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Learning in archaeological sites with mobile devices

Aprendizaje con dispositivos móviles en yacimientos arqueológicos

KEY WORDS: Archaeological site, Mobile device, *Mobile learning*, Heritage education, Secondary education.
PALABRAS CLAVES: Yacimiento arqueológico, Dispositivo móvil, *Mobile learning*, Educación Patrimonial, Educación secundaria.
GAKO-HITZAK: Aztarnategi arkeologikoa, Gailu mugikorra, *Mobile learning*, Ondareari lotutako hezkuntza, Bigarren Hezkuntza.

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ABSTRACT

The social relevance and incidence of *mobile learning* seem increasingly evident. These effective mechanisms are being applied intensively in educational support programmes in archaeological sites and museums and through the development of ICTs, as well as via mobile devices, but the question is whether these programmes are effective as anything other than a technological innovation.

To research this issue, the implementation was assessed of a learning programme with historical-patrimonial contents for secondary education, combining receptive methodologies in a visit to an archaeological dig with other active approaches in drawing up a self-guided itinerary, carried out at the museum.

Ninety students took part in this study, responding to a survey with questions related with the assimilation of conceptual content, attention and effectiveness of the programme as well as aspects related with satisfaction, perceived usefulness and the difficulty of use of mobile technology.

The results are satisfactory in terms of the assimilation of contents, obtaining the best results in methodologies that combine the lecture with tasks involving the use of this technology in educational and learning processes. The satisfaction and perception of utility confirmed good results from preceding works.

RESUMEN

La relevancia social del *mobile learning* es cada vez más evidente. Estos mecanismos, a través de TICs y dispositivos móviles, se aplican ya en programas educativos en yacimientos arqueológicos y museos, pero la pregunta es si estos programas son efectivos para el aprendizaje. Para investigar esta cuestión, hemos evaluado la implementación de un programa educativo con contenidos histórico- patrimoniales ofertado para estudiantes de secundaria. Noventa estudiantes participaron en este estudio respondiendo un cuestionario que abordaba cuestiones relacionadas con la asimilación de contenidos conceptuales, la atención y la eficacia del programa, así como aspectos relacionados con la satisfacción, utilidad percibida y dificultad de uso de la tecnología móvil. Los resultados son satisfactorios respecto a la asimilación de contenidos, y se aprecian mejores resultados con la combinación de metodologías receptivas y el uso de tecnología móvil. La satisfacción y la percepción de la utilidad confirman los buenos resultados de anteriores trabajos.

LABURPENA

Gero eta nabarmenagoa da *mobile learning* delakoak gizartean duen garrantzia. Mekanismo horiek aztarnategi arkeologikoetako hezkuntza-programetan aplikatzen dira jada IKTen eta gailu mugikorren bidez, baina galdera zera da, ea programa horiek ikasteko eraginkorrak diren. Gaia aztertzeko, bigarren hezkuntzako ikasleei eskainitako historia eta ondarearen inguruko hezkuntza-programa bat ebaluatu dugu. Laurogeita hamar ikaslek hartu zuten parte azterlanean eta galdetegi bat erantzun zuten gai hauei buruz: eduki kontzeptualak barneratzea, arreta eta programaren eraginkortasuna, gogobetetzea, hautemandako erabilgarritasuna eta teknologia mugikorra erabiltzearen zailtasuna. Emaitzak onak izan dira edukiak barneratzeari dagokionez eta emaitzak hobeak izan dira metodologia errezeptiboak eta teknologia mugikorraren erabilera konbinatu direnetan. Gogobetetzeak eta hautemandako erabilgarritasunak berretsi egin dituzte aurreko lanetan eskuratutako emaitza onak.

1.- INTRODUCTION

Mobile learning has been highlighted as effective learning mechanisms, identifying a series of processing strategies that facilitate significant learning mechanisms such as contextualization, the connection with daily life, the effective use of intrinsic motivation, and affective emotional involvement, to the extent of becoming a point of reference for formal learning. The inexorable development of new digital resources has distorted this whole panorama by including stand-alone learning formats and platforms.

Within this line, our interest lies in finding out more about this mobile learning in the context of heritage presentation spaces, and specifically in this work, about the implications in these processes of using mobile technology.

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The research work described in the article was carried out in collaboration with the Museum of Art and History of Zarautz (MAHZ) to assess the results of an activity for secondary education, with the aim that the students should become acquainted with the patrimony of the municipality in its own context, independently and by means of mobile technologies. This activity makes use of an emergent methodology, which enables tasks to be accomplished with spatial autonomy using mobile devices. There are still very few empirical evaluations of these technologies available, and this study is an attempt to offset said deficiency and contribute elements and data to the scientific debate.

2.- HERITAGE PRESENTATION SPACES AND MOBILE LEARNING

Museums and archeological sites are places where didactic activities can be more easily undertaken because they count on a series of features not provided by other educational institutions (FALK, DIERKING & FOUTZ, 2007): contact with the material culture; great cultural and community identity; contextualization of contents; narrative discourse; possibility of voluntary and active learning; hands-on experience of materials and interactive situations; prior curiosity of the visitor arousing intrinsic motivation; creation of feelings; discourse arising from the familiar; learning understood as a social activity; diversification of messages aimed at a segmented audience; or the use of different expository approaches which can connect with different learning style (LEINHARDT & KNUTSON, 2004). This characterization obviously corresponds to modern exhibitions, closer to science museums and centres than to the more habitual, contemplative and descriptive museums and archeological sites.

