Article

Research Skills for Information Management: Uses of Mobile Devices in Research Training

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Abstract: Although we live in a knowledge society, instruction in research is still given traditionally. Mobile devices are present in learning processes, but their possibilities for research have not been broadly explored. This paper explores the research skills that could be supported using information communication technology through mobile devices. We start from theoretical frameworks related to andragogy, knowledge management, the technology acceptance model, and mobile learning. As a case study, 20 Colombian virtual education students studying for master's degrees answered a questionnaire. The results revealed an acceptance of mobile device use in education and a tendency to use apps for information management. These results suggest the need to change the teaching process and design a strategy for the inclusion of mobile learning in research. The use of mobile learning can enhance research training processes framed in the emergent mode of knowledge or context-centric research, especially in virtual higher education.

Keywords: research skills; master's degree; virtual education; mobile learning; technology acceptance model; ICT; andragogy; knowledge management

1. Introduction

In Colombia, higher education is regulated by the Ministry of Education, which requires research, as a quality requirement, to be one of the substantive functions of education for the opening of postgraduate programs (Salmi, 2009) [1,2]. For this reason, postgraduate programs are not conceived without applied research processes [2] and research products [3].

Consequently, master's programs design research processes within the curriculum that can generally meet the needs of the sector [1] and impact the nature of the program. The research nucleus is generally a meso curriculum, which contains modules that contribute to research training. Therefore, in Colombia, it is common in some master's programs to learn research methodologies and prepare a research project. These modules are offered so that master's students can acquire the research competencies [4] required for their degree work, which is a mandatory requirement for obtaining a diploma.

Notably, master's degrees taught through a virtual modality require methodologies and tools [5] to achieve the teaching–learning objectives. Moreover, students should be able to access the research contents anywhere using mobile devices [6].

The knowledge society [7] connects digital ideas and includes several sectors. This type of society causes information to be constantly transformed [8] mainly at the university level, where consultation and migration are focused on mobile devices [9] whenever the use of such devices is planned for courses or academic activities.

Krull and Duart (2017) [10] revealed problems that relate research with mobile learning in higher education, as presented below:

1.   The need to broaden the focus of research topics.

More research is needed on issues related to innovative approaches; studies that focus on student mobility and transitions through different environments and the use of advanced technologies, such as cloud computing and learning analytics, may become a topic of greater interest to students.

2. The promotion of variety in research design.

There is a need for a wide range of research designs using mixed research methods. More longitudinal studies are essential to understanding the long-term effects and impact of mobile learning initiatives. Fewer studies are required comparing the teaching and learning mode (mobile or virtual learning). This is due to the many variable conditions within a teaching and learning mode.

3. The growth of one's own device.

A key catalyst for current the study was that a significant proportion of previous studies did not focus on a specific device for learning but on generic devices or the use of various types. For the successful integration of mobile learning, the use of mobile devices for research must be critically evaluated for design-specific learning experiences.

4. A focus on sustainability and the integration of mobile learning.

Many innovative research projects in mobile learning over the last 15 years did not extend beyond pilot projects to integrate or embed themselves in education, partially due to financial and cultural barriers.

On the other hand, there is evidence that students not only require a methodological basis but also already know how to use investigative skills that enable them to search and carry out the correct management of information through mobile devices, thereby allowing students to structure their research activities.

To cover these aspects that require further investigation, the objective of this study was to identify research skills, taking into account two basic aspects, information management and acceptance of mobile devices, to explore the inclusion of mobile learning in research training.

2. Theoretical Framework

This section is divided into three segments that give a brief introduction to the subject. The information presented here integrates contributions from different authors surrounding the concept of mobile learning and its technological factors, as well as a review of studies that relate research to information and communication technologies (ICTs), as well as educational approaches.

2.1. Concept of M-Learning

Based on the works of various authors, Talidong and Toquero (2021) [11] proposed a concept of Mobile Learning or M-Learning. The authors argued that mobile learning is based on different meanings that focus on learning in various contexts through mobile devices. In addition, the authors suggested that mobile learning is placed under the umbrella of virtual education and, at the same time, is a complementary tool of educational technology in traditional learning. M-learning includes three characteristics: portability, context sensitivity, and connectivity.

