Bulletin of the *Transilvania* University of Braşov, Special Issue
Series VII: Social Sciences • Law • Vol. 9 (58) No. 2 - 2016

# MOBILE-LEARNING IN A RURAL COMMUNITY. PROBLEMS OF THE PSYCHOLOGY OF LEARNING IN CONTEXT AT PRIMARY AND SECONDARY SCHOOL STUDENTS

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***Abstract:*** *The research presented is based on a series of educational experiments spanning 4 years, conducted in rural communities in Southern Romania with students of various ages in primary and secondary schools. The objective was to evaluate teaching and learning approaches in context using mobile devices and interactive and adaptive learning applications. The paper presents results and discusses different problems of the psychology of learning enhanced by modern technologies. Thus, the paper evaluates the research hypothesis that an educational approach of teaching and learning in a familiar context – local site or landscape – by overlapping familiar notions with new notions represents an important psychological factor likely to enhance the results of the process of learning.*

***Key words:*** *visual perception, mobile-learning, Augmented Reality, learning in context, primary - secondary school.*

## 1. Introduction

The current paper is based on a 4-year body of research work consisting of informal educational experiments within rural communities from Southern Romania targeting various generations of students at primary and secondary school levels. The experiments were conducted as part of the "TimeMaps" research project (http://www.timemaps.net) focused on the teaching and learning of the history of different local communities, whose objective was to evaluate modern educational paradigms, such as teaching and learning in authentic historical contexts, while exploring the affordances of mobile devices and technologies.

Augmented Reality (AR), as a complex visualization technology, was specifically evaluated by designing an interactive and adaptive mobile learning application ("Archaeology-at-home"), in which cultural data (archaeological and historical) were projected on geographical points of interest (POIs), representing the visualizations of archaeological and historical sites, which in some cases, were overlapped by

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contemporary dwellings. The developed mobile application was also a result of the improvements and lessons learned from previous educational experiments (Ştefan & Gheorghiu, 2013; Gheorghiu, & al., 2013; Ştefan, & al., 2013).

Our study had the initial research hypothesis that an educational approach of teaching and learning in a familiar context, a local site or landscape, representing an overlapping of familiar notions with new notions, can offer an important psychological impact in an alternative informal learning process. Thus, the results were further evaluated from the perspective of the psychology of perception and consequently of learning outcomes produced by the current mobile technologies, as derived from our empirical approach.

The paper is structured as follows: a) a review of learning affordances provided by modern digital technologies, in particular mobile devices and AR technology; b) the methodology used to develop and conduct the educational experiment; c) the results and evaluation of teaching and learning in context; d) a discussion of psychological problems and lessons learned from the experiment; e) conclusions and further research.

## 2. Digital Technologies and Learning Paradigms

The digital technologies and the knowledge-based society challenge teaching and learning with new paradigms, seeking to enhance the cognitive processes and more actively involve the students, either in collaborative work or in personalized environments (Johnson, Adams Becker, Estrada, & Freeman, 2015, Johnson et al, 2016). This pedagogical paradigm shift has placed the students at the centre of the learning process and has substantially modified the roles played by teachers. Besides being a tutor and a digital assistant, the teacher has to assess the learners' needs and accordingly select or design the educational offer (Kukulska-Hulme, 2012).

Mobile learning (m-Learning) is a modern learning paradigm initially related to informal learning. The reduced costs of ownership of more advanced mobile devices and strategies such as "Bring Your Own Device" (BYOD) (Ballagas, 2005) have led to m-learning becoming not only a learning style, but a research area in K-12 schools and in higher education, to better understand the way it enhances and challenges the present-day learning approaches (Kukulska-Hulme, 2010; Sharples, Taylor, & Vavoula, 2005).

In the current context, the importance of the informal learning grew due to the necessity for life-long learning, individual learning or ubiquitous access to information, as part of the m-Learning paradigm.

### 2.1. M-Learning

M-Learning is defined as a learning process which does not take place at a fixed and pre-determined location (Alsheail, 2010). From a psycho-pedagogical point of view, m-Learning is "the acquisition or modification of any knowledge and skill through using mobile technology, anywhere, anytime and results in the modification of behaviour" (Geddes, 2012).