Moreover, modern museums and archeological sites exhibitions, go beyond the limits of the institution itself in a more global consideration, working with heritage in successive layers of territorial integration. All these features of learning in museums and patrimony are based on the advantages described in the theoretical frame of situated learning (LAVE, 1981), which gave rise to more elaborate models of the processes of knowledge acquisition and conceptual change (RAINBIRD, FULLER & MUNRO, 2004).

Process indicators very similar to those found in the museum sphere have been posited for the ICTs, whose application in education cannot be divorced from the role they are taking on in day-to-day life, where they are substantially changing our knowledge, habits, skills and even values, generating a distinct mobile culture (CLOUGH, JONES, MCANDREW & SCALON, 2008; KUKULSKA-HULME, 2010). The data indicate that the mobile devices has become an essential element of daily life for young people and it comes as no surprise, considering that it is an apparatus of limited dimensions, although not all cell phone services are currently within reach of all.

The many educational possibilities provided by these appliances have not gone unnoticed, and ever since the late 20th century research has been conducted into mobile learning (INKPEN, 1999), which in principle was considered no more than an evolution of e-learning via mobile communication devices (SHARPLES, 2003). It is anticipated that mobile learning will be reinforced in years to come, as a result of its evolution both in technological terms and educational research.

The latest studies into these technologies surpass the initial technological vision of mobile learning and delve into other types of possibilities beyond those related with the spatial mobility provided by mobile devices, especially their application at any time and in any social context (VAVOULA & SHARPLES, 2002), increasing learner mobilities and the dynamism of the learning processes and the flow of information (EL-HUSSEIN & CRONJE, 2010).

Thus, there are five features of mobility which nowadays define mobile learning (SHARPLES, LONSDALE, MEEK, RUDMAN & VAVOULA, 2007) and are summarized as portability of the tools, which allow access to information at any place and time, making learning something possible on a lifelong basis, but also in any social context, without necessarily having to be through specific learning programmes. The learning thus sets out from a personal interest and gradually evolves in line with personal interests and circumstances.

Nevertheless, it may be that not everything is advantageous when we encourage students to work using mobile technology, such as the problem that the technological novelty might overshadow the traditional learning experience; the danger that young people might pay more attention to the apparatus than the main contents of the experience, giving rise to an inverse paradoxical effect to that anticipated; or the limitation that the restrictions of the technological format itself may excessively condition the learning strategy (MIFSUD & MØRCH, 2010).

In recent years, many experiments in mobile learning have been carried out in museums, archaeological sites or another heritage presentation spaces (ARDITO, COSTABILE, DE ANGELI, & LANZILOTTI, 2012; CUTRI, NACCA-

Mobility feature	*Description*
PHYSICAL SPACE	Learning is not linked to a specific physical space. Mobile technologies allow freedom in physical space.
MOBILE DEVICE CONCEPTUAL	Portability of devices: telephones, PDA, laptops. Access to information and resources in/at any space and time through digital mobile networks: wireless
SPACE	Learning stems from a personal interest which progresses and is modified on the basis of personal interests and curiosity.
SOCIAL CONTEXT	Learning takes place in the different social contexts in which we take part: family, work, school …
DISPERSION IN TIME	Learning is a cumulative process taking in wide variety of experiences in formal and informal contexts over time.

Tabla 1: Mobile learning mobility features.

RATO & PANTANO, 2008; IBÁÑEZ-ETXEBERRIA & ASENSIO, 2009; LOHR, 2009; NORDMARK, S., & MILRAD, M. 2012; RODRIGUEZ ECHAVARRIA, KAMINSKI, & ARNOLD, 2012; STYLIARAS, & KOUKOPOULOS, 2012; VLAHAKIS, KARIGIANNIS, TSOTROS, IOANNIDIS & STRICKER, 2001), and there are even research work compilations on the subject (IBÁÑEZ-ETXEBERRIA, ASENSIO, VICENT & CUENCA, 2012; TALLON & WALKER, 2008). However, in most cases, the technology has been treated as an element of support for the contents worked on in museums, rather than as a useful tool for the development of their educational programmes. The panorama, in our opinion, is insufficiently defined for three main reasons: there are still very few assessments with complex designs available (IBÁÑEZ-ETXEBERRIA, VICENT, & ASENSIO, 2012.); the results obtained are more linked with the impact and features of use than to the learning process (SPALLAZZO, CECONELLO & LENZ, 2011) and finally, the formats and technological platforms involved vary substantially from some experiences to others, making it very difficult to draw out common lines. It is evident that this is still a field of work in its infancy and that it is necessary to accumulate both experiences and evaluations of the same.

On the basis of the heritage presentation spaces and mobile learning, a research project into the design, implementation and evaluation of an education programme with use of mobile devices was developed at the MAHZ, in Santa Maria la Real archaeological site. At first, with PDA (Personal Digital Assistant) and GPS devices (Global Positioning System), and actually, with smartphones that integrate these two technologies, but differentiating both functions. Thus, to understand more easily, in the results, we will discuss about mobile devices (PDA & smartphones) and GPS system. In this case, mobile technology, in addition to exerting a motivating influence, is designed to work with the contents at the time and place required, without having to transfer them to the classroom, thus avoiding separation from their context.