Marín et al. (2016) [12] provided a framework for the use of mobile devices in personal learning environments in higher education in Finland, supported by the advantages of ubiquitous learning. The authors highlighted the demands and challenges of the 21st century in terms of using technology in education, which is generating new space–time dynamics and an emphasis on permanent learning. The authors based their work on two main characteristics of mobile learning: personalization and portability.

Thus, mobile learning provides an integrative learning model for the acquisition of knowledge and skills through the use of mobile devices in order to develop learning experiences and practices. Moreover, mobile learning can be implemented at any time or

place through the mediation of portable devices in different study contexts. Connectivity is also required to work online and connect to virtual learning environments.

Mobile learning is not just a concept for educational technology. Mobile learning's ubiquity and portability make this type of learning unique compared to other types of learning, especially in creating flexible learning experiences between students and the learning context. This sensitivity to the learning context supports the learning concepts emphasized by mobile learning and takes on importance according to the situation of the student. Under mobile learning, students can listen to online lectures, download, and read content, watch videos, or engage in other activities while retaining mobility.

Finally, we note that the technology acceptance model (TAM) has become a useful model for implementing mobile devices in teaching–learning activities.

2.2. Technology Acceptance Model

The TAM is a theory of information systems developed by Davis, Bagozi, and Warsaw (1989), as cited in Sánchez Franco et al. (2007) [13], that consists of establishing the degree of acceptance of technological innovations. This model was positioned as an analytical tool that can determine the perceived utility and ease of technology. The first aspect measures the degree to which a person considers technology to be a tool that allows them to stand out personally or at work. The person analyzes what he/she will gain from the use of technology; if he/she does not perceive utility, it will be difficult for him/her to acquire utility. The second aspect is the degree to which a person believes that using a technological system will save effort; this factor refers to the work that will cease by adopting new technologies.

In this research, the difficulty that a student perceives in the use of a mobile device in his/her research determines his/her decision to adopt and implement that technology. For example, although a technology may be useful, it may take time for that technology to be incorporated since its potential users do not perceive the technology's usefulness.

2.3. Formative Research through the Use of Information Communication Technology

According to Díez-Echavarría et al. (2018) [14], an effective strategy to promote M-Learning is to increase M-Learning's ease-of-use during a student's first, rather than last, semester. This is similar to the definitions of relevant policies, which indicate that introducing students to virtual learning practices in the very early stages of their academic lives is favorable for the later voluntary adoption of these practices, even if the institution (and not the student) makes the first decisions.

Additionally, Coleman and O'Connor (2019) [15] conducted a focused investigation on WhatsApp and its relevance in medical education. The authors found that this app can be effective as a medical learning tool by using strategies for WhatsApp that integrate exploration, performance, and evaluation. In addition, the authors proposed a model of instant messaging for medical education in which the instructional design was based on the theory of learning in social networks.

Likewise, Christensen and Knezek (2018) [16], in the results of their study, confirmed that mobile learning, as an educational innovation, is significantly aligned with well-established measures based on more traditional information technologies and, in general, exhibits the desirable properties of advancement in tiered digital competition.

Suárez et al. (2018) [17], highlighted several observations that advocated caution when determining the optimal support and balance between agency and student scaffolding. First, the authors advised more teachers and students to reflect on the use and appropriation of mobile technology in learning. Such reflections can enhance the self-identification of learning strategies and consequently lead to more genuine and authentic learning.

The results of Kawulich and D'Alba (2019) [18] indicated that online virtual environments can simulate real-word experiences. This study investigated how students perceived the usefulness of Second Life (SL) as a tool for teaching research methods to a doctoral-level qualitative research class. However, to be successful, the students required the presence of

tutors. Likewise, the authors mentioned that online virtual environments are an innovative means to teach important aspects of qualitative research, such as securing key informants and controlling, observing, and taking field notes and interviews.

