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Formative Research in Ubiquitous and Virtual Environments in Higher Education

La investigación formativa en ambientes ubicuos y virtuales en Educación Superior

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Abstract
Academic training in research is fundamental in the quality of higher education and within this context, technological mediation becomes pivotal to reach student-centered learning objectives in any moment and at any time. The findings of a study, the purpose of which has been to evaluate the results of the formative research of two groups of students that have interacted in learning environments (E-learning and U-learning), are presented. The research follows a quasi-experimental study with a design of chronological series and multiple treatment, framed in three stages that were defined as referencing, systematization, and analysis. The sample consisted of 189 fourth-year students of the Early Childhood Education degree, at El Bosque University in Bogotá, Colombia. The results reveal that U-learning environments strengthen and consolidate formative research as an ongoing process for undertaking educational research through personalization, adaptation, and situational learning, marking meaningful differences with respect to E-learning environments during the systematization stage. The intervention with U-learning environments has revealed challenges and needs in the academic curriculum such as strengthening the link between evaluation and educational research in the field of professional practice, as well as the incorporation of technology with the purpose of making it something natural, adaptable, and interoperable, that students are able to use it without even thinking about it.

Resumen
La formación en investigación es fundamental en la calidad de la Educación Superior, y en este contexto, la mediación tecnológica resulta esencial para alcanzar objetivos de aprendizaje centrados en el estudiante en cualquier momento y lugar. Se presentan los hallazgos de un estudio cuyo propósito ha sido evaluar los resultados de la investigación formativa de dos grupos de alumnos que han interactuado en ambientes de aprendizaje E-learning y U-learning. La investigación obedece a un estudio cuasi-experimental con un diseño de series cronológicas y tratamiento múltiple, enmarcada en tres etapas definidas como referenciación, sistematización y análisis. La muestra ha estado constituida por 189 estudiantes de cuarto año de Licencia-

tura en Educación Infantil de la Universidad El Bosque en Bogotá, Colombia. Los resultados revelan que los ambientes U-learning fortalecen la evaluación y consolidan la investigación formativa como un proceso permanente para aprender investigación educativa por medio de la personalización, adaptación y el aprendizaje situacional, marcando diferencias significativas con respecto a los ambientes E-learning durante la etapa de sistematización. La intervención con ambientes U-learning ha traído consigo retos y oportunidades de innovación en el currículo académico, tales como el fortalecimiento del vínculo entre la evaluación y la investigación educativa en los campos de práctica profesional, así como la inclusión de la tecnología hasta convertirla en algo natural, adaptable e interoperable, de modo que los alumnos pueden utilizarla sin tan siquiera pensar en ella.

Keywords / Palabras clave

Educational research, formative research, higher education, ubiquitous learning, U-learning, virtual learning, systematization of experiences, teaching practice.
Aprendizaje ubicuo, aprendizaje virtual, educación superior, investigación educativa, investigación formativa, práctica docente, sistematización de experiencias, U-learning.

1. Introduction

Quality in education is a key issue that has been included in the agendas of the Ibero-American governments in the last decade. The Colombian Ministry of Education (MEN, 2015-2016) points out that quality education is a generator of opportunities that change realities. In this context, quality in higher education is related to the capacity of university institutions to make it possible for students to achieve academic results directly related with their learning process and their area of study, through technology, professional practice, and research (Ardila, 2011).

Higher education should be essentially an ongoing process of research mediated by the development of science and technology, since these elements are fundamental for consolidating high quality education (Restrepo, 2003). This process requires an ongoing dialogue between the appropriation of knowledge, its transformation, and its linkage to the professional practice in order to ensure that students adapt to the conditions and requirements of the context, understanding that the quality of education is associated with the research practices and, at the same time, these are linked to the search for, construction, and appropriation of knowledge (Herrera, 2013).

It is in this context that formative research, which is conceived as the research process that is developed so that the student is educated from problematic situations close to the curricular context and their professional future, becomes meaningful (Restrepo, 2003). The academic scenario of our work and that of the participants fourth-year students on the Early Childhood Education degree at El Bosque University, in Bogotá, Colombia-, necessarily leads us to contemplate formative research for academic training in Educational research from the perspective of the experiences and paradigmatic and methodological approaches that logic and their particular activities impose in the field of education.