In an initial programme, the portability, accessibility, usage and impact parameters were assessed, without going into evaluation of the learning outcomes. Among the interviewees, the majority claimed to have learnt something, although it was observed that there were serious difficulties in specifying what type of learning had been achieved. The strong motivation for the students in carrying out field work in situ and with this kind of technology was also evident (CORREA, IBÁÑEZ-ETXEBERRIA & JIMÉNEZ, 2006).

On the basis of these assessments, the programme was redesigned and is now known as 'Zarautz in your hands". The purpose of this activity is for the students to gradually become comprehensively involved with local heritage, history and material and immaterial culture, as well as the evolution that the area has undergone, through several exercises, notably including a self-guided visit to the locality using mobile technology. This enables work on heritage to be done in situ, in such a way that the tasks are performed on the ground, based on each student's own experience.

On the basis of this programme, an assessment was designed which in addition to research into the usage parameters included an exploration of the learning types and outcomes during the experiment, as well as the programme's effectiveness in achieving its goal. From these bases, the following hypotheses were proposed:

- Assimilation of contents: There are significant differences in the results achieved by the students depending on the working methodology applied, in favour of the active attitudes mediated by the technology. An improvement was observed in the understanding of geo-historical contents when using mobile technologies in real contexts, if these are reinforced by a theoretical base, with no significant differences found on the basis of gender, level of studies or whether the activity was arranged by a regulated or unregulated source.
- Programme effectiveness: The use of mobile devices does not constitute a disruptive element or distract from the attention paid by the student to the activity.
- Student Appraisals and Satisfaction: Carrying out the activity is well appreciated, and perceived as useful. The students had no difficulty in learning to use the mobile devices, which in turn aroused a sensation of greater simplicity and user friendliness, and contributed a sense of freedom to the learning process, presenting no differences in terms of gender, study level or the source of engagement of the activity, regulated or otherwise.

3.- METHODS

A total of 90 secondary students (n=90) aged from 12 to 17 years from the autonomous communities of the Basque Country and Castile-Leon (Spain) took part in this study.

The gender distribution was proportional, with 55.6 % (n=50) males and 44.4 % (n=40) females (table II), although not for study level, with 76.7 % (n=69) belonging to the first secondary cycle and the remaining 23.3 % (n=21) in second cycle (table III). In this sense, it was noted that these subsample figures and distributions would impose certain statistical limitations on the study, but as the work was of an exploratory nature it was deemed interesting to take them into account.

		Fre q.	Percent	Percent valid	Percent acumul.
Val	Female	40	44,4	44,4	44,4
.	Male	50	55,6	55,6	100,0
	Total	90	100,0	100,0	

Tabla 2: Sex

		Fre q.	Percent	Percent valid	Percent acumul.
Val.	First Secondary	69	76,7	76,7	76,7
	Second	21	23,3	23,3	100,0
	Secondary				
	Total	90	100,0	100,0	

Tabla 3: Study level

An ex post facto design with descriptive and correlational methodology was used for the study. The dependent variables considered in this study were gender, study level and the origin of the arrangement. In terms of study levels, the cycle was chosen as grouping criterion, splitting the sample between students in first or second secondary education cycle. As for the source of arrangement, this is a specific variable proposed in this study, related with the informal nature of the proposal. The visit may be contracted through regulated or unregulated channels, understanding regulated engagement as when the education centre proposes the activity in its classroom and class-group programming and arranges it. The engagement is understood as unregulated when it is arranged by another body, and may or may not consist of a class-group, being considered a complementary training activity. The sample distribution at this point is also proportional, with 44.4 % (n=40) of participants presenting a regulated origin, and the remaining 55.6 % (n=50) unregulated (table IV).

		Fre q.	*Percent*	*Percent valid*	*Percent acumul.*
Val	*Regulated*	40	44,4	44,4	44,4
	Unregulated	50	55,6	55,6	100,0
	Total	90	100,0	100,0	

Tabla 4: Learning

The independent variables were organized around three areas described: assimilation of contents, attention paid, and those related with use and satisfaction.

Regarding assimilation of contents, the aim was to gauge the knowledge acquired by the students during their participation in the visit to the dig and their experience of the expedition. They were asked to fill in a questionnaire on geohistoric contents methodologically worked on receptively (received passively via the lecture given by the monitor on site), actively (outcome of the tasks performed by the students during the expedition) and/or both ways (information was received receptively and subsequently worked upon during the field trip). The results per methodology are grouped as Receptive, Self-guided, and Complemented.

For attention paid, the aim was to establish whether the students were able to identify the elements they had been working on during the field trip, taken as a measure to determine if the use of the technology affects the degree of attention.

Finally, regarding the user experience and satisfaction, data were compiled on their declared interest in the visit, perceived usefulness of the activity and their appraisal of the use of ICTs in general and mobile devices in particular. Data collection for program evaluation, was conducted on the activity carried PDA and GPS devices, but the results are transferable to current work with integrated smartphones.

The data gathering instrument used was a questionnaire, previously submitted for scrutiny and suggestions by teachers and monitors of the activity, which passed a pilot test with 8 groups. This process was repeated again twice, until the definitive version was achieved. A large part of the questionnaire is common to all interviewees, but depending on the four physical itineraries the students can follow, the questionnaire presents a specific version for each one, involving changes to some of the questions related to the contents they worked with during the trip. The three sections into which the evaluation tool is structured relate to the hypotheses and are Assimilation of contents, visual Recognition and Use and satisfaction:

A. Assimilation of contents: By means of 9 “true/false” dichotomizing questions, three per category, the aim is to determine under which of the three proposed methodologies the contents worked upon were best assimilated: 1) Receptive Content, 2) Self-guided Content and C) Complemented Content. For each itinerary, seven questions are common and two are specific.