Hawkes (2017) [19] noted that students consider educational platforms and the use of technological resources as important aspects within their environments that improve students' confidence in their degree work. The authors also noted that the administrative processes and university regulations for such resources are unknown.

Veytia and Contreras (2018) [20] indicated that technological tools have become interactive and interesting due to structural changes in education alongside the implementation of educational models and policies, which have also made it possible to carry out research through applications and platforms such as iCloud, Classroom, Moodle, and Blackboard.

Ramirez (2019) [21] indicated that new pedagogies tend to highlight the construction of investigative competencies for learners. Some examples include critical thinking and creativity competencies, autonomous learning and metacognition, and teamwork and collaborative learning. The main finding of the research regarding the development of linked theoretical–methodological skills, collaborative skills, and project creation was the positive impact of using multiple digital resources to mediate learning.

Integrating personal learning environments among university students with information competence, Marín et al. (2012) [22] suggested an application of mobile devices and proposed a strategy for content curation among university students that integrates informational and digital competence. The authors cited Area (2010), who explained that the aforementioned competencies consist of "skills, knowledge, dispositions, and behaviors that enable individuals to recognize when they need information, where to locate it, how to evaluate it and give it an appropriate use according to the problem that arises" (p. 52).

The authors identified that students do not have information management skills when they arrive at the university, which is a problem that was also identified in the sample of the present study.

As previously stated by the authors, based on the ideas of Cruz-Pérez (2019) [23], a new research environment must be created through didactic strategies that encourage communication between students and teachers, connect research with experience, develop teamwork, and take advantage of the amount of information and knowledge that technology offers. The use of ICT tools means that the research processes applicable to the particular contexts of students should be supported by mobile devices because, given the current demands for the support of these devices, it is possible to investigate information at any time or place, giving rise to communities of university research–technological activities.

2.4. Educational Approaches

Another particularity of this research relates to andragogy [24] collaborative learning [25] and the emergent mode of knowledge generation (De Souza, 2002). This type of study has been called context-centric research.

This type of study is framed within andragogy because the sample carries this implicit characteristic. Moreover, as Muduli (2018) [26] noted in relation to Knowles' (1984) theory, andragogy is defined as "a student-centered teaching philosophy, assuming that students are independent and sovereign learners who take the initiative, control and responsibility to achieve their learning objectives learning, and the professor plays the role of facilitator, emphasizing the problems rather than the content" (p. 169).

3. Methodology

This study was designed as a case study [27] to provide a general description than can facilitate an approach to addressing the reality implicit in students' environments when students are immersed in their research contexts, in relation to mobile devices. To carry out this approach, a questionnaire was designed to determine the status of the students based on the dimensions of knowledge management alongside the ease-of-use and perceived usefulness of mobile devices, before starting research training in a virtual

master's environment in Colombia. Knowing the criteria that necessarily interact and are present in each student's research context will allow us to determine an answer to the following question: What research skills are used through ICT to support virtual research processes?

3.1. Context

For context, it is necessary to clarify that this research was carried out at a higher education institution in Colombia as part of a research module. The 20 students in the sample were all over 28 years old. Therefore, this research was also framed within andragogy [24]. Moreover, the students were all from the aeronautical sector and generally do not work in front of a computer all day. Instead, such students travel through hangars and airport runways and have the latest-generation cell phones. For this reason, we chose to carry out our e-activities using the advantages of mobile learning under the emerging mode of knowledge generation [28] i.e., context-focused research.

The case presented here is thus aimed at activities related to virtual research among a group of adults from the aeronautical sector.

3.2. Data Collection

For data collection, an instrument entitled "Research and ICT" [29] was applied to 20 master's students during the second semester of 2020; in addition, the data gathering was performed during the health emergency caused by COVID-19 [30].