Strengthening the link between educational research and professional practice is one of the fundamental objectives of the Higher Education Institutions and, therefore, it is an element of essential importance for the generation of new knowledge. From this perspective, the student is expected to follow the path of educational research through continuous and systematic praxis, and in so doing, to fulfill student-centered learning objectives. Academic training for research should take advantage of all those activities that are oriented towards the «learning to learn» process with the purpose of strengthening and consolidating skills and knowledge in students that enable them to successfully develop activities related to academic research, development, and innovation.

In Colombia, for 65.000 students which represents 5% of the entire child population according to the National Accreditation Council (CNA, 2015), virtual assistance has been essential in their formative process. In the context of the study presented in this article, technological tools have been used to assist and evaluate the formative processes in educational research, particularly through

applications which capture and edit digital data, software for the analysis and systematization of information, electronic resources for bibliometric studies, and platforms for evaluation and research evaluation. Recent technological developments have also allowed access to databases and referencing managers for formative processes in research, which has facilitated the use of specialized sources of information (Velandia, 2014). Similarly, technological progress has strengthened research in the way that it has initiated collaborative work and communication between peer researchers in accessing research practices, socializations and disclosures (Herrera, 2013). Another fundamental factor that is associated with technological development in formative research processes has been the orientation and flexibilization of tutoring in synchronous and asynchronous manners, which in terms of quality of education is considered to play a pivotal role in the development of research competence through the formative assessment of the student. (Martínez, Pérez, & Martínez, 2016).

Nevertheless, for the participants in this study, who are being trained as future teachers in Early Childhood Education, there are conditions and elements where virtual environments do not facilitate a permanent dialogue between educational research and the reality of the student in his/her professional practice. Only 54.3% of the students carry out their professional practice in urban and rural areas (Velandia, 2014), where internet connection becomes a factor that makes the systematization of the pedagogical experience and the tracking process of formative research difficult. Although digital resources have allowed the extension of guidance processes in other scenarios beyond the classroom, certain requirements such as access to electronic devices and the quality of the internet connection are still to be met, under the assumption of effective functioning of the tools at any time and location. Strengthening the link between technology and formative research in the field of professional teaching practice implies restructuring the educational experience to consider acknowledged standards for the academic community and, at the same time, it must respect the rigor of the systematization. This task requires an intellectual labour, the manifestation of skills, and the implementation of those resources that assist the process. Educational research must systematize the experience in which analysis is key to build knowledge and to developing professional competences. With this statement in mind and with the contextual need to build environments that allow the monitoring of the processes of formative research at any time and place, an ad hoc U-learning environment was designed and implemented. Although communication and information exchange through learning environments that are mediated by digital technologies have made relevant formative processes possible, the need to analyze ubiquitous learning environments has arisen as a possibility for strengthening scenarios of pedagogical practices for the educational research training in higher education and to determine if there are differences regarding the use of virtual environments.

The articulation of educational research with professional practice requires the systematization of the pedagogical experience, which is understood as an ongoing exercise in the production of critical knowledge from practice (Jara, 2012). This process implies considering and interpreting what takes place and reconstructing what has happened by engaging in the identification of elements that have intervened in the experience from a critical perspective in order to understand it from the basis of the practice itself. The articulation of educational research with professional practice has 3 stages that are sequenced and called referencing, systematization, and analysis. The initial or referencing stage involves the construction of antecedents, theoretical referents, and epistemological frameworks that are determined by the emergent issues in the pedagogical practice scenarios; the intermediate or systematization stage (Torres, 1999) embraces data collection and processing of the context, and the final or analysis stage corresponds to the triangulation, interpretation, and discussion of findings (Correa-García, 2003). This process requires technological assistance that allows access and ongoing information tracking, in addition to a formative evaluation that provides students with feedback. In the same way, the process cannot be limited to a physical and temporal space, given the fact that knowledge is built in a conscious and unconscious way at any time and place.