The state-of-the-art in mobile technologies, such as responsive content-rich applications, cross-platform or cross-device concepts (e.g. Microsoft Universal Windows Platform Applications, https://developer.microsoft.com/en-US/windows/develop/build-apps-shared-code) are stimulating factors for the development of educational applications (Kukulska-Hulme, 2010). Existing educational platforms migrate to a corresponding

mobile counter-part (e.g. Moodle Learning Management System, www.moodle.org) or new mobile learning environments emerge (e.g. Google Classroom mobile application, https://classroom.google.com). Content delivery on mobile devices may follow different patterns like content push, pull or collaboration (Kadle, 2012). M-learning is also a technology enabler for other technologies supporting education, such as video-based learning, social learning, Augmented and Virtual Reality.

Compared to traditional classroom teaching and learning, m-learning also supports active learning outside or complementary to the classroom, i.e. modern learning theories, such as the experiential learning (Dewey,1938), authentic learning (Freinet, 1970), or recently the flipped-classroom (Johnson et al., 2015). In a few cases, m-Learning has proven to be a distraction from the main learning objectives (Underwood, 2014).

M-Learning applications have been mostly created for language learning in formal education (Kukulska-Hulme, 2012). In Bárcena et al. (2015) recent and on-going progresses in Mobile Assisted Language Learning (MALL) are reported, to exemplify how fertile and promising this domain is. In Ştefan & Gheorghiu (2015) an informal application for learning history while promoting the local tourism is presented. Kukulska-Hulme (2012) pledges for creation of conceptual frameworks to enable the interpretation of emerging learner practices. Important European m-Learning projects are reported in Kukulska-Hulme et al. (2009). Particular m-learning applications are described in Crompton (2016), Kurti, Spikol, and Milrad (2008), Spikol and Milrad (2008), Sharples, Lonsdale, Meek, Rudman, and Vavoula (2007).

### 2.2. AR Technology

Augmented Reality (AR) (Azuma, 1977) is a series of complex digital visualization techniques which mix real and digital information to generate new realities and enhance the cognitive processes and the grasp of new knowledge.

In the latest decades, AR was strongly connected to the advancements of mobile technologies and their affordances: GPS and GSM communications, mobile video camera or gyroscope, being also referenced as Mobile Augmented Reality (MAR). Therefore, MAR can be considered a special case of m-Learning, with proven efficiency, mainly in informal K-12 education (Gheorghiu, Ştefan, & Rusu, 2013; Langlotz et al., 2011; Ştefan et al., 2013; Zöllner (2009).

### 2.2. AR Technology

Our research is also in line with Freinet (1968) or Vygotsky (1978) pedagogies which have as objective the active training of students taking into consideration several principles, among which “the centres of interest (centre d'intérêt): the children's interests and natural curiosity are starting points for a learning process” and “the natural method (méthode naturelle): authentic learning by using real experiences of children” (Freinet, 1970: 117-118). In Kukulska-Hulme et al. (2009) a design of a mobile application is presented trying to facilitate the grasp of new concepts by means of the graphic structuring of the information.

Numerous current research studies present m-Learning applications in relation to modern learning technologies, but less in relation with the psychology of learning, in particular that of students of primary and secondary school levels.

## 3. The Methodology

Our research work concerned the development of an m-Learning application for learning local history, as an informal learning digital tool, having the objective of facilitating the children's processes of learning and understanding about past dwellings, technologies and daily life. Therefore, the design consideration was essential and needed to be conducted according to modern psycho-pedagogical theories in order to meet the learners' needs and also engage learners from primary and secondary schools in an active and authentic learning process.

Taking into consideration the visual character of the mobile technologies, and assuming that MAR challenges the learners' creativity, our mobile application was designed by first analyzing how the psychology of the visual can help students learn. Thus, the methodology of our research consisted in a complex approach based on the psychology of the perception of complex visual forms.

In the first stage, graphic diagrams were designed which structured the information under the form of *mental maps*. In the second stage, the information was presented under the form of metaphors and allegories. These elements of our pedagogical strategy were easily integrated in the mobile application for smartphones and tablet computers, supporting the AR technology, i.e. by the overlapping of this additional information on the real data. This augmentation of the real view, displaying places familiar to the students with new digital information, had the role of stimulating the curiosity, and led to the memorization of a high volume of the transmitted information, as well as to the development of creativity and of the ability to interpret historical facts.

### 3.1. Mapping the Cultural Elements of a Community

The first step of our research was to determine the most significant cultural elements for the local identity. We have employed both historical sources and in-situ archaeological experiments in order to reproduce technologies specific to certain time periods and to the sites in question (Gheorghiu, 2001).