B. Visual recognition: Through 12 photographs of different heritage sites visited and worked upon along the four routes followed (3 per itinerary), the aim is to determine whether the students were able to identify the ones they had worked on during their visit, assessing their degree of attention.

C. Use and satisfaction: With a combination of open and closed option rating scale questions, data were compiled on the satisfaction felt by the students after completing the activity, their perception of the task’s worth and the degree of difficulty in handling the mobile devices, and the relation of use with satisfaction and the perception of personal autonomy.

Finally, as per procedure, the pilot trial was held during the 2006-2007 course, with the programme up and running in 2007-2008. The “Zarautz in your hands” programme was structured in three phases: 1) Pre-trip activity, carried out in the education centre, working on contents to improve understanding of the activity; 2) Visit to Zarautz and field trip activity; and 3) Final post-trip reflective task. To ensure experimental control, the assessment was proposed at the end of the second phase, since the first two phases were quite homogenous, whereas the third was highly variable, each unit depending on the interests of the trainer or person in charge and the place of the visit in the programming.

In this programme, the students enjoyed two complementary learning situations. On one hand, in the visit to the archaeological site they were given a lecture in classic format by one of the museum’s educators, with contents related to the theme of the excavation, combined with video viewing and a stroll over the glassed surface covering the dig. For this activity, the church itself was used as though it were a traditional classroom, with its dais and long stone pews, although with the added dynamic of movement. In the second activity, the expedition, the students, organized in groups of 4-5, were given the mobile devices loaded with information needed to follow the itinerary. Along with complementary information that helps them carry out the activity, they were set a series of tasks concerning local heritage to work on and resolve using the recording tools integrated in the device, while using the GPS device for orientation and fieldwork. As described, there are four possible routes.

4.- RESULTS

Starting with the results related with assimilation of content, we see that when considering the success in obtaining the contents on a scale of 0 to 9, the average number of correct answers received from students who answered this question (n=85), was 6.32 (d.t. 1.685), although we find 18.8 % (n=16) of individuals presenting a poor result, with fewer than 50 % of correct responses (from 0 to 4 correct). A majority 65.8 % (n=56) got between 6-8 correct, while only 7.1 % (n=6) of the participants obtained the maximum score (table V). If we try to look for differences between the predefined groups, we see that, within their generalization limitations, statistically significant differences arise in the group comparison by study cycle, in favour of students in second cycle of secondary education t(83)=-2.784, p<.01, giving an average of 7.20 correct responses (n=20 and d.t. 1.542), compared to 6.05 (n=65 y d.t. 1.643) of first cycle students. There are also differences t(83)=-2.619, p<.01 depending on the source of engagement, as the students who came through an unregulated activity obtained an average of 6.71 correct (n=49 y d.t. 1.568), whereas those that came in a regulated activity directly arranged by the school obtained a lower percentage of correct answers, with an average 5.78 (n=36 and d.t. 1.709) (table VI; VII).

In terms of the reception methodology of the contents received in the visit (Receptive, Self-guided and Complemented), we see that the Complemented Content (n=86) obtained the highest score, with an average of 2.58 (d.t. 0.711) on a scale of 0-3, followed by Self-guided Content, with 1.95 (d.t. 0.924), and finally Receptive Content, with an average of 1.80 (d.t. 1.027) points. In this case, the differences between groups occur only in the Receptive content category, t(47.7)=-3.702, p<.001, where the second cycle students obtained an average of 2.38 correct out of 3 (n=21 y d.t. 0.740), compared to 1.62 (n=65 y d.t. 1.041) obtained on average by the younger pupils in 1st and 2nd year of secondary. Significant differences also appeared t(84)=-3.613, p<.001 depending on the regulated or unregulated nature of the trip arrangements, where the education centres that contracted it directly obtained an average score of 1.36 (n=36 y d.t. 0.990), compared to 2.12 (n=65 y d.t. 0.940) achieved by the groups that came through a company that organized the activity for them.

When attempting to analyse the correct use of the mobile devices, we set out from the basis that their use would not constitute a distraction for the student and thus hinder the identification and of the places they visited and worked on throughout their field trip.

In an attempt to gauge this assumption, a visual recognition task was proposed, in which pupils were asked to identify the ones they had worked on and those they had not from among 12 photos featuring significant elements of Zarautz. To avoid a ceiling effect in the task, the success criterion was very demanding, considering every exercise that did not obtain a 100 % success rate as unsuccessful (table VIII). Thus, of the 81 pupils that answered this question, 63.0 % (n=51) completed the recognition test successfully, whereas 37.0 % (n=30) made some kind of mistake when identifying the sites. With a minimum of six correct answers, the average for site recognition was 11.05 (d.t. 1.45).

	Cycle First cycle	Second Cycle	Total
Content 2	1	0	1
3	5	1	6
4	9	0	9
5	5	2	7
6	11	1	12
7	25	7	32
8	7	5	12
9	2	4	6
Total	65	20	85

Tabla 5: Assimilation of content/cycle.