2. State of art

The use of technological tools in educational process began around the 1950s with distance education, in which media were positioned as an alternative for democratising learning and which allowed the extension of academic participation to different scenarios in which printed texts, manuals, and books sent via mail sealed the beginning of an education generation blessed with technological resources (Aparici, 2002). Later, towards the 1970s the concept of 1.0 formation was born, it was considered as an analogical stage characterized by unidirectional mediation through radio and television: a static network for transmitting information and knowledge in a unidirectional way (Sevillano-García, Quicios-García, & González García, 2016). Towards the early 1990s, offline learning incorporated multimodality (Díaz, 2009). CD-ROM and computer science enabled the student to interact in two ways, teacher-digital medium-student (Capacho, 2011). The great advances in the field of science and technology at a virtual educational level (E-learning) have transformed economic, educational, political, social, and cultural sectors since the early 1990s; the so called digital era has produced great development and challenges that must be taken on board in the face of the dynamics imposed by the information and knowledge society (García, 2006). The incorporation of technology in face-to-face learning processes led to blended learning (Hinojo, Aznar, & Cáceres, 2009). Similarly, the combination of electronic learning and smart mobile devices (Smartphone, iPod, Tablet, PDA) was seen, developments that allowed combining geographical mobility with virtual scenarios (Marcos, Támez, & Lozano, 2009).

2.1. Genesis and development of U-learning

Ubiquitous learning (U-learning) emerges as an inclusive learning paradigm, since it assimilates elements of each one of the modalities that were previously mentioned and, it also seeks to integrate technology in the assessment and monitoring of educational processes of the students in a natural way with a high dose of spontaneity, breaking the barriers that are framed by place and time. On the other hand, U-learning comes from the intelligent computing field, the artificial neuronal networks and the diffused logic whose main objective is that technological systems develop tasks of identifying patterns tasks in different sets of data in order to make decisions based on the optimization of processes. As an e-innovation agent, U-learning has been consolidated as an important concept in the last decade, since the technological development of mobile devices has allowed the operational focus to be the user, allowing student centered learning mediated by technology. In other words, at the beginning a computer was shared by several users, later, the use of personal computers was incorporated and, today we find that further development has led to the incorporation of ubiquitous technology, a third paradigm , which seeks to put different interconnected devices at the user's service. Through this technological approach, the devices are integrated into people's life; instead of intentionally interacting with only one device, technological ubiquity looks for simultaneous interaction with several devices for solving everyday tasks and, in many cases, without the person's awareness.

Strictly focusing on U-learning scenarios, there are different studies that have focused on the definition, construction, characterization, and application of ubiquitous learning environments as a situation of total immersion in the learning process. Jones & Jo (2004) develop a U-learning model based on intelligent computing and adaptive learning; the authors point out that digital devices are, day by day, naturally embedded in every aspect of our lives, making ubiquitous learning a certainty for the future of education. The research group (I+G) incorporates the concept of adaptive learning and, in this way, builds digital systems that adjust themselves to the needs of each student based on the personalized teaching method (Paramythis & Loidl-Reisinger, 2004).

Dey (2000) and Hornby (1950) agree on considering that students are able to assimilate knowledge when it is built as part of everyday context or real environments. Within this scenario, the student's profile and contextual information are used to collect, systematize, and evaluate data in order to respond to students' requirements at the moment they require them. In the study con-

ducted by Chen, & Li (2010), the student's learning process is monitored by keeping track of his/her location, learning time, leisure time, time available to work on learning objectives and, time for group and individual work using artificial neuronal networks. Hwang & al. (2012) and Kim & al. (2011), both research teams at the «Anticipatory Computing Lab at Intel Labs» who developed an anticipatory communication model for the scientist Stephen Hawking, pointing out that systems can predict actions only with information from the context. The technological devices for forecasting the weather, transport routes and other events are commonly used today to improve quality of life. U-learning environments seek to predict the learning path of students and, in that way, anticipate guiding elements and activities that are synchronized with the suggested learning objectives. Through the interaction of students with electronic devices, it is intended to register their academic training and, in this way, to compare objectives and evaluation of learning, allowing the system to anticipate and adapt the answer so that students and teachers make decisions regarding the formative process.

