Effects of Social Constructivist Mobile Learning Environments on Knowledge Acquisition: A Meta-Analysis

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Abstract—This meta-analysis has two aims: a) to address the main effects of social constructivist mobile learning environments on learners' knowledge acquisition and their academic achievements b) to address potential factors regarding design principles and instructional methods for successful social constructivist mobile environments in a blended learning context. We selected 24 articles that meet the inclusion criteria: empirical studies implementing mobile learning in a blended environment using social constructivism approach. The selected studies are not identical in terms of instructional strategies, tools and devices, period and student's expertise level. These factors lead to variations in the magnitude of the effect sizes. The review reveals that there is a positive effect of mobile learning on the knowledge acquisition, learners' achievements, attitudes and motivation despite the high cognitive load. This is shown through the combined effect size. A last remarkable finding related to retention is that students in such environments fulfill their academic tests, but remember less the acquired knowledge after a retention period.

Keywords—mobile learning, instructional approaches, pedagogical activities, social constructivism, collaborative learning, blended learning, meta-analysis.

1 Introduction

We are witnessing an era of an accelerated technological progress characterized by new innovations, high availability of information, easy access to digital resources and, especially, by a permanent presence of mobile technologies in our daily lives. However change is not made without inconvenience. In fact, as mentioned by Kuznecoff

[1], it has become a common occurrence to observe students who are physically present, yet mentally preoccupied by non-course-related material on their mobile devices.

Educational systems around the world suffer from the use of traditional approaches and a weak and unstructured integration of technologies. Most educators are still trapped in the use of Behaviorist methods, which are teacher-centered and based on the transmission of knowledge through seminars, lectures, presentations and exercises. These methods are typically focused on knowledge memorizing and reproduction, characterized by lack of personal involvement in the learning activity. An environment of this kind does not promote social interaction, collaboration, problem solving and critical thinking. We end up with workforce that does not necessarily match the market needs and expectations in terms of creativity, autonomy and efficiency.

Recent education systems reforms around the world have attempted to improve the teaching and learning process. The solution was to implement more interactive learning environments based on technology and constructive methods promoting real-life problem-solving skills and considering the fact that the learner is not a passive receiver but rather a knowledge producer and a principal actor in the educational activity. The implementation of such environments is still fairly limited given the shortage of resources, teachers' reluctance and the lack of easy-to-use educational Frameworks. In this context, countless research projects (detailed below) explored and demonstrated the effectiveness and educational benefits of mobile Learning, a concept largely referred to "a rational and planned use of mobile technologies for educational purposes ".

Since the late 90s, Mobile Learning has been the subject of a number of projects and research. Each of these projects has gone through a wide range of areas using different technologies as PDAs, Cell Phones, Smartphones, MP3 Player; iPods, etc. examples of these projects are as follows:

- Language learning: vocabulary and communication lessons [2], [3] [4], [5], [6], [7], [8].
- K-12 learning, implementing: independent learning: [9], [10], [11], [12], [13], [14] constructivist environments [15], informal contexts [16] [17], etc.
- Sciences [18] and [19], Social science [20], Mathematics [21].
- Mobile devices as a tool to encourage participation and feedback during seminars [22]
- Mobile educational games : [24], [23]
- Learning for student with difficulties, special needs and autist learners [26] [25]

Many approaches were used to explore mobile learning potential effects on learners' engagement, motivation, critical thinking and knowledge acquisition. Social constructivism is one of the most adapted approaches for such environment as it promotes collaboration, social interaction and positive attitudes. If one ponders the implementation of mobile learning using social constructivist approach, a major question is: do learners for such environments reach the goals in a more effective way than learners who receive conventional instruction? And what are the best implementation practices to take full advantage of mobile learning in such context?

In order to find an answer to these questions, a meta-analysis was conducted. The focus is set on teaching methods and educational activities implemented in different experiments. The experiments results in terms of knowledge acquisition, learners' academic achievements and attitudes toward using Mobile Learning are then highlighted. The aim is to identify implementation issues and gather the key success factors of a blended social constructivist learning environment based on mobile technologies.

The first part of the article gives an overview of the educational benefits of mobile technologies and sets the study context. We then present our meta-analysis including a set of experiments implementing mobile Learning according to social constructivist approach and their educational results. And to wrap this up, we will shed some light on guidelines and best teaching practices to fully utilize the potential of mobile Learning.