	Learning Regulated	Unregulated	Total
Content 2	1	0	1
3	3	3	6
4	6	3	9
5	4	3	7
6	6	6	12
7	12	20	32
8	3	9	12
9	1	5	6
Total	36	49	85

Tabla 6: Assimilation of content/learning.

		N	Aver.	d.t.
Cycle	First cycle	65	6,05	1,643
	Second cycle	20	7,20	1,542
Learning	Regulated	36	5,78	1,709
	Unregulated	49	6,71	1,568

Tabla 7: Assimilation of content/cycle-learning.

		Freq.	Percent	Percent valid	Percent acumulated
Valids	No	51	56,7	63,0	63,0
	Yes	30	33,3	37,0	100,0
	Total	81	90,0	100,0	
Lost	System	9	10,0		
Total		90	100,0		

Tabla 8: Distraction

If we analyse the sub-samples in the chi-squared application, we see that there are significant differences x2(1)=6.94, p<.05 in favour of the girls with 78.3 % (n=29) completing the test successfully, compared to 50 % (n=22) of the boys. Significant differences were also observed in the cycle category x2(1)=10.40, p<.001, in favour of 1st cycle (71.21 % and n=47) compared to 2nd cycle (26.66 % and n=4).

Satisfaction was assessed by means of a question in which, on a scale of 0 to 3, where 0 is not at all and 3 is a lot, the students were asked to rate whether they had found the trip to Zarautz interesting. The average score in this question is 2.13 (n=89 y d.t. 0.625), which expresses a student rating between quite and very interesting, with no differences in any of the sub-groups.

As for the perception of usefulness, the students declared that this activity had indeed been appropriate to find out about the evolution of the town of Zarautz over time, which we must bear in mind is the main purpose of the activity.

In this valuation, we find that on a scale from 0 to 3, the students present an average rating of 2.40 (n=89 y d.t. 0.598), with a scant 5.6 % (n=5) who considered the activity not very suitable or unsuitable. Some 94.4 % (n=84) considered the activity quite or very suitable, with no significant differences found in the sub-group analysis.

Finally, when rating the use of new technologies, the general opinion of the 88 students who answered this question (87.5 % and n=77) is that ICT made the visit quite or very pleasant, while the remaining 12.5 % (n=11) said that it contributed little or nothing. In general, the average score is 2.36 (d.t. 0.790), with a moderate positive correlation r=.44, p<.0001 between the activity rating and the use of the technology, establishing a direct connection between the technology and the experience which is not related to the acquisition of contents. Another interesting aspect is that 77.2 % (n=68) say that the use of mobile devices gave them quite a bit or a lot of leeway in the learning process. This rating of the independence obtained also provides a small positive correlation r=.24, p<.05 with the general score for the visit (table IX).

In the use of ICT, when focusing on the specific use of mobile devices we must establish clear differences between the two types used in the route. So, for mobile device use we see that 97.7 % (n=86) of the 88 students who answered this question considered it easy or very easy to use, in equal distribution, whereas in contrast, 2.3 % (n=2) considered hard to use, with no differences in the sub-groups.

		Freq.	Percent	Percent valid	Percent acumulated
Valids	Nothing	3	3,3	3,4	3,4
	Little	8	8,9	9,1	12,5
	Quite	31	34,4	35,2	47,7
	Much	46	51,1	52,3	100,0
	Total	88	97,8	100,0	
Lost	System	2	2,2		
Total		90	100,0		

Tabla 9: Use TIC.

As for the rating of the device, 21.3 % (n=16) perceived that made it easier to carry out the activity, because "it helps" and enables them to do it better or more comfortably. Some 12 % (n=9) also referred to the satisfaction and fun arising from its use. Specifically, they responded that the activity had been "fun", "better" or "more pleasant", but also that it allowed them to "learn" and "take an interest in searching for information." 8 % (n=6) of the sample pointed out the possibilities of interaction with the social framework arising from the use of the mobile device, with answers such as "asking people", which we interpret as them making reference to having to interview people to gather the information demanded of them by voice and image in the device. 5.3 % (n=4) declared generically that it contributed a lot. Moreover, we find comments such as that the personal organizer means that "the monitors know for sure that we have been to this place", that students value its use because they can "remember the most visited sites" and even an ecological contribution, considering that "we use less material" (5.3 % and n=4). Finally, the mobile device was the highest rated aspect of the programme, being cited by 40.5 % (n=30) as an element to maintain, whereas a minimum percentage (4.2 %; n=3) considered it an element to be modified (table X).

		Freq.	Percent	Percent valid	Percent acumulated
Valids	Difficult	2	2,2	2,3	2,3
	Easy	43	47,8	48,9	51,1
	Very easy	43	47,8	48,9	100,0
	Total	88	97,8	100,0	
Lost	System	2	2,2		
Total		90	100,0		

Tabla 10: Use mobile device.

As for GPS system use, 19.5 % (n=17) of the participants declared that handling it was difficult or very difficult for them (notable when compared to the rating obtained by other device), whereas the remaining 80.5 % (n=70) affirmed that it seemed easy or very easy to them. Applying the chi-squared statistic, a significant difference is identified in favour of the girls x2(1)=12.96, p<.0001, where only 2.63 % (n=1) declared that learning to use it had been difficult for them, compared to 34.04 % (n=16) of the boys.

