A Synchronous Collaborative Service Oriented Mobile Learning Architecture (SCSOMLA)

Charles Wamuti, Stephen Kimani, Michael Kimwele

Abstract: Despite the growth of mobile learning and advantages offered, such as portability, social interactivity, context sensitivity, convenience, inclusive and non-discriminatory, independence data collected showed that there is low use of such mobile learning systems. Investigation, on mobile learning sought the participation of users and availability of users, the mimicability of the class room, and the various implementations in institutions and attempts at synchronous collaboration in existing Mobile Learning based infrastructure. As seen in the research, the social aspect of smart mobile phones has not been leveraged to be incorporated in mobile learning infrastructure, where a class is seen as a social place. Mobile Learning has not allowed a collaborative (part of the social constructivism theory) approach to users of these technologies which have focused on technology other than the fundamental of teaching – collaborative pedagogy. Options that would enable group collaboration would be necessary to increase the quality of service for those teaching and learning in a mobile environment. With this lack of environmental feel, and exposing the services that are offered in the teaching business, service oriented architecture, a mature technology, was applied due to its seamless integration to business processes. Research explored; what standards have been proposed regarding Service Oriented Architecture (S.O.A. and M-Learning, how has time-based collaboration been archived in other m-learning systems and how can time-based collaboration, S.O.A. and M-Learning be wrapped around? An architecture based on the intersection of time-based collaboration, S.O.A., and M-Learning, then was designed and evaluated. Results of a user study comparing a mobile learning system integrated social collaborative pedagogical features suggest that an enhanced social presence was achieved where users worked together similar to a conventional classroom.

Index Terms: Service Oriented Architecture, Collaboration, Pedagogy, Mobile Learning, Business Process Engineering, Object Orientation, Conversation analysis.

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1 Introduction

Mobile learning involves the use of mobile technology, either alone or in combination with other information and communication technology (ICT), to enable learning anytime and anywhere [1]. Various authors have identified advantages of m-learning which include portability, Social interactivity, Context sensitivity, convenience, inclusive and non-discriminatory, independent [2], [3], [4]. At the same time, growing 45 percent annually for the past four years, mobile cellular subscriptions have hit 5.9 billion throughout the world. The world population is just over 7 billion; in 2014, the world's population has already surpassed 7 billion [5]. Mobile broadband (the marketing term for wireless Internet access through a portable modem, or mobile phone) (at the end of 2011) was at 1.2 billion users [6]. With this high number of devices, more use of the devices in learning should be used. As data collected showed, there is no much mobile learning taking place in Kenyan institutions. This was despite 51% of the students, teachers, and administrators who filled questionnaires having knowledge of some form of mobile learning implementation. Further, the data showed that 86% of the 51% did in fact leave the mobile learning environments. Authors have identified problems such as students Embracing M-Learning are disjoint and Student tutor relationship severed when the student is away [7].It was noted the lack of use of current M-Learning systems. The study sought to find out what standards have been proposed regarding S.O.A and M-Learning, how has learning collaboration been archived in other m-learning systems, and how can collaboration, S.O.A. and M-Learning be wrapped around. Other authors such as [8], have come up with alternative solutions applying S.O.A. but they do state that m-learning has not allowed a collaborative approach to students using these technologies. They have focused on technology other than the fundamental of teaching – pedagogy (social). [9] Recognize that options that would enable group collaboration would be necessary to increase the quality of service for those teaching and learning in a mobile environment. Collaboration, as part of the social constructivism theory, emphasises the importance of intrinsic learning through social interactions [10] (cites Vygotsky). [11] propose a platform that attempts to put collaboration in a S.O.A. based architecture, however, their architecture does not guarantee platform independency and fails to show how the collaborative structure work together intrinsically. To address this problem, [12], propose the "Global architecture for the mobile blog". Despite the exponential growth of smart phones, their proposed and developed architecture fails to take advantage or the synchronicity (real-'timeness') of smartphones. Focus on technology other than the business operations has been focused on leading to a techno centric approach while developing mobile-learning applications. Author [13] suggests seven tips to develop M-Learning content. They are; Design for the Small Screen, Keep it short. Keep it simple, Talk to the hand, Keep designs colorful but simple, Make it relevant, and finally Make it ongoing and flexible. The problem with this is that they are just opinions on usability and fail to reflect on other critical aspects as the social aspect. Thus [14] proposes a model known as FRAME (Framework for the Rational Analysis of Mobile Education).