2 Social Constructivism For Mobile Learning Environments

Recent educational Frameworks bring to surface the importance of interaction, conversation and dialogue in learning and teaching [27]. They aim to put the learner at the center of the educational process whether in-class or online. The goal is to provide an effective learning environment with the ability to engage individuals in a creative and high order critical thinking in regard to subjects at hand [15].

Mobile technologies seem to be the most adequate mean to create such learning environment. Mobile phones have positive effects on learning process and students show positive feedback and positive attitudes. They made better scores [28]. According to [29], the deployment of mobile technologies is increasing students' commitment, motivation and learning construction and it helps improve the learning experience. Mobile technologies enable learning process to take place in a multiplicity of formal and informal contexts and allow better monitoring and guidance for instructors. These learning scenarios vary from structured experiences, supervised by the teacher in semi informal places and we take for example museums and libraries, and experiences in learner's generated-contexts outside of the classroom.

Mobile technologies became omnipresent in our lives through their multiple features allowing mobile learning to overcome time and space limitations of the traditional formal learning. [27] They are at the same time multimedia access tools, connectivity tools, capture tools; representation and analysis tools. Essentially they have helped do the following:

- support students' motivation, encourage their sense of responsibility [30], improve their commitment [31] and promote their learning and retention [32];
- help increasing individual's organizational skills and self-regulatory capacity of learning through planning applications [33] [30];
- support communication, collaboration and knowledge building via real-time data sharing [33] [30];
- offer both individualized and social interactive learning environment [34] and promote student-student and student-teacher interactions [30];

- improve learners' reasoning skills and self-confidence [30];
- support independent, constructivist and contextualized learning [30] [21];
- offer active and experiential learning opportunities [13] allowing quick note taking through photos, sound and video recording;

Mobile learning was mostly implemented using social constructivist approach as it promotes collaboration, interaction. Social constructivism considered to be one of the deep approaches, is characterized by an orientation towards sense-making, constructing of personal understanding and active learning. Some of the descriptions of these approaches are authentic, learner-centered and active [13]. Such paradigms consider learning to be an active and interpretive process of "sense making" rather than facts memorizing [35]. The knowledge acquired is a product of the learning experience and the nature of the learning activity. Social constructivist Learning environments follow the bellow design principles:

- put all the learning activities in a larger task;
- make the learner feel more engaged in the problem solving;
- design tasks and learning experiences to reflect the complexity of the environment in which learners will work;
- set up the learning environment to support and challenge the learner's thinking;
- encourage idea testing versus alternative views and contexts;
- provide opportunities for support and reflection both on the learning content and process;
- Moreover, social constructivism emphasizes on the fact that knowledge construction is an interactive social exchange [36]. The social context is very important in the construction of knowledge through interaction with peers and teachers during learning tasks [37].

The educational benefits of mobile technologies in such contexts have encouraged researchers to explore them in multiple learning scenarios. Scenarios that we have chosen to study and analyze in this article to measure the previously mentioned mobile learning contributions and to help answer the questions: "What is the effect of using social constructivist mobile learning on leaners' knowledge acquisition and learning achievements? Why some environments fail while others succeed? And what are the contexts and educational activities to advocate for a successful implementation of Mobile Learning in a blended social constructivist environment?"

3 Research Questions

Two sets of research question guided this meta-analysis. First, we addressed the main effects of mobile learning on the experiments outcomes: learning acquisition and academic achievements. Secondly, key factors of a successful implementation of such environments in terms of expertise level, instructional strategies, and experiment duration and retention period. We also investigated the influence of mobile learning on learners' attitude and cognitive load.

4 Method

4.1 Criteria Of Inclusion

Before searching the literature for work pertaining to the effects of social constructivist mobile learning, we determined the criteria for inclusion in our analysis.

- The work has to be empirical. Although non empirical literature and literature reviews were selected as sources of relevant research, this literature was not included in the analysis.
- The characteristics of the learning environments had to fit the previously described core model of mobile learning
- Mobile learning should be implemented in a blended learning environment
- Studies should have been published after 2009
- Subjects of study should be students in tertiary education
- To maximize ecological validity, the study had to be conducted in a real-life classroom rather than under more controlled laboratory conditions.

4.2 Literature Search

The review and integration of research literature begins with the identification of the literature. A wide variety of computerized databases were screened: the Educational Resources Information Center (ERIC) catalogue, Elsevier (Science direct), APA PsycNET (APA research database), LIBIS (Library Catalog of the University of Leuven), SAGE Journals, EBSCO's databases, also, the current contents connect was searched. The following keywords were used: mobile learning, mobile learning experiments/studies, higher education, social constructivism, mobile learning case studies.

The literature was selected based on reading the abstracts.