If we attempt to relate the activity rating to the difficulty in handling the GPS device, statistically significant differences t(19)=-2.281, p<.05 are appreciated when we observe that the students who expressed handling difficulties (n=17) gave the activity a score of 1.82 (d.t. 0.809) on a scale of 0-3, 0.38 points below those pupils who found it easy or very easy, which reached an average of 2.20 (d.t. 0.554) in their rating (table XI).

		Freq.	Percent	Percent valid	Percent acumulated
Valids	Difficult or very difficult	17	18,9	19,5	19,5
	Easy or very easy	70	77,8	80,5	100,0
	Total	87	96,7	100,0	
Lost	System	3	3,3		
Total		90	100,0		

Tabla 11: Use GPS system.

5.- DISCUSSION

In terms of content assimilation, the average for correct responses provides an encouraging vision of the programme's conceptual learning processes, which would go some way towards confirming its educational possibilities, in accordance with the theoretical bases of mobile learning. This idea would also be transferable to others heritage contexts. This notion is reinforced when the programme's learning objectives are reasonably fulfilled, even though that degree of fulfilment can and should be improved.

Examining the analysis of these results more closely on the basis of the learning methodology used, we see that the more active education-learning process, based on experience in a real context mediated by the technology, provides better results than learning by less active or receptive methods, although we cannot forget that the combination of both brings an even better result, pointing to an increasingly complex, multi-tasking, flexible and free choice structuring, through the problem-solving system, in this type of programme (SUNG, HOU, LIU & CHANG, 2010).

If we analyse the results from the sample subdivisions considered in the study, we must bear in mind that these are limited in their generalization, but from their exploratory nature, they signal future trends for study.

In this sense, we note that a descriptive study of this type, in an innovative activity carried out in an area bordering three complex territories such as ICT, education and heritage, makes sense as soon as we observe that there are few in-depth assessments usually consisting of descriptions of proposals and declarations of good outcomes, generally focused on use and satisfaction.

After this explanation, we note that differences came to light in the acquisition of contents depending on the cycle and source of arrangement. Thus, the more educated students, those in 3rd and 4th secondary cycle, obtained better results for the total count and the specific block that measures the contents studied receptively, which prevents us concluding that the more adult students obtained greater benefit from the self-guided learning process by means of mobile technology. The students who took part in the activity through a regulated channel also obtained better results, which may be related to motivational factors, both on the side of the pupils and of the teaching staff in charge.

In line with other research works in formal contexts (LI, RYU & PARSONS, 2009) proposing that the use of mobile technology need not constitute a reason for distraction for the pupils, the data indicate that although most students were able to identify 100 % of the heritage sites visited and worked on during their field trip, there was also a large number of students who did not, so we consider that this hypothesis in informal contexts is not verified. The 37% of students who failed to recognise the sites studied seems excessive, so we regard this as an issue to be revisited. Better results were also observed among the participants whose trip was not arranged by a regulated source. In the latter case, it seems clear that the better results have to do with the motivation generated by an activity not strictly academic.

As for the student ratings, regarding the hypothesis which states that the use of mobile devices and tools does not involve difficulty and presents no group differences, the results confirm previous studies for primary education (GERÓNIMO, & ROCHA, 2007) and secondary education (CORREA, IBÁÑEZ-ETXEBERRIA & JIMÉNEZ, 2006; HWANG, KUO, WU, HUANG, & ZHUANG, 2010) in which the pupils did not perceive any kind of difficulty in handling the mobile device, whereas 1 in 5 did. The mobile device was in moment evidently much closer to their habitual technologies such as PCs and mobile phones and smartphones, which means that this device is more familiar to them. Currently, surpassed this technology, currently investigates learning activities with smartphones (ANGELOPOULOU *et al.*, 2012; GUAZZARONI, 2012; LIU *et al.*, 2014; STYLIARAS, & KOUKOPOULOS, 2012).

In contrast, the GPS system presents other conditioning factors further removed from their day-to-day experience, and calls for more complicated and abstract mental operations, which would help explain the greater difficulty in understanding. In any case, good results seem to be achieved by their use. In terms of the possible group differences in learning and use, we see that they only arise in the case of the GPS, and in favour of women, who perceive their learning as simpler than men.

The results provided by this study also verify that the use of mobile devices makes the activity easier and more pleasant. The answers recorded by the students indicate that the mobile device is seen as a very useful tool for gathering the information in situ, something which could not be done, or at least would be less motivating and immediate, by means of traditional data collection methods, generally confirming that the use of mobile technology is amusing and attractive for the students. In this sense, it is noted that the simpler they perceive its use, the higher they rate the activity.

The results also support the hypothesis that the mobile device enables the students to develop their own skills when gathering the data needed to carry out the activity, while use of the GPS system means that the students can undertake the expedition independently, guiding themselves by the apparatus to reach the places proposed to them. A specific improvement through the use of GPS in open spaces is confirmed in relation with the sensation of freedom perceived by the students, which is highly valued, since it collaborates in making the activity less physically supervised, while the students perceive that greater trust has been placed in them for the accomplishment of an academic task under their own steam.

6.- CONCLUSSIONS

In conclusion, we may affirm that the mobile learning situation is perceived as a propitious scenario for learning in general and its outcomes, measured by complementary parameters, are considered very positive per se. More precise assessments are needed to be able to really pinpoint the workings of the different parameters that make up this kind of learning situations. So far, we have a more rational than empirical reflection on the design of mobile learning conditions, both from experience, as of the participants.