The data collected from experiments was modelled to be transferred to the community under the form of *re-enactments*, in which artists and technical experts played the roles of past craftsmen. Our previous experience indicated that the historical information was more easily understood and retained if presented in context. For this purpose some historical contexts were physically reconstructed and were used for the re-enactments.

Due to financial and timing constraints, most of the historical contexts were performed in Virtual Reality (VR), by observing the forms and visual properties of the materials. Consequently, the historical characters and the craftsmen have been integrated in the virtual reconstructions, under the form of 3D scanned images and video footage.

This type of visual complex information has been placed in each relevant location on the local geographical map. For this objective, a customized Google Map was created. In a final stage, layers for augmenting the perception were implemented (Figure 1), as a narrative map containing cultural POIs which presented in a visual manner the history of past technologies and of the contexts in which they took place. This represents an efficient way to retain *the narration*, for the decoding and understanding the local history.

Fig. 1. *A narrative map with cultural elements*
(https://www.google.com/maps/d/viewer?mid=1gryIDYFarTq60gh4-7RSFuQQbEA)

### 3.2. A Mental Map Related to the POIs

The maps, as well as the narrations are rational creations structured on the principle of exploration (Turchi, 2004:14ff). The mental diagrams created from the relationships among the POIs also have a strong mnemonic character, due to the associative character of the memory (Fuster, 1995; Mallgrave, 2011), especially in the domain of visual arts (Zakia, 1997).

Thus, long-term memories (LTM) (Zakia, 1997) related to each place were easy to recall by means of the association with the other points on the map and with all the augmented information overlapped, which resulted in a thick mapping (Budrick et al., 2012:61). Two special cases of the overlapped information were those of the utilization of metaphors and corporal memory, produced by experientiality.

### 3.3. Augmentation: The use of Visual Metaphors

An effective method of capturing the interest of students but also of creating a long-term memory of the data associated with a POI was the utilization of the visual metaphors. It is known that metaphorical thinking is of capital importance in understanding the surrounding world (see the seminal study by Lakoff and Johnson, 2003; Mallgrave, 2011).

The definition of a visual metaphor of each POI on the map was made starting from the significant historical elements of each place. The metaphor was materialized under the form of an art work, generally by means of land-art and installations (Figure 2), which highlighted and allowed experientiality to occur (Pallasmaa, 2011), e.g. the architectural structures or the *rites of passage*, invisible in archaeological record. Another type of metaphor was included in some re-enactments, in which the "objective" historical message was presented under the form of a performance.

Fig. 2. *A land-art, a visual metaphor for revealing a prehistoric settlement wall* (http://www.panoramio.com/photo/124854511)

### 3.4. Augmentation: The Use of Experientiality

Another factor which acts on memory is the personal experience, i.e. experientiality. As stated by Zumthor (2006) "our perception is visceral. Reason plays a secondary role". This phrase can also be expressed as an embodied cognition (Csordas, 1999), or in other words a *thinking through the body* (Hamilakis, Pluciennik, & Tarlow, 2001), which can be exploited for a pedagogical purpose. To augment the experientiality of the student participating in discovery of the materiality of the site, in some experimental architectural reconstructions or in the 3D virtual reconstructions the colours have been intensified to influence the "colour memory" (Zakia, 1997), while the texture of the materials increased the tactile sensations and therefore the visual imagery and memory (Mallgrave, 2011).

### 3.5. The Experiment

Several experimental campaigns were conducted having the following demographic characteristics: a) 2 teachers, one history teacher and one digital facilitator; b) 10 students from Vădastra Primary School; 5 girls and 5 boys; c) 4 students from Luica Primary School; 2 girls and 2 boys. The selection criterion for teachers and students was their level of digital literacy.

During the m-Learning experiment different aspects of the psychology of learning were observed and analysed, with the most important summarized below:

- Learning in a real or virtual reconstructed contexts (the most important aspect in the present study);
- Learning by physical participation (i.e. embodiment) in experiments and re-enactments;
- Learning by memorization of analogue (metaphoric) information;
- Memorization by means of sensorial augmentation of images;
- Utilization of the mobile application supporting the learning objectives already mentioned during the m-Learning sessions.

## 4. Results

These multisensory pedagogical experiments designed to involve the sensorium of the students and to produce a more profound and immersive experience (Dede, 2009) were put into practice with the help of a mobile application and Android devices.