4.3 Coding Study Characteristics

We defined the characteristics central to our review and analyzed the articles we've selected on the basis of these characteristics. Specifically, the following information was recorded in tables:

- First author and year of the publication
- Study domain
- Number of subjects
- Duration and year of study
- Learning strategy/method
- Principal outcomes of the research
- Method of analysis and the statistical values
- Subjects' level

Outcomes related to knowledge acquisition were considered. One condensed table was created that contain potential critical characteristics. The table is included in Appendices A. In the table, the statistical values were summarized and reported as effect size (ES) and p-value.

4.4 Selecting A Method

According to [38]; [39] and [40]; we have chosen a statistical Meta analyses for our purpose. This analysis was supplemented by more inclusive vote counts based on sign test.

Vote counting methods: Meta-analyses use 'vote counting' to compare the number of positive studies with the number of negative studies. Vote counting is limited to answering the simple question "is there any evidence of an effect?" [41]. To do a vote count of directional results, the reviewer must count the number of comparisons that report significant results in the positive direction and compare this to the number of comparisons reporting significant results in the negative direction [38].

In performing the vote count, we have counted experiments reporting significant positive effects and negative findings. Some studies contain multiple experiments, they were all counted.

Statistical meta-analysis: A statistical meta-analysis is the quantitative accumulation and analysis of effect sizes and other descriptive statistics across studies.

Metric for expressing effect sizes: Kline defined the effect size as the magnitude of the impact of the intervention on the outcome. The effect size is recognized by researchers in a variety of disciplines as a simple and straightforward way to quantify the effects of an intervention relative to some benchmark comparison (as reported by [42]). [40] suggests using the standardized mean difference that would be comparable across studies in meta-analysis when the studies do not use the same scale. This metric is appropriate when the means of two groups are being compared. The standardized mean difference (d-index) effect size was used as a metric to measure the strength and effect of mobile learning on knowledge acquisition and academic achievements.

Combining effect sizes across studies: Once an effect size had been calculated for each study, the effects testing the same hypothesis were averaged. Unweighted and weighted procedures were used. Theses weighted combined effect sizes were tested for statistical significance by calculating the 95% confidence interval. [38].

Analyzing variance in effect sizes across studies: The last step was to examine the variability of the effect sizes via a homogeneity analysis. This can lead to a search for potential moderators. So we can distinguish the factors affecting mobile learning effects.

To test whether a set of effect sizes is homogeneous, a Qt statistic is computed. A statistically significant Qt suggests the need for further grouping of the data. The between-groups statistic (Qb) is used to test whether the average effect of the grouping is homogeneous. A statistically significant Qb indicates that the grouping factor contributes to the variance in effect sizes, in other words, the grouping factor has a significant effect on the outcome measure analyzed [38].

5 Results

Twenty four studies met the inclusion criteria for the meta-analysis (Table VI). On the 24 studies, 22 (91.7 %) presented data on learning acquisition and achievements effects, 4 (16.7 %) reported data on students' practical skills effects while 11 (45.83 %) reported data on effects concerning learners' attitudes, cognitive load and satisfaction. These percentages add up to more than 100 since several studies presented outcomes of more than one category. All the information related to included experiments are detailed in table VI (Appendix A); such as duration, scope, the instructional strategies used, year of study and main results. Symbol used in table VI are explained in the legend (Appendix B).

This section is dedicated to our analytical study of experiments using social constructivism methods such as Social Learning, reflective Learning, Cooperative Learning, Project-based Learning, etc.

5.1 Main Effects Of SCML On Learning Acquisition

The main effect of social constructivist mobile learning on learning acquisition is detailed in Table I. A total of 22 studies measure students' academic achievements in a mobile learning environment.

The results of the combined effect size were statistically significant. These results suggest that students in such contexts acquire more knowledge compared to conventional learning environments and get better learning achievements which reflect the positive effect. The vote count shows a positive tendency with 17 studies yielding a significant positive effect and only 4 studies yielding a significant negative effect (unweighted ES=0.624, weighted ES= 0.431, CI: +/- 0.115). Researches [39] have proposed that Hattie's criterion is appropriate for evaluating the effect size in education contexts, in which >0.60 is high, around 0.4 is medium and around 0.2 is low. Therefore we adopt this criterion to interpret the effect size in our research. It was found that using social constructivist mobile learning had a medium effect size for learning achievements.