The instrument consisted of a questionnaire with a Likert-type scale [31]. To construct this scale, we used state-of-the-art information, a portion of which was presented [32]. First, the dimensions of knowledge management were used, including (1) information research, (2) information sources, (3) information managers, and (4) information storage. Second, we used the characteristics of ease-of-use and perceived usefulness of mobile devices. The instrument was validated by two experts with profiles in education [33] to ensure reliability. To analyze the reliability of the results of the responses from the participants under this instrument, we calculated the Cronbach's alpha coefficient using the SPSS statistical software, obtaining a value of 0.934 for 20 elements. In accordance with the scales proposed by George and Mallery (2003) cited in [34], the internal reliability of the instrument was determined to be 93.4%, which indicates that the data are reliable.

3.3. Data Analysis

For information processing, descriptive statistics were used to characterize the practices of researchers in the use of ICT in research processes through the statistical software SPSS. By using frequencies and percentages, the data can be processed to achieve better interpretations.

4. Results

The results are presented for each of the following dimensions of information management. These dimensions involve mobile devices that can support the development of investigative skills among students of master's degrees in virtual environments.

4.1. Information Management Tools

An information management process was carried out by organizing the information found through an internet search. Table 1 shows that around 65% of participants used scientific repositories with medium frequency, and 70% used internet search engines with medium or high frequency.

Table 1. Information search tools.

	Scientific Repositories		Internet Browsers (Ex. Google)		Web Pages		None	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Strongly disagree	4	20.0	1	5.0	0	0	19	95.0
Moderately disagree	0	0	1	5.0	1	5.0	0	0
Indifferent	3	15.0	4	20.0	3	15.0	0	0
Moderately agree	7	35.0	6	30.0	6	30.0	0	0
Strongly agree	6	30.0	8	40.0	10	50.0	1	5.0
Total	20	100.0	20	100.0	20	100.0	20	100.0

We observed that 50% used internet pages frequently and 30% moderately frequently, which indicates that, in general, internet searches are very common among researchers. Almost unanimously, the researchers indicated that the use of these electronic means was necessary to undertake investigations. However, one researcher noted that the use of physical means was more relevant.

When we asked the researchers about information resources (see Table 2), 70% indicated they were moderately or strongly in agreement with the use of specialized databases for research. On the other hand, 45% indicated that they used electronic journals with moderate frequency, 15% indicated that their use of such journals was very common, and 25% indicated that they were indifferent to the use of such journals. There was significant use or acceptance of use of electronic books by researchers, with 85% of researchers agreeing or strongly agreeing with the use of such books. Only two researchers (10%) indicated that they did not agree with the aforementioned sources of information and instead preferred articles and the assistance of libraries or magazines and physical texts.

Table 2. Tool information sources.

	Specialized Databases for Research		Electronic Magazines		Electronic Books		None	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Strongly Disagree	2	10.0	1	5.0	2	10.0	18	90.0
Moderately disagree	2	10.0	2	10.0	1	5.0	0	0
Indifferent	2	10.0	5	25.0	9	45.0	0	0
Moderately agree	7	35.0	9	45.0	8	40.0	0	0
Strongly agree	7	35.0	3	15.0	20	100.0	2	10.0
Total	20	100.0	20	100.0	2	10.0	20	100.0

By analyzing the preferences of researchers toward information managers (Table 3), we observed little use of such managers by researchers. More than 60% of all researchers disagreed or strongly disagreed with the use of these managers. Of the three managers presented (Zotero, EndNote, and Mendeley), the manager with the greatest representation was EndNote, which 35% indicated they strongly or moderately agreed with using.

Table 3. Information management tools.

	Mendeley		Zotero		EndNote		None	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Strongly disagree	10	50.0	9	45.0	10	50.0	14	70.0
Moderately disagree	4	20.0	4	20.0	2	10.0	0	0
Indifferent	2	10.0	3	15.0	1	5.0	0	0
Moderately agree	1	5.0	2	10.0	3	15.0	0	0
Strongly Agree	3	15.0	2	10.0	4	20.0	6	30.0
Total	20	100.0	20	100.0	20	100.0	20	100.0

As shown in Table 4, the data storage tool with the highest acceptance was Office 365, with which 80% strongly agreed, while for Google Drive and Dropbox, there was acceptance of 40% and 30%, respectively. Only 5% (1 researcher) indicated that storage was achieved using equipment such as a personal computer.