At a general level, both E-learning and U-learning have differentiating characteristics regarding the type of interaction in the construction of learning and, in the use of communication technologies. The construction of the referents in this study has led us to synthetize the characteristics of E-learning, M-learning, and U-learning based on the proposal by Laouris & Eteokleous (2005) as shown in Table 1.

Table 1. Comparison between E-learning, M-learning and U-learning

Comparison between E-learning, M-learning, and U-learning			
Learning environment	**E-learning**	**M-learning**	**U-learning**
Device	Computer	Mobile Device	Smart PDA
Connectivity	Broadband	GPRS, 3G, 4G, Blue-tooth	WIFI, 3/4G, NFC, OSR
Content	Multimedia	Light	Interoperable
Learning Approach	Interactive	Spontaneous	Invisible
Information Flow	Hyperlinked	Connected	Associated
Communication	Collaborative	In network	Personalized
Mode	Virtual or Blended	Geo-positioned	Ubiquitous
Education	Formal	Informal	Non formal
Teaching method	Virtual	Shared	Personalized

Based on the characteristics of the aforementioned technological environments and the contextual needs determined by the pedagogical practice, an ad hoc U-learning environment was designed and validated at El Bosque University with the purpose of analyzing its influence in the educational research that is required from fourth-year students in the Early Childhood Education degree. This process was conducted under the assumption that assessment and monitoring are key elements that facilitate the development of autonomous skills in these students (learning to learn) in the necessary research training that is required for the completion of the thesis work. In particular, in this study we ask: Does the designed ad hoc U-learning environment for the development of research competence significantly improve the learning process of the fourth-year students of the Early Childhood Education degree at El Bosque University, compared to those who have learnt through an E-learning environment?

3. Materials and method

This is a quasi-experimental study with a pretest-posttest approach and a chronological series design with multiple treatments and a non-equivalent control group (Campbell & Stanley, 1995). The purpose of this study is to analyze the influence of U-learning environments on the learning outcomes of the formative research or academic training in educational research across three estab-

lished moments in the process of systematizing the pedagogical experiences (referencing, systematization, and analysis), that are carried out through virtual classrooms. The students in the control group had access to the aforementioned academic training process through the E-learning virtual classrooms, while the students in the experimental group interacted with a U-learning environment. Both environments were built with the same educational research learning environments. The design in this study is shown in Table 2.

Table 2. Methodological Design of chronological series

	Dependent Variable						
Independent Variable	**Pretest**	**Referencing**		**Systematization**		**Analysis**	
RG $_{U\text{-learning}}$	O_1	X_1	O_3	X_3	O_5	X_5	O_7
RG $_{E\text{-learning}}$	O_2	X_2	O_4	X_4	O_6	X_6	O_8

In the framework of a quasi-experimental design, the initial equivalence of the two groups is not guaranteed; this is because there is not random assignment (Hernández, Fernández, & Baptista, 2010). This is our case due to the fact that both groups were arranged in the process of student enrollment according to the criteria of academic management of the participating university and therefore, before this study started. The sample of this study is a total of 189 students (all of them women) in the fourth-year of the degree in Early Childhood Education in the Education Faculty at El Bosque University in Bogotá, Colombia. Out of the 189 students, 96 were the experimental group (U-learning environment) and 93 were the control group (E-learning environment). All of them were in academic training to become teachers through pedagogical practice and, at the same time, they take the educational research formative program. This program seeks to develop students' competences in research in order to contribute to the building of new knowledge in different fields of the educational system and to elaborate the research document (thesis) that is a requirement for them to graduate. Moreover, in the aforementioned program research topics that are related to the professional pedagogical practice are defined. The characteristic features of U-learning environments seek to accompany the formative process in different learning scenarios. Students from an education degree were selected to participate as they were already carrying out their teaching practicum in an educational context and that allowed the two components to be articulated into the thesis process.