Distribution of effect sizes: The results of the homogeneity analysis (Table 1) suggest that further grouping of the knowledge acquisition data is necessary to understand the moderators of the effects of social constructivist mobile learning. As indicated by statistically significant Qt statistics, one or more factors other than chance or sampling error account for the heterogeneous distribution of effect sizes for knowledge acquisition.

Table 1. Main Effects Of Social Constructivism Mobile Learning Environments

outcome	sign +	sign -	Studies Na	Average ES		Qt
				unweighted	weighted (95% CI)	
academic achievements	17	4	22	0.624	0.431 (+/-0.115)	176.299 (p=0.000)

all weighted effect sizes are statistically significant
+/- number of studies with a significant (at 5% level) positive/negative finding
A: Number of total non-independent outcomes measured

5.2 Moderators Of SCML

The studies included in the meta-analysis can all be categorized as quasi-experimental. All experiments use a random sampling of the participants and are all based on a comparison between groups belonging to the same institution. Learning environments implement social constructivism mobile learning as a part of a single course. Thus, there are no methodological or design differences between studies.

Expertise-level of students: The experiments were grouped according to students' expertise level as a possible moderator of SCML environment. Table II reports the results of vote counting and effect size measures as follow:

- Nine studies involving 1st year students: 7 with significant positive effect and 2 with significant negative effect
- Two studies involving 2nd year students. The 2 of them reports significant positive effects
- Three studies involving 3rd year students with no significant effect
- Twelve studies involving junior and senior students with 8 reporting significant positive effect and 4 reporting significant negative effect.

The analysis of moderators suggests that significant variation in effect sizes exists for academic achievements (Q_b = 4.804, p<0.0001). The results of these analyses are summarized in table 2. The weighted combined effect sizes are all positive with a high effect size in second year which may be explained by the expertise and maturity gained by learners in comparison with 1st year students.

Retention period: Some studies conducted delayed tests after different retention period to evaluate long term mobile learning effects on academic achievements. Table 3 presents the result of the analyses with retention period as moderating variable. The following categories resulted:

- Five studies with retention period, including 2 with significant positive effect and 2 others with significant negative effect
- 17 studies with no retention period. Twelve of them reports significant positive effect and three with significant negative effect.

Results on homogeneity analysis suggest significant variation in effect sizes for learning acquisition outcome can be attributed to retention period influences (Q_b=19.19, p=0.0001). Weighted combined effect size of studies with no retention period (ES=0.652) is considerably higher comparing to studies with delayed tests (ES=0.032).

Our analysis is in agreement with Zhang, 2011 results. In fact, even if mobile learning help increase students' academic achievements, the mere use of mobile technologies does not help integrating acquired knowledge into long term memory which might explain delayed tests results and the low effect size. There are many factors that possibly explain the small effect size like knowing that all the needed information are permanently stored in our devices and can be retrieved whenever we want (brain external hard drive). Being exposed to much information while using mobile technologies can as well affect memorization process.

Instructional strategy / Educational method: Three main methods were used in the selected studies. Collaborative/interactive learning, individual/autonomous learning and personalized learning. Results are presented in Table 4.

Collaborative strategy was implemented using forums, messaging and social networks. Sharing students' own work and evaluating each other's contributions were main activities used in the studies.

Personalized strategy was mainly based on adapting the learning process to learners' pace using SMS. While multimedia, self-assessment self-observation, note taking and instant messaging were used to implement individual learning.

Homogeneity analysis suggest that significant variation in effect sizes as well as effects on knowledge acquisition (Q_b = 17.62, p=0.000). Weighted combined effect sizes are all positive. A ranking based on the size of the weighted combined effect sizes gives the following: individual learning (ES=0.273), personalized learning (ED=0.64) and collaborative learning (ES=0.918) showing that more the activities favor interaction and respond to students' preferences larger the ascertain effect

Table 2. Expertise Level As Moderating Variable

expertise level	sign +	sign -	studies N	Average ES		Q	Qb
				unweighted	**weighted (95% CI)**		
1st year	7	2	9	0.6795	0.578 (+/-0.195)	26.553 (p<0.0001)	4.804 p<0.0001
2nd year	2	0	2	0.998	0.996(+/-0.51)	19.462 (p=0.35)	
3rd year	0	0	2	-	-	-	
All	8	4	12	0.57	0.292(+/-0.006)	125.48 (p=0.000)	

All weighted effect sizes are statistically significant
Two sided sign-test is significant at the 5% level

Table 3. Retention Period As Moderating Variable

Retention	sign +	sign -	studies N	Average ES		Q	Qb
				unweighted	**weighted (95% CI)**		
retention	2	2	5	0.18	0.032(+/-0.197)	47.621 (p=0.75)	19.19 (p<0.0001)
no retention	12	3	17	0.973	0.652(+/-0.15)	109.485 (p=0.000)	

All weighted effect sizes are statistically significant
Two sided sign-test is significant at the 5% level

Intervention duration: Table 5 summarizes the results of dividing the studies into those that lasted less than one month, 1 semester and 2 semesters. The division leads to more homogeneous groups (Qb=41.45, p=0.000). All weighted combined effects are positive. Studies which lasted longer (more than one semester) report higher effect size. (ES=0.9 , ES = 0.6).