Table 4. Information storage tools.

	Office 365		Dropbox		Google Drive		None	
	Frequency	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Strongly disagree	0	0	3	15.0	1	5.0	19	95.0
Moderately disagree	1	5.0	3	15.0	1	5.0	0	0
Indifferent	0	0	3	15.0	2	10.0	0	0
Moderately agree	3	15.0	5	25.0	8	40.0	0	0
Strongly agree	16	80.0	6	30.0	8	40.0	1	5.0
Total	20	100.0	20	100.0	20	100.0	20	100.0

4.2. Ease-of-Use and Perceived Usefulness of Mobile Devices

Most of the students indicated that it is easy for them to view, download, and consult content through their mobile devices. The students also considered mobile phones to be useful in supporting or carrying out an investigation.

To complete the information in Table 5, the students were given the following prompt: "Indicate the most outstanding advantage for you on a mobile phone". The results are presented in Figure 1.

Table 5. Ease-of-use and perceived usefulness of mobile devices.

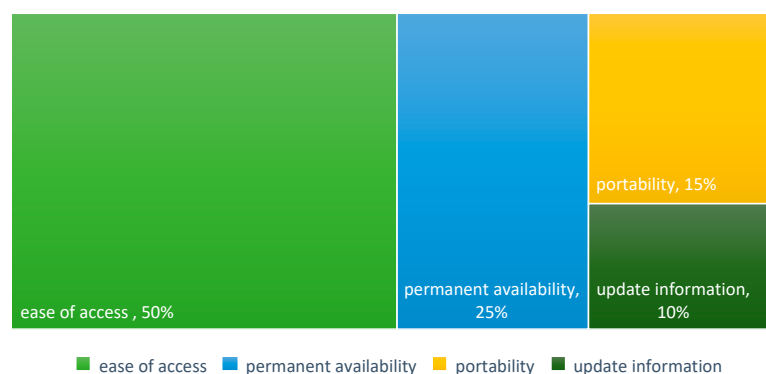|	Is It Easy for You to Learn Using a Mobile Device?		Is It Easy for You to View, Download, and Consult Content through Your Mobile Device?		Do You Think That Mobile Devices Are Useful to Support an Investigation?		Do You Think It Is Useful to Access and Collect Information through a Mobile Device to Support an Investigation?	
	Frequency	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Strongly disagree	0	0	1	5.0	0	0	0	0
Moderately disagree	4	20.0	0	0	0	0	1	5.0
Indifferent	0	0	1	5.0	4	20.0	2	10.0
Moderately disagree	0	0	5	25.0	3	15.0	7	35.0
Strongly disagree	16	80.0	13	65.0	13	65.0	10	50.0
Total	20	100.0	20	100.0	20	100.0	20	100.0

Figure 1. Advantages of using a mobile device according to the students (by percentage).

Regarding the advantages of using a mobile device for work, most researchers high-lighted ease of access (50%), 25% highlighted permanent availability, 15% highlighted portability, and only 10% highlighted the ability to update information in real time.

5. Discussion

The search for, and acquisition of, information is related to the user and his/her knowledge structure, which is why we inferred that searching on the internet (see Table 1) is common among students. Likewise, a portion of the sample used scientific repositories. However, these electronic resources are provided by the institution through the virtual library and are generally favored by professors as sources of information, which may have skewed the results. However, it would be interesting to determine what results Google searches yield and how useful those results may be in student research.

It should be noted that the location of information is crucial until the students read, download, analyze, synthesize, and manage it. Students preferred, as primary information resources, the use of specialized databases for research, which allowed them to find information associated with the research topic, beginning with a systematic review of the literature [35], however, some students preferred magazines and electronic books. From the above, we determined that students prefer digital resources when conducting their research, rather than physical books and visits to the library. These preferences may also be because this research was carried out in the context of the COVID-19 pandemic [36–38], and all of the universities and libraries in the country were quarantined, preventing visits to these places.

