frequent use of electronic devices are presented for both classes. A negligible difference between the use of specific technological tools that facilitate the development of the investigative, organizational, analytical, collaborative and reflexive skills is observed.

Although both, the applicants and the graduating students of the Master of Science in Education, own laptops and other electronic devices, and more than half mentioned having received information about the use of ICT related with research, they do not carry out activities to use ICT to develop skills for research. This leads to think about the training in research that participants developed in their previous studies, as well as the use of ICT in their current professional or work activities. It is necessary to promote the development of knowledge in ICT related to research skills in undergraduate and postgraduate studies.

It is a fact that the use of ICT has considerably increased in recent years in several fields. It is very common to observe postgraduate students coming to the classroom with one or more electronic devices such as cell phone, ipad and laptop; however, after this first diagnosis in both classes of the Master of Science in Education, it is remarkable that its use is from an instrumental perspective and not necessarily from a pedagogical or research perspective.

Both applicant and graduating students referred to regularly use ICT. Nevertheless, they have not used tools that favor collaborative work such as Google Drive and blogs, which enhance the development of research processes. To become a good researcher, it is necessary to develop inquiry skills, where ICT offers a diversity of resources for the search, analysis, selection and integration of knowledge and information that is fundamental to develop the theoretical and methodological frameworks for the grounds, publication and dissemination of research. Therefore, it is necessary to constantly review and strengthen inquiry and research skills in postgraduate students.

During their training, applicants and graduating students of the Master of Science in Education were able to understand and use, from lower to higher intensity, the conceptual, procedural and attitudinal knowledge on the use of

ICT for a variety of activities; particularly for assignments, ICT-related courses and online practice. Since the orientation of the Master of Science in Education is research-based, the use of Information and Communication Technologies can be done transversally in each of the seminars to be taught.

The findings of this study present a picture about the level of use of ICT to perform research activities by students of two classes; one that is about to begin and the other that is about to graduate. At the same time, it constitutes an area of improvement for each one of the academicians that participate as professors in the seminars of the Master of Science in Education, by using ICT as didactic resources to strengthen the research processes in their students, generating activities oriented towards the construction of knowledge, both individually and collaboratively.

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