Secondly, we can conclude that the mobile devices are perceived by the pupils as very positive tools, which improve their learning conditions and make it easier and more pleasant. Nevertheless, these good results usually mask serious problems in the use of certain technologies, which need to be studied in more detail and are reported in our own results at difficulty of use level. We can also confirm that the contents worked upon through the same are well acquired, although it did not come to light in this work whether or not their motivating potential might somehow eclipse the attention paid by the students.

This study, as was to be expected when discussing an emergent field such as the applications of mobile technology in informal contexts, is merely an initial effort, which seeks to allow the comparison of experiences and draw

some brief conclusions, while opening up a multitude of questions in the face of a future that promises to be active and in which new technologies follow one another at breakneck speed. However, these changes in formats and platforms do not affect the basic foundations involved in each learning condition. Thus, the evaluations of PDA, (TESORIERO, LOZANO, GALLUD & PENICHET, 2007), GPS (GIROUX, MOULIN, SANNA & PINTUS, 2002), WEB (HSI, 2003; VICENT & IBAÑEZ-ETXEBERRIA, 2012), smartphones (HAUGSTVEDT, & KROGSTIE, 2012; STYLIARAS, & KOUKOPOULOS, 2012) or devices in general (ARNEDILLO, M. SHARPLES, G. VAVOULA, 2007; VICENT, 2013), are demonstrating the weight of certain process parameters (narrativity, re-drafting of contents, socialization, contextualization, etc.), which are the true pillars of learning and which benefit from the technological platforms, favouring their applicability in learning situations. This is a path along which further progress should be made.

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8. REFERENCES

ANGELOPOULOU, A., ECONOMOU, D., BOUKI, V., PSARROU, A., JIN, L., PRITCHARD, C. & KOLYDA, F.

2012 Mobile Augmented Reality for Cultural Heritage. In *Mobile Wireless Middleware, Operating Systems, and Applications* Springer Berlin Heidelberg. 15-22.

ARDITO, C., COSTABILE, M. F., DE ANGELI, A., & LANZILOTTI, R.

2012 Enriching Archaeological Parks with Contextual Sounds and Mobile Technology. *ACM Transactions on Computer-Human Interaction (TOCHI), 19*(4), 29.

ARNEDILLO-SÁNCHEZ, I., SHARPLES, M. & VAVOULA, G. (Eds.)

2007 *Beyond mobile Learning Workshop*. Dublin: Trinity College Press.

CLOUGH, G., JONES, A.C., MCANDREW, P.M. & SCALON, E.

2008 Informal learning with PDAs and smartphones. *Journal of Computer Assisted Learning*. 24, 359-371.

CORREA, J. M., IBÁÑEZ-ETXEBERRIA, A. & JIMÉNEZ, E.

2006 Lurquest: Aplicación de tecnología m-learning al aprendizaje del patrimonio. *Iber. Didactica de las Ciencias Sociales.* 50, 109-123.

CUTRI G., NACCARATO G. & PANTANO E.

2008 Mobile Cultural Heritage: The case study of Locri. *Lecture Notes in Computer Science Technologies for E-Learning and Digital Entertainment.* 5093, 410-420.

EL-HUSSEIN, M. O. M., & CRONJE, J. C., 2010.

Defining Mobile Learning in the Higher *Education Landscape. Educational Technology & Society*., 13(3), 12-21.

FALK, J. H., DIERKING, L. D. & FOUTZ, S. (Eds.)

2007 *In principle, in practice*. Walnut Creek: Altamira Press.

GERÓNIMO, G. & ROCHA, E.

2007 Edumovil: Incorporando la tecnología móvil en Educación Primaria. *Revista Iberoamerica de Educación a Distancia*. 10(1), 66-73.

GIROUX, S., MOULIN, C., SANNA, R. & PINTUS, A.

2002 Mobile Lessons: Lessons based on geo-referenced information. *Proceedings of E-Learn* 2002, AACE, Charlotesville, 331-338.

GUAZZARONI, G.

2013 Emotional mapping of the archaeologist game. *Computers in Human Behavior, 29*(2), 335-344.

HAUGSTVEDT, A. C., & KROGSTIE, J.

2012 Mobile augmented reality for cultural heritage: A technology acceptance study. In *Mixed and Augmented Reality (ISMAR), 2012 IEEE International Symposium on* 247-255. IEEE.

HSI, S.,

2003 A study of user experiences mediated by nomadic web content in a museum. *Journal of Computer-Assisted Learning*. 19, 308–319.

HWANG, G. J., KUO, W. L., WU, P. H., HUANG, Y. M., & ZHUANG, Y. Y.

2010 An investigation on students' cognitive load and learning achievements for participating in a local culture mobile learning activity. In *Wireless, Mobile and Ubiquitous Technologies in Education (WMUTE), 2010 6th IEEE International Conference on* , 27-33. IEEE.

IBÁÑEZ-ETXEBERRIA, A. & ASENSIO, M.

2009 Mobile devices and archaeological sites: An emergent context in Mediterranean Europe. In *Proceedings of the 8th European conference on e-Larning* (ed. D. Remenyi), Reading, Academic Publishing Limited, 267-275.

IBÁÑEZ-ETXEBERRIA, A., ASENSIO, M., VICENT, N. & CUENCA, J.M.

2012 Mobile devices: a tools for tourism and learning at archaeological sites. *International Journal of Web-Based Communities*. 8(1), 57-72.