Even if learners are accustomed to the use of mobile technologies in their daily life, integrating those tools to educational contexts still represent a new concept. Thus, learners need more time to use them appropriately and effectively.

Table 4. Educational Method As Moderating Variable

instructional strategy	sign +	sign -	studies N	Average ES		Q	Qb
				unweighted	weighted (95% CI)		
collaborative	5	0	5	0.9766	0.918(+/-0.246)	9.546 (p<0.0001)	17.62 (P=0.000)
individual	13	3	17	0.55	0.273(+/-0.14)	148.092 (p=0.00012)	
personalized	3	0	3	0.7	0.64(+/-0.315)	1.235 (p<0.0001)	

All weighted effect sizes are statistically significant
Two sided sign-test is significant at the 5% level

Table 5. Duration As Moderating Variable

duration	sign +	sign -	studies N	Average ES		Q	Qb
				unweighted	weighted (95% CI)		
2 semesters	3	0	3	0.6	0.6(+/-0.33)	0.087 (p=0.0004)	41.45 (P=0.000)
<=1 semester (3-6months)	10	1	14	1.34	0.9(+/- 0.2)	76.156 (p=0.000)	
<= 1 month (hours-4 weeks)	6	3	9	0.175	0.15(+/-0.18))	59.177 (0.206)	

All weighted effect sizes are statistically significant
Two sided sign-test is significant at the 5% level

5.3 Main Effects Of SCML On Attitude

12 studies report results on students' attitudes towards using mobile technologies. All results are positive with a mean of 3.86 on five-point Likert scale. Learners' expressed their satisfactory and favorable attitudes towards mobile learning integration in educational contexts.

Studies used questionnaire and interviews to assess mobile learning usefulness, students' involvement, satisfaction and interest while and after experiments. Most students' answers "I agree" or "I strongly agree" to following questions:

- Are you satisfied with the experiment?
- Do you thing learning with mobile learning is more fun and effective?
- Did you enjoy the experiment?
- Does mobile learning promote the motivation and engagement?
- Did mobile learning help you to learn better?

6 Findings And Discussion

The research question of this meta-analysis dealt with the influence of social constructivist mobile learning on the acquisition of knowledge. The vote count as well as the combined effect size (ES=0.431) suggest a robust positive effect from social constructivist mobile learning on students' achievements. According to Cohen, in [44], the combined effect for knowledge acquisition is moderate.

6.1 Moderators Of Social Constructivist Mobile Learning Effects

Expertise level of students: The analysis suggested that the expertise level of the students is associated with the variation in effect sizes. The results for knowledge acquisition give a consistent positive picture for different levels. The distribution of combined effects sizes shows a higher effect size for 2nd year students proving that students have to be more mature and experienced to effectively use mobile learning in educative contexts.

Retention period: This moderator analysis indicates that students in such contexts gain more knowledge but remember less the acquired knowledge after a retention period. A possible explanation is that the use of mobile technologies is funny and efficient but students get easily distracted which doesn't help integrating knowledge into long term memory. Also the great amount of information received makes it difficult to recall.

Instructional strategy: In other contexts, research has shown that instructional method and used strategies influence the finding. In this review the effects of mobile learning are moderated by the method knowledge was delivered. The result indicates that more social interaction is used, the larger the ascertained effects of social constructivist mobile learning.

Collaborative learning, personalized and individual learning were mainly used along the studies. Individual learning studies showed the smaller effect size, reflecting that even when using such innovative devices, social interactions should be advocated in learning contexts. It is recommended to favor personalized environments and deliver knowledge according to learner's own pace and preferences but being a member of a community and sharing knowledge and work increase learner's motivation which help him learn more and achieve better.

Duration: The most important conclusion resulting from the analysis of the implementation duration factor seems to be the increasing effect size of mobile learning on knowledge acquisition, if the experiment lasts longer. Thus, integrating mobile technologies in educational contexts still represent a new concept; learners need more time to get used to it. Teachers also need more time to adapt their methods and content to such technologies. Mobile learning experiments should last at least one semester before we get significant positive results.