The systematization of experiences carried out in the U-learning environments registers in a databank the interoperation between devices, location, time synchronization, characterization of learning paths, monitoring of learning goals, and notifications regarding each user's personalization, adjusting the goals to the student's needs. The systematization of experiences based on the suggested parameters in the educational research processes, enables the student to take advantage of the articulation of the referencing, systematization, and analysis stages, understanding that they are a sequence of interdependent operations. During these stages, contents were structured and tools for data analysis were provided, thus establishing connections between the context and the educational research processes.

The evaluation of the research competence of students from both groups (control and experimental) was done through evaluation rubrics (Andrade, 2013), taking as reference the models of research in ubiquitous and mobile contexts in higher education (Sevillano & Vázquez, 2015). The instrument has 41 items, each with four levels of achievement that are distributed as follows: Ten value the learning outcomes linked to the referencing stage of the context, twenty to the strategies of systematization, and eleven to the analysis and reflection of the experience. The analyses conducted, Cronbach's Alpha model and the Guttmann's split-half reliability method, revealed that the instrument to collect data has a high internal consistency since it showed a value of $\alpha \geq 0.80$ (Table 3).

Table 3. Reliability Statistics

Reliability Statistics			
Cronbach´s Alpha	Part 1	Value	,791
		N of elements	21[a]
	Part 2	Value	,830
		N of elements	20[b]
	Total N of elements		41
Correlation between forms			,810
Spearman-Brown Coefficient	Even length		,806
	Uneven length		,811
Split half Guttman Coefficient			,815

Note: Confidence Intervals ≥80%

With the purpose of guaranteeing methodological rigor, contents, activities, and interoperable learning objectives were implemented, elements that intervened in both environments and were structured from the student-centered learning theory according to the proposal by Fink (2008). After the theoretical and epistemological foundation, and the strategic planning of the methodological design, the consent form was distributed to the participating students. Later, a piloting test was carried out in three sessions: academic training, personalization, and the configuration of both learning environments proposed in this study.

As a consequence, the intervention in the learning environments to accompany the participating students in their context-situated research process took place, a process in which the first stage (referencing) was simultaneously evaluated and monitored. In the next stage the data was collected and the second phase (systematization) was implemented; later, the data analysis and the implementation of the third stage of the formative research process took place. Finally, we worked on the reflection on and publishing of the results. The field study allowed collection and storage of data in a real context. Each stage of the formative research required 12 sessions that corresponded to three academic semesters.

Prior to the confirmatory analysis of the data, the parametric assumptions of normality and the population distribution were compared through the Kolmogorov-Smirnov test and the Levene test for homogeneity variables. Regarding the inter-group analysis differences, and given the non-equivalence between them, the possibility was opened for the Student's T-test for independent samples with parametric data, or the Mann-Whitney U test for independent groups with non-parametric data. The comparison between the dependent variables was done through the average scores obtained by the students in the evaluation rubrics at the beginning of the program (pre-test) and along the three points (referencing, systematization and analysis). The critical value assumed for the contrast hypothesis is $\alpha<0.05$. The analytical treatment of the data was carried out with the IBM SPSS 23 statistic software.

4. Analysis and results

Table 4 summarizes the results that were obtained in the pretest and in the three subsequent stages of the intervention in formative research processes in both environments: U-learning (experimental group) y E-learning (control group).

Table 4. The parameters estimated in the stages of referencing, systematization, and analysis, are compared with the criterion of variation index, Typical error of the mean and N=number of participants (Maximum score=50)

Group statistics					
Learning Environment		**N**	**Mean**	**Standard deviation**	**Standard error mean**
Pre-Test	E-learning	93	40,5562	7,25382	,75219
	U-learning	96	38,8380	7,00327	,71477
Stage 1 – Referencing	E-learning	93	42,1971	5,99855	,62202
	U-learning	96	41,8563	5,21804	,53256