IBÁÑEZ-ETXEBERRIA, A., VICENT, N., & ASENSIO, M.

2012 Aprendizaje informal, patrimonio y dispositivos móviles. Evaluación de una experiencia en educación secundaria. *Didáctica de las Ciencias Experimentales y Sociales,* 26, 3-18

INKPEN, K. M.

1999 Designing Handheld Technologies for Kids. *Personal Technologies Journal*. 3(1-2), 81–89.

KUKULSKA-HULME, A.

2010 Learning Cultures on the Move: Where are we heading? *Educational Technology & Society,* 13(4), 4-14.

LAVE, L. B.

1981 *The Strategy of Social Regulations: Decision Frameworks for Policy.* Washington, D.C.: The Brookings Institution.

LEINHARDT, G. & KNUTSON, K.

2004 *Listening in on museum conversations.* Walnut Creek, CA: Altamira Press.

LI, L., RYU, H., & PARSONS, D.

2009 The influence of spatial working memory on mobile learning content design. In *Proceedings of IADIS International Conference mobile Learning,* 203-206.

LIU, M., SCORDINO, R., GEURTZ, R., NAVARRETE, C., KO, Y., & LIM, M.

2014 A Look at Research on Mobile Learning in K–12 Education From 2007 to the Present. *Journal of Research on Technology in Education, 46*(4), 325-372.

LOHR, M.

2009 Mobile Learning by the Example of the Carnuntum Scenario. In international conference on intelligent networking and collaborative systems (eds YK. Badr, S. Caballe, F. Xhafa, *et al.*), 46-52. IEEE, Washington.

MIFSUD, L. & MØRCH, A.I.,

2010 Reconsidering off-task: a comparative study of PDA-mediated activities in four classrooms. *Journal of Computer Assisted Learning.* 26, 190-201.

NORDMARK, S., & MILRAD, M.

2012 Using Mobile Digital Storytelling to Support Learning about Cultural Heritage. In *Proceedings of the 20th International Conference on Computers in Education ICCE 2012* 408-412.

RAINBIRD, H., FULLER, A. & MUNRO, A. (Eds.)

2004 *Workplace learning in context.* London: Routledge

RODRIGUEZ ECHAVARRIA, K. R., KAMINSKI, J., & ARNOLD, D.

2012 3D heritage on mobile devices: scenarios and opportunities. In *Progress in Cultural Heritage Preservation,* 149-158. Springer Berlin Heidelberg

SHARPLES, M.

2003 Disruptive devices: mobile technology for conversational learning. *International Journal of Continuing Engineering Education and Lifelong Learning,* 12(5-6), 504-520.

SHARPLES, M., LONSDALE, P., MEEK, J., RUDMAN, P. D. & VAVOULA, G. N.

2007 An Evaluation of MyArtSpace. *Mobile Learning Service for School Museum Trips (eds. A. Norman & J. Pearce),* University of Melbourne, Melbourne, 238-244.

SPALLAZZO, D., CECONELLO M., & LENZ, R.

2011 Walking, Learning, Enjoying. Mobile Technology on the Trail of Design Masterpieces in M. Dellepiane, F. Niccolucci, S. Pena Serna, H. Rushmeier, & L. Van Gool (Editors) The 12th International Symposium on Virtual Reality, Archaeology and Cultural Heritage VAST (2011), The Eurographics Association.

STYLIARAS, G., & KOUKOPOULOS, D.

2012. Educational Scenarios with Smartphones in Cultural Heritage Sites and Environments. *Journal of Educational Multimedia and Hypermedia, 21*(3), 285-315.

SUNG, Y.T., HOU, H.T., LIU, C.K. & CHANG, K.E.

2010 Mobile guide system using problem-solving strategy for museum learning: a sequential learning behavioural pattern analysis. *Journal of Computer Assisted Learning.* 26, 106-115.

TALLON, L. & WALKER, K. (Eds.)

2008 *Digital Technologies and the Museum Experience. Handheld guides and other media.* Walnut Creek: Altamira Press.

TESORIERO, R., LOZANO, M. D., GALLUD, J. A. & PENICHET, V. M. R.

2007 Evaluating the Users' Experience of a PDA-Based Software Applied in Art Museums. *Proceedings WebIST, Barcelona, Spain, 351-358.*

VAVOULA, G.N. & SHARPLES, M.

2002 KLeOS: A personal, mobile, Knowledge and Learning Organisation System. In *Proceedings of the IEEE International Workshop on Mobile and Wireless Technologies in Education (WMTE2002)* (eds. M. Milrad, U. Hoppe & H. Kinshuk), IEEE, Los Alamitos, 152-156.

VICENT, N.

2013 Evaluación de un programa de educación patrimonial basado en tecnología móvil. *Tesis doctoral* https://repositorio.uam.es/handle/10486/14321 (Consulta 8 de noviembre de 2014)

VICENT, N. & IBÁÑEZ-ETXEBERRIA, A.,

2012 El uso de las nuevas tecnologías y el patrimonio en el ámbito escolar. *Aula de Innovación Educativa,* 208, 22-27

VLAHAKIS, V., KARIGIANNIS, J., TSOTROS, M., IOANNIDIS, N. & STRICKER, D.

2001 Personalized augmented reality touring of archaeological sites with wearable and mobile computers. *Wearable Computers, 2002. Proceedings. Sixth International Symposium.* IEEE.