6.2 Learners' Attitude

Twelve studies report learners' positive attitude when testing social constructivist mobile learning.

Learners were satisfied from using mobile learning. They found it fun, motivating and more effective than conventional classroom. Some students [46] are willing to continue learning via mobile technologies because they increase interaction with both classmates and teachers.

6.3 Similar Studies

[39] conducted a meta-analysis to measure mobile learning effects on learning achievement. The analysis included experiments from 1993 to 2013 implemented for different learning stages from primary to university. It was found that using mobile devices in education has a medium effect size (ES=0.523) for learning achievement.

The study evaluated also the trends in implementing mobile learning and results show that more handheld devices are used in mobile learning experiments which are designed for formal settings.

This meta-analysis also made similar conclusions about mobile learning effects on learning achievements and provide further validation of the findings from the mentioned study. However, our study focuses mainly on experiments involving students from tertiary education and implementing social constructivist approach.

6.4 Other Findings

Analyzing the different studies allowed us to come up with other conclusions regarding social constructivist mobile learning implementation as follow.

Mobile devices – Personalized environments

Developing customized Mobile Learning systems is high cost demanding, and requires great effort from instructional designers and educators. Additionally, they are difficult to adapt against different operating systems (Android; iOS, windows phone, Linux, etc.). Advocating the use of predefined features can overcome these limitations by ensuring an environment easy to manage/maintain, a better usability and common setup for learners. Using learners' own device allows to:

- Promote ownership: students work in a private and personalized environment that drives towards individualized learning.
- Reduce the cognitive load: learners are familiar with their own devices and features which reduces the cognitive load that is caused by being introduced to a new environment.
- Reduce cost: cost is a major limitation when implementing a Mobile Learning environment especially if there is a need for high-performance device.

Technology adopters categories: Here we note five technology adopter categories [45]: innovators, early adopters, early majority, late majority, laggards. With this in mind, we must advocate the following practices, especially during early integration of mobile learning:

- give learners the freedom to choose adequate specifications and preferences of technological tools;
- focus on activities sharing and team working in order to set off the curiosity of skeptics and encourage them to use these technologies;
- demonstrate successful examples of Mobile systems in other learning situations;
- Provide community of practice involving learners (technological natives) and educators considered relatively reticent. Emphasis is placed mostly on students but we must not ignore educators. They are not familiar with the use of mobile technologies in such contexts. There should be a sharing of experience and knowledge with their students;
- Favor activities on PC and mobile devices for the first use versus mobile based platforms. Experiments show that better results were obtained when students had the freedom to choose between different devices, including laptops;

Implementing intercative and collaborative strategies: Learning is a social process of building knowledge and skills. The social dimension in formal settings is particularly ignored especially in transmissive courses where interaction is mainly unidirectional from educator to learner. Using mobile technologies can promote social interaction.

Experiments now favor social networks, microblogs and instant discussions, reflecting the importance of social interaction that represents a motivational and engaging asset. Especially since learners are familiar with such contexts whose implementation remains easy. This dimension promotes reflection. And by definition, reflection represents the human capacity for higher-order thinking, specifically, our Ability to make connections between thoughts [45]. Developing this feature via mobile technologies can be done through microblogs, supervised discussions on social networks regarding various topics. This represents an opportunity to criticize students' own work and that of others, and it opens windows for reflection.

The added value of mobile technologies for collaborative learning is the ability to integrate real-world problems. In fact, activities such as investigation, academic projects and internships can be effectively implemented. Mobile technologies can be used to collect data (text and multimedia), to receive tutors' feedback and mentorship and to assure that all group members are up to date on overall work progress and as a result guarantee effective work. Mobile technologies can also be used as a documentary source or a reference tool and as a mean to simplify the integration of scaffolding; tutors must be clear on objectives and should assign roles to each student when needed. Moreover, students can use moblogs or Facebook pages for instant sharing results, to be aware of other groups' progress and to use comments for advice and orientations. Accordingly, widen the activity scope and allow everyone to work in synergy. Collaborative activities promote role shifting, enhance real-world problems solving and critical thinking.

Multimedia tools: Social networks, messaging and RSS feeds should be advocated when implementing mobile learning, but also multimedia. [47] indicated that the multimedia was perceived by students with substantially high value. This suggested that the mobile application with multimedia inclusion not only enhanced cognition, eased off learning anxiety, and heightened learning motivation, but also provided enough visual and auditory support to meet learners' learning needs in reading and listening skill development.