Stage 2 – Systematization	E-learning	93	38,6260	8,56053	,88769
	U-learning	96	42,5328	6,33121	,64618
Stage 3 – Analysis	E-learning	93	43,9841	7,32660	,75973
	U-learning	96	44,2970	7,47595	,76301

Table 4 shows the means for each moment of the study (dependent variables) and for both groups. Taking into account that the coefficient on the variation does not exceed 25% in any of the dependent variables, the mean is statistically considered as a good criterion to apply the contrast hypothesis with parametric tests (Wayne, 2003). Subsequently, the Kolmogorov-Smirnov normality test was applied and the results show probability values higher than 9.05, indicating that the data of the dependent variables are adjusted to a normal distribution. The homogeneity of variance (Leven test) and the normality in the distribution of the implied variables led us to make the choice of parametric techniques for the analysis of possible differences between the control and the experimental group. The average values obtained in the diagnostic test of the pretest were similar for both groups ($\bar{x}_p$=38.83, σ=7; $\bar{x}_p$=40.55. σ=7.25), which was confirmed through the Student's T-test for the independent samples, since significant differences are not observed between the two groups prior to being exposed to both experimental situations (t=-1.66; p>.05).

Table 5 shows the results of contrasting the differences between means for independent samples in the three stages of the intervention (referencing, systematization, and analysis). In stage 1, there was an improvement in the mean scores of the E-learning group in comparison with the experimental group U-learning ($\bar{x}_{1e}$=42.19 versus $\bar{x}_{1u}$=41.85) with a homogenization of less dispersion in the experimental group (σ_{1e}=5.99 vs σ_{1u}= 5.21), showing that there are no statistically significant differences in the referencing stage between the two groups that interact in E-learning and U-learning environments (t=-0.42; p>.05). Both groups of students improve referencing activities in the educational research process, regardless of the learning environment in which they had interacted.

Table 5. Test –Student's T-test for two independent samples. F=Fisher-Snedecor Statistic, Sig.=Statistical significance of contrasts. t=calculated value; gl=degrees of freedom

Independent Sample Tests										
		Test Levene of equality of variances		Test T for equality of means						
									95% difference confidence interval	
		F	Sig.	t	gl	Sig. (bilateral)	Difference of means	Difference of standard error	Lower	Upper
Pre-Test	Equal variances are assumed	,128	,721	1,66	187	,099	1,71823	1,03705	-,32759	3,764
Stage 1 – Referencing	Equal variances are assumed	2,92	,089	,417	187	,677	,34077	,81705	-1,2711	1,952
Stage 2 – Systematization	Equal variances are assumed	9,39	,003	-3,57	187	,000*	-3,9067	1,09285	-6,0626	-1,750
Stage 3 - Analysis	Equal variances are assumed	,038	,846	-,291	187	,772	-,31290	1,07709	-2,4377	1,811

* Weighting factor<.05 highlighted in bold

In the intermediate stage of systematization, the results indicate that there are significant differences between the means of the two groups ($\bar{x}_{2e}$-$\bar{x}_{2u}$=-3.9). In this case, the students of the control group are the ones who obtained the lowest results in the intervention, increasing the dispersion with a coefficient of variation higher than 20%; on the contrary, the experimental group (U-learning) showed a stable dispersion (Figure 1). The inter-groups analysis through Student's T-test confirms that such differences are significant between the E-learning and U-learning groups of students in the processes of systematization of the pedagogical experiences with (t=-3.58 y p<.05), being the one with the best average scores. The results, therefore, reveal that the students who interact with a U-learning environment meaningfully improve their systematization processes in their educational research training in contrast to those who only interact in the virtual classrooms.