To verify this statement, a case study of identification of some elements of the local prehistory currently invisible was performed. The POIs that represented the border of a prehistoric settlement and the position of a reconstructed prehistoric house trigger a MAR view when the students approach a pre-determined area around the house. Instead of a MAR type game such as a "treasure hunt", we created an educational, discovery-based MAR application labelled "Archaeology at home" (Figure 3) that reconstructs the whole objects from the scanned shards.

To help memorize the displayed images, beside the overlapped text explanations, the augmented images were visually processed to present *strongly highlighted colours and textures*. Some of the architectural elements were presented using land-art as visual metaphors contrasting with the natural forms and the real colours of the archaeological site.

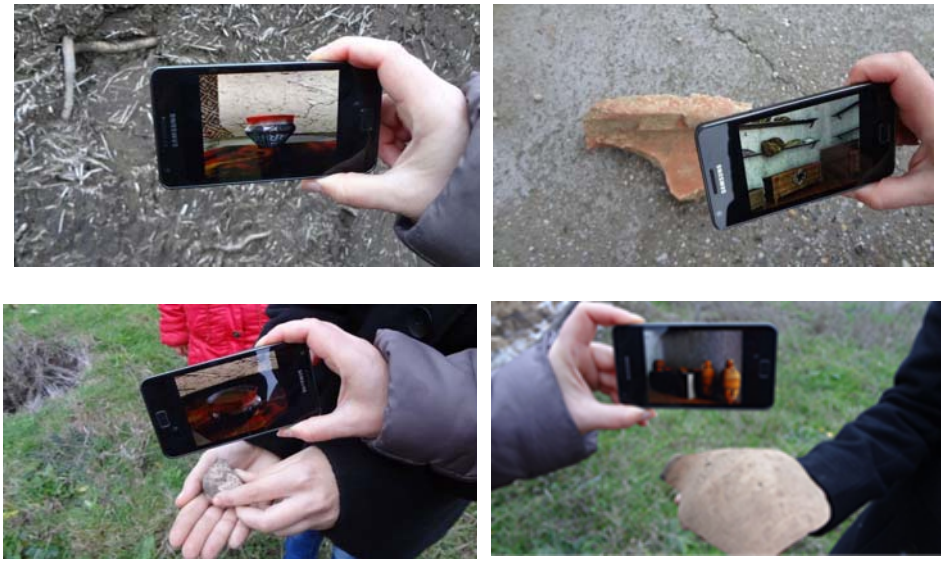

Fig. 3. *Capture from the mobile application "Archaeology at home" showing the reconstructed objects from shards*

## 5. Evaluation

The evaluation of the results had two objectives: a) measuring the learning outcome (Table 1); and b) measuring the usability of the MAR m-Learning application (Table 2). This assessment was conducted with the participation of two primary-secondary schools from Southern Romania, i.e. Vădastra and Luica.

For the evaluation of the learning outcome between 2014 and 2016, the students answered 3 questionnaires posted on the project's Google+ blog (http://tinyurl.com/j9rrpeq) concerning the topics of local history.

*Evaluation of learning outcome with m-Learning* Table 1

| Learning outcome [% correct answers] | 2013 (pre-test) | 2014 | 2015 | 2016 |
|---|---|---|---|---|
| Vădastra School | Knowledge of the local history 10% | Increased by 30% | Increased by 30% | Increased by 30% |
| Luica School | Knowledge of the local history 5% | Increased by 25% | Increased by 30% | Increased by 35% |

For the evaluation of the usability of the mobile application, students answered an online survey created as a Google Docs Form. The answers were given using notes on a 3-item Likert scale, for facilitating the students' choice of answers: I strongly agree, I agree, I strongly disagree (Figures 4, 5).