7 Conclusion And Future Work

In the previous publications we focused on mobile learning environment features and components [48]. We also proposed the adaptation of the MISA- Method of engineering learning system- for Mobile Learning design [49]. This requires incorporation of Mobile Learning specifics and appropriate learning and teaching approaches. The article at hands reports to this context, and enables extraction of the best teaching practices in a mobile learning environment.

All the studies reviewing mobile learning show the importance attached to the use of mobile technologies through multiple experiments and research projects in different contexts and disciplines. The survey conducted on 2012 by EDUCAUSE, Center for Applied Research, on Mobile IT in higher education, states that students are the ones that are driving the adoption of mobile computing devices, such as cellphones, smartphones, and tablet computers, 67% of surveyed students believe that mobile devices are important to their academic success. This does not exclude the limitations of this paradigm and the need to structure and regulate the implementation of Mobile Learning for better results.

Technology integration in learning and teaching processes cannot be made randomly and without pedagogical basis. As reported in [1], a survey examined students' use of digital devices, while in class, for non-classroom-related reasons. Across six universities and over 700 participants, findings show that, while in class, 86% of participants used these devices for texting, 68% for emailing, and 66% for social networking. Thus we need guidelines with mobile learning best practices and instructional methods.

Mobile learning should not replace traditional education but rather help students and teachers by providing services that facilitate teaching and learning. [50] The most successful experiments are those that have used mobile technology as a teaching tool in a blended learning environment.

Nevertheless there is an urge to work within the limits of mobile devices and to consider breaking down tasks as to match mobile technologies environment [24]. Moreover, Mobile learning should be distinguished from e-learning. Recent researches (e.g [51]) still define mobile learning as a mobile form of e-learning.

Effective integration of mobile technology into the teaching and learning process can only be successful by appropriate teaching methods. Reason why, we have chosen to study mobile projects implementing deep educational approaches, because they promote learners' interactivity, sharing, collaboration, autonomy and independence and most of all they are learner-centered. Every single teaching method, subject of our study, is adequate to a specific context, to make the most of mobile technology

An implementation that respects previously presented practices promises to solve reluctance problems to new technologies, reduce the digital gap between generations and improve learner' information literacy. The use of technology in learning environments with the proper guidance and monitoring enables the learner to acquire the skills needed for lifelong learning.

Experiments are concentrated in Europe, Asia and America; this does not exclude Africa from this trend where mobile Learning is becoming more and more appealing. Africa as an emergent continent represents a serious opportunity of growth in terms of mobile subscribers; representing 8% year to year margin increase between 2008 and 2012. In terms of forecasts, Africa and Latin America are expected to show a year to year combined growth rate of 7% to 8% for the next 5 years. According to the same source, in terms of penetration rate of mobile telephony in the population (130% in 2013), Morocco has moved from 56th to 52nd place out of 144 countries. This growth is attributed to the multitudes of mobile service providers and the competitive market nature.

With that in mind and moving forward, we will use educational system in Morocco as a study case. Investigation is already in place regarding the acceptability and perception of postgraduate students toward Mobile Learning and its ability to improve the quality of the Moroccan education system

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9 Appendix A

See Table 6.

10 Appendix B – Legend For Table 6

Study: First author and the year of publication
Institute: Institute in which the experimental condition has taken place
Level: Participants' level

- 1 = first year,
- 2 = second year,
- 3 = third year,
- A in every year,
- L: last year

Subjects: Number of subjects in the experimental condition (social constructivist mobile learning) / number of subjects in the control condition
Strategy: Instructional strategy used in the experimental design

- C: collaborative learning
- Ind: Individual learning
- Per: Personalized learning
- PBL: Problem-based learning

Retention: Is there a retention period between treatment and test?

- Y: Yes,
- N: No

Operationalization dependent variable (Operat. AV)

- MCQ: Multiple Choice Questions
- Questionnaires
- Practical case
- Skill exam
- Vocabulary test

Results

- Effect size (ES): the sign of the ES shows if the result is greater (+) or smaller (-)
- If it was not possible to compute an ES, than only the sign of the results is given