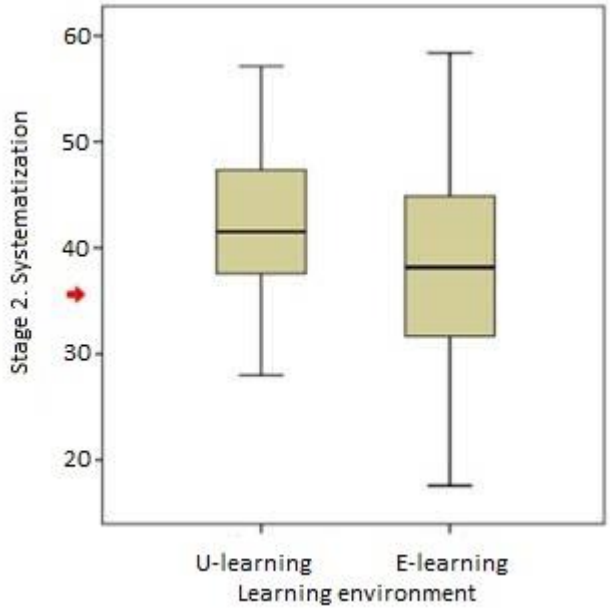

Figure 1. Box plot U-learning versus E-learning environments, systematization stage of pedagogical experiences.

Finally, regarding the last stage of the intervention (analysis), the lowest mean difference is observed concerning the rest of the independent variables in the work ($\bar{x}_{3e}$-$\bar{x}_{3u}$=0.31). The comparison of means between the E-learning and U-learning groups through the Student's T test evidences that there are no significant differences between the two groups (t=0.29 y p>.05). Therefore, the students' achievements in the activities for the analysis of the formative research process in which they have participated, is independent of the learning environment in which they have interacted.

5. Discussion and conclusions

The intervention with U-learning environments in general shows positive results in the processes of formative research so that students learn the logic and the proper educational research activities in the pedagogical practice scenarios through the ongoing dialogue between the pervasive technology and the students' reality at any time and place. The experimental results explain that ubiquitous learning environments facilitate contextual learning given the fact that proper content is provided at the right time and place, this in line with the statement by Chen and Li (2010). The actions performed in the U-learning environment (personalization, contextual information, comparison between evaluation and learning objectives) show that students in research formative process make the knowledge their own in a more meaningful way if pedagogical experiences are systematized in

real contexts; customization, adaptation, and situational learning are fundamental factors for the technological system to anticipate and adapt the formative needs of different academic actors.

There are no significant differences between the learning outcomes achieved by students who have interacted in both environments (U-learning versus E-learning) along the referencing and analysis stages of our own formative research proposal. Nevertheless, the use of U-learning environments to systematize experiences makes a significant positive difference in the research formative process of those students who have used E-learning environments. This conclusion leads us to support the belief that ubiquitous learning environments consolidate higher education as a permanent research process when integrated with science and technological development. While it is true that virtual education generates opportunities that change realities (MEN, 2015-2016), education that is supported with U-learning environments seems to extend this picture and to affect the quality of education through assessment, monitoring, adaptation, and situational learning.

Based on the evidence and on the level of acceptance by the different participants in the study, the need to suggest and develop intervention initiatives with U-learning environments in different educational contexts is shown. This might allow comparing our findings and assessing their level of generalization. The positive results of the intervention in U-learning environments in higher education are the beginning of new studies in search of the inclusion of technology in academic formative processes with the goal of making it something so incorporated, so adaptable, so natural, so interoperable that we can use it without even thinking about it.

Finally, it is important to note that the incorporation of ubiquitous learning environments requires a significant investment of human and physical resources, which is both a limitation and a challenge. Nevertheless, the impact of the academic training is reflected in the creation of personalized and contextually adapted systems, the building of learning paths and technology that monitors student-centered learning objectives through diagnostic, formative, and summative evaluation. The development and conclusions of this study have meant an ongoing challenge of innovation and the improvement of the curriculum and of the learning and teaching process of the afore mentioned course and group of students, which has meant the consolidation of a link between technology and educational research training in the field of professional practice. The formative research processes in ubiquitous contexts strengthen the evaluation due to the assessment and ongoing monitoring of professional practice. One of the fundamental conditions for the construction and intervention of U-learning environments in the formative process, is the incorporation of experienced teachers in the research groups with pedagogical, technological, and research skills, understanding possible deductions and opening space for future research regarding the use of smart learning environments, evaluation of the impact of virtual and distance educational policies, and the construction of learning paths in formative research.

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