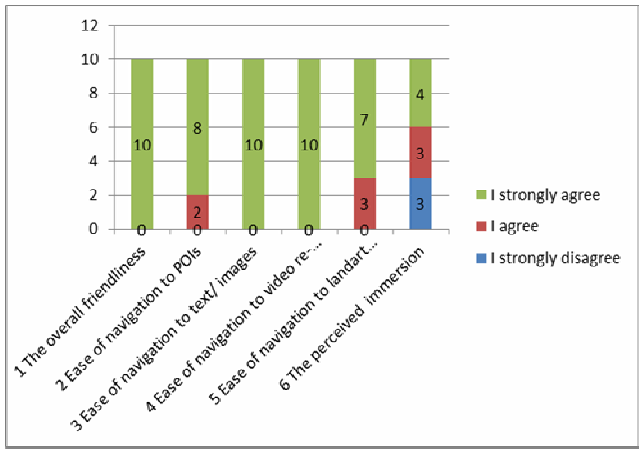


Fig. 4. *Evaluation of the usability of the m-Learning application (Vădastra)*

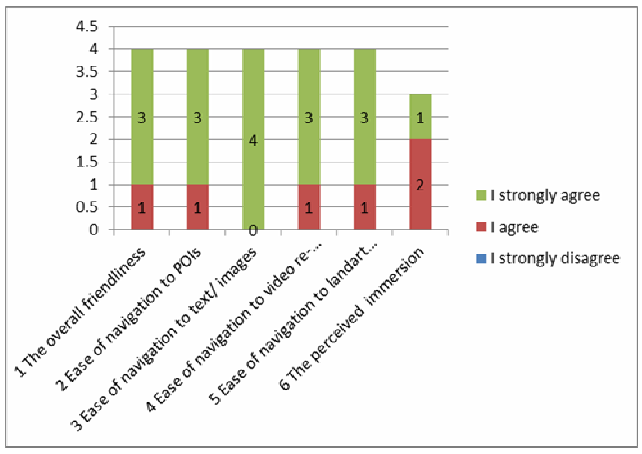


Fig. 5. *Evaluation of the usability of the m-Learning application (Luica)*

## 6. Discussion

The m-Learning experiments were conducted according to the cultural specificity of each context. Furthermore, different learning styles were observed in the two communities, which have been also reflected in the results. Thus, in Vădastra the experiments were organized on a more frequent basis (3 months versus 1 month in Luica), therefore the children acted more independently and rapidly understood the objectives of the experiment.

The following m-Learning affordances improved the process of learning through a psychological impact, as the results of the post-test evaluation had shown, as well as the direct observations:

a) Ubiquity and mobility/discovery-based learning;
b) MAR technology/stimulated curiosity toward a new subject of learning;
c) MAR technology/enhanced interest levels for the local history materialized in the development of the sense of observation/perception of the context;
d) Familiarity with mobile technology/a high adaptability of students to the m-Learning process, i.e. to the use of mobile digital tools;
e) Visual instructional design/development of visual pattern recognition, both in real life and at work with mobile tools.

From the debriefing sessions with the students, one could observe that the information stored under the form of the POIs allowed them to create mental maps, i.e. networked points, overlapped on the real geographical view.

The overall usability of the mobile application was appreciated by 100% for the respondents from Vădastra and by 75% for the respondents from Luica. The instructional design was conceived by the research team, while the usability of the application is partly a characteristic of the commercial MAR platform employed for the development of the mobile application, i.e. Aurasma (www.aurasma.com).

## 7. Conclusion

The paper presented the results of a methodology of designing a better method of learning local history, taking into account the psychology of visual perception for improving the memory, experientiality and immersion of students, by using current AR technology on mobile devices (MAR). An m-Learning application labelled "Archaeology at home" developed as a digital informal learning tool, was experimented at two primary-secondary schools during 4 consecutive years.

We conclude that learning in context as well as the metaphorical or material augmentations (by means of colours and textures) are educational features with high psychological content, which can improve the process of learning and can be easily transferred to mobile learning technologies, by means of which they have the same psychological efficiency. With the support of the MAR technology a mix of familiar (already existing) and unfamiliar (new) data in the process of learning were created, with the objective of producing knowledge and improving learning.

The limitations of the study were associated with the limited sample of users (students and teachers) and number of schools which participated in the experiments, due to the project's constraints. Although objective statistical methods could not be applied, the

research had relevant findings in relationship with the psychology of learning supported by mobile technologies. Future research will be developed on a larger number of subjects and schools or during longer periods of time, to search for patterns in the learning processes supported by mobile technologies.

**Acknowledgements**

The present study was carried out within an exploratory research project "Time Maps – Real Communities, Virtual Worlds, Experimented Pasts" (PNCD II IDEI project). Special thanks to the local communities that were involved in our experimental work. The authors also thank Mr. Bogdan Căpruciu for proofreading the English version of the text, and also to the anonymous reviewers for suggestions regarding the clarity of the argumentation. Last but not least, our thanks go to the enthusiastic students from the Vădastra and Luica schools. Photos by D. Gheorghiu.

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