P-value: ns= not significant

Table 6. Studies Measuring Learning Achievement

Study	Institute	Level	Subjects	Duration	Strategy	Retention	Operat. AV	Results	
								p value	ES
Jaradat, R. M. (2014) [46]	Princess Nora University, Saudi Arabia.	1	30/	2 semesters	C	N	MCQ	p<0.005	+
Basoglu (2010) [28]	National Formosa University, Taiwan.	1	29/29	six weeks	Ind	N	MCQ	p<0,05	0,1769
de-Marcos (2010) [52]		3	28/28	1 semester		N	Questionnaire 1	0,328	0,3822
							Questionnaire 2	0,305	0,3884
							Questionnaire 3	0,411	0,3075
							Questionnaire 4	0,608	0,1945
							Overall	0,357	0,3468
Garcia-Cabot (2015). [53]		L	14/16	1 semester (15 weeks)	Per / Ind	N	Practical case	0,15	0,5761
					C		Practical case	0,056	0,7676
							MCQ (20 Q)	0,264	0,45
							Overall	0,04	1,0135
Agca, 2013 [54]	Gazi University	A	40/	14 course hours		N	academic achievement test	0,008	+
Martin,2013 [43]	southeastern university	A	36/35		Ind.	N	MCQ (10 Q)	0,009	-0,524
			36/38				MCQ (10 Q)	0,051	-0,6538
Azar, 2014 [55]	Zaban Amooz, Iran	A	35/35	6 weeks	C	N	OPT test (vocabulary)	<0,05	1,561
Kim, 2015 [56]	a university in South Korea	A	30/30		Per	N	MCQ	0,007	0,4148
Hsu, 2013 [57]	university in Taiwan	A	33/42	22 week	Per	N	MCQ	<0,05	0,5833
			33/42		C		MCQ	<0,05	0,485
Lin, 2016 [58]	Taiwan		20/16		PBL	N	skill exam	0,003	2,4565
Zhang, 2011 [59]	China university	A	40/38	3 weeks		Y	vocabulary test	<0,05	0,5488
				after 5 weeks			delayed test	>0,05	0,1398
Oberg, 2013 [60]	Japanese university	1	61/59	one quarter (15 sessions)	Ind	N	skill-based test (1st)	0,203	0,2555
			61/61				skill-based test (2nd)	0,097	0,3067
			59/60				skill-based test (3rd)	0,003	0,4842
wang, 2016 [47]	Taiwanese University	1	35/32	1 semester	Ind/Per	N	simulated TOEIC test	0,167	0,3638
			33/30				simulated TOEIC test	0,000	1,7928
			32/34				simulated TOEIC test	0,024	0,6778
Kuznekoff, 2015 [1]	Midwestern university	A	27/32		Ind.	Y	MCQ	<0,05	0,2467
			29/32		Ind		-	<0,05	-0,4285
			27/32		Ind.		-	0,015	-0,428
			30/32		Ind.		-	<0,05	-0,519
			27/32				free recall	<0,05	-0,01

Study	Institute	Level	Subjects	Duration	Strategy	Retention	Operat. AV	Results	
								p value	ES
Li, 2013 [61]	American university	all	19/	16-week semester		N			+
Kondo, 2012 (1)[62]	Kyoto University	1st year	42/46	1 semester	C	N	listening	0,536	-0,1599
							reading	0,031	-0,02
Kondo, 2012 (2) [62]	Kyoto University	1st year	15/	1 semester		Y	post test		+
							delayed test		-
Kuznekoff, 2013 [63]	large Midwestern university	1st, 2nd and 3rd year	14 /19		C	Y	Low distraction - MCQ	>0,05	-0,44
			14/19				high distraction - MCQ	<0,05	-0,884
							Low distraction - Free recall	>0,05	-0,543
							High distraction - Free recall	<0,05	-0,766
Alemi, 2012 [64]	Sharif University of technology in Tehran,	1st year	28/17	16 weeks		N		0,42	0,4884
			28/17					0,864	0,8637
Thabit, 2012 [65]	King Abdulaziz University	1st year	15/45	1 month	C	N	Mid test	0,34	0,2811
							final test	0,03	0,6945
Saran, 2012 [66]	English Preparatory School	1st year	18/17	4 weeks	C	Y	post test	0,001	0,8344
							retention test	0,211	1,2102
			18/18		C		post test	0.000	0,525
		2	17/17		C		post test	0.000	1,0395
							retention test	0,022	1,418
			17/16		C		post test	0.000	1,048
							retention test	0,005	1,3139
Baleghizadeh, 2010 [67]	Kish Language Institute in Isfahan	1	20/20		C	N		0,003	0,9455
Motallebzadeh, 2011[68]	Islamic Azad University (IAU) of Mashhad, Iran	1	17/17	5 weeks	C	N		0.000	3,36
Motallebzadeh, K., Beh-Afarin, 2011[69]		1	20/20	5 weeks	C			0.000	2,2588
							retention test	0,012	0,7312