Negre et al. (2013) [39] noted that the management of information, or informational competence, is an essential requirement in the knowledge society since large amounts of information are generated that must be applied when searching, selecting, storing, evaluating, distributing, and building knowledge.

In research, once an information search is carried out and the information sources are located, the sources recovered through information management must be organized. However, we observed very little use of information managers. Most of the sample did not use such managers, though some mentioned the use of EndNote. Upon inquiry, we found that these managers are used and/or required by other universities.

The most widely accepted method of information storage was storage in the cloud using tools such as One Drive in Office 365, followed by Google Drive and Dropbox. The observed affinity for the use of One Drive may be due to the fact that One Drive is provided by the school's institutional email accounts.

In the analysis of information management, we noted an opportunity to design a strategy that involves search tools, especially a strategy that strengthens organization of the recovered sources. Indeed, as evidenced by the sample, information management competence should be strengthened. For this purpose, Negre et al. (2018) [40] provided a didactic strategy based on a cycle of evaluating and filtering information, which increases the value of information by sharing it. The ease-of-use and perceived utility of mobile devices were also investigated. From the outset of this research, importance was given to incorporating mobile devices in the training of master's students. To promote research skills for the development of degree work, it was important to determine, through questions based on the TAM, the perceptions of the sample. Most of the students indicated that it is easy for them to view, download, and consult content through their mobile devices. The students also noted that mobile devices are useful for supporting or carrying out an investigation, arguing the following advantages: "ease of access", followed by "permanent availability", "portability", and "updating of information in real time".

The majority of the students felt it was easy to learn how to use a mobile device, as well as view, download, and consult content through that mobile device. In addition, most students had the perception that mobile devices provide useful support for an investigation by accessing and collecting information.

Finally, we determined that incorporating mobile devices in the training of master's students can strengthen the investigative skills and application of information among such students, enabling information to become knowledge. Within this research, we frequently observed that students used information transformed into knowledge as an active result of the information. On the other hand, the answers that students disagreed with may be due to ignorance in carrying out the relevant activities.

6. Conclusions

Mobile devices contribute to research skills among graduate students who are part of the teaching process. Although the sample presented some investigative skills related to information management, it remains necessary to further develop the investigative skills of students through the organization of information using bibliographic managers. The strategies to be implemented must address the low level of information manager use and the importance of such managers in establishing state-of-the-art and theoretical frameworks through academic activities that integrate the use of such frameworks and can be implemented using different applications.

To successfully incorporate mobile learning in teaching processes, it is important to understand the level of appropriation of mobile devices among the sample.

Likewise, adult education must be focused on solving practical problems. Therefore, problem-based learning activities must be designed to facilitate the correct management of information. Moreover, when ICT tools for research are included in teaching–learning processes, training or tutorials should be planned to provide instruction on the correct use and application of these devices in the classroom.

Finally, as mentioned by authors [41–43], mobile learning, as part of the inclusion of technology in education, is based on the internal motivation of the teacher to innovate in his or her teaching practices.

Ultimately, it is necessary to design a strategy that strengthens the development of investigative skills mediated by mobile learning and favors information management.

6.1. Limitations

The most important limitation of this study is the size of the sample, which included only 20 subjects. Although this work was methodologically developed as a case study, at the time of processing the instrument data, trends or correlations among the variables could not be determined. Moreover, the results could not be generalized. Nevertheless, the contribution of the present study to the field of M-Learning is original and covers a relevant literature gap.

6.2. Recommendations

Interactions between technology and research occur in the teaching–learning processes in higher education and open the doors to future research, as well as digital epistemological approaches that can identify virtual research models. The incorporation of mobile devices supports research, which, from the onset, involves information management through bibliographic manager apps. Such devices also support the collection of information through recordings, text-based notes, voice notes, etc.

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