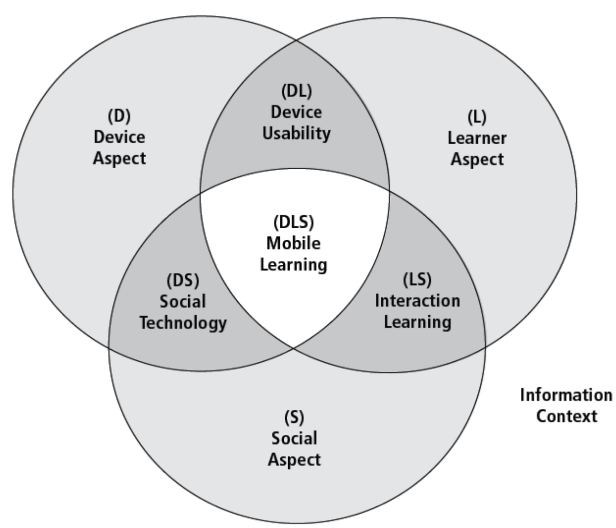

***Figure 1**: The FRAME Model*

Such a model is an acceptable reference point while developing an M-Learning application since it does not overlook any aspect (pedagogical). From the user interface, to the collaborative aspect highlighted in social technology. A pedagogical approach with respect to learning business operation is used. S.O.A. is a journey that promises to reduce the lifetime cost of the application portfolio, maximize return on investment in both application and technology, and reduce lead times in delivering solutions (such as m-learning accessibility) to the business [15]. It takes an approach to align business processes and needs. Ergo, in alignment advantages cited by [16] and m-learning, first, mobile learning is not about rapid authoring, it's about rapid reuse. In other words, automating the assembly and reassembly of content and media assets in myriad different ways based on what the end user want to see [17]. Pedagogy is used as the foundation of the architecture by identifying learning methods applied by the sample institutions. Pedagogically, while Emic Analysis is just one the techniques of analyzing the classroom society, surely, such analysis directly contribute to model business architectures for mobile learning [18]. The author continues to say that Conversation analysis is applied as a detailed analysis of the transcribed data of talk occurring in natural situations.

2 Materials and Methods

2.1 Participants

The researcher proposed to use questionnaires to collect the requirement of the m-learning architecture and prototype development. The questionnaire was both open and closed end questions. These data will be elicited from stakeholders, primarily, the students, lecturers, and systems administrator. A sample size of 112 respondents were categorized as such; 30 were tutors/lecturers/educationist, 82 students, all from 3 different universities, and 8 administrators some from universities, but most importantly, two were from well refuted institutions. Various institutions of higher learning and one privately controlled tuition for high school student were studied. Before the questionnaires were given out, the researcher collected information on three popular mobile oriented learning application and others that is; Moodle, Edmodo, Room21 SOMA, and BlackBoard Mobile. The subject included administrators to the systems, teachers and learners. While two of the institutions of higher learning were located in urban and semi-urban localities, the privately controlled high school and one higher learning were in rural areas. System logs and activities were examined and questionnaires were finally administered. Data and analysed using both SPSS and MS Excel collected was meant to answer; 1) Attempts at synchronous collaboration in existing Mobile Learning based infrastructure - any implementation of a formalized mobile learning system, 2) Mobile Learning Implementations in institutions, 3) Participation of users in a Mobile Learning environment, 4) Mimicability of the class room by existing Mobile Learning based infrastructure, 5) Availability of users in a Mobile Learning environment during mobile learning based sessions, 6) Ownership or intended ownership of a smartphone. From the data collected, a number of facts could be draw, 57 respondents were aware that there exists a mobile learning application running in the organizations they were in. By ratio techniques, this amounted to about 51%, slightly over half sample population. Despite this being over half of the percentage, which was somewhat commendable, the percentage was still small given that mobile learning is supposed to fully compliment traditional learning. Thus, about half of the population (49%) did not know if such a valuable learning asset (Mobile Learning) existed, even though a large percent had some form of mobile learning applications and access to such as this was revealed later. It was sought to find out the threshold of users in a mobile learning system. This was because if users did not stay long enough (Any implementation of a formalized mobile learning system.), synchronous collaboration would never be achieved. Among the 51% who knew there existed a mobile learning system within their campuses, 77% (44 out of 112) of who participated in the mobile learning system; where 86% (38 of 44) left the mobile learning system in less than 10 minutes. It was discovered that 75% (6 out of 8) of the system administrators interviewed felt that the technology that their mobile learning applications was running on (networks, operating systems, hardware) was outdated. Beside the systems administrators who said they were always available in a Mobile Learning Environment, the other respondents had a low turnout. Numbers showed that slightly more than a third (38%) (of both the lecturers and student who did participate) strongly agreed that learner and/or tutors were available for a learning session using Mobile Learning. However, over 90% (67 out of 74) of the students and slightly over three quarters (77%, 23 out of 30) of the lecturers felt that most mobile learning applications were boring, tedious, and slow to use. Various methods were used to construct the architecture. Data collection methods such as questionnaires, interviews, were applied. To put the architecture together, various literature was examined, and techniques involving service engineering in software engineering were applied. The primary means of data collection was done by questionnaires and interviews. There were a total of 112 respondents. While 67% the population owned a smart phone or planned to buy one, and over half the population (51%) knowing that there were some form of mobile learning implementation within their institution of study, 86% showed disinterest in the mobile learning application as data showed that they quit (not necessarily having completed their tasks within the learning system), only within 10 minutes of usage. This is short than most class duration times, especially for adults who can actually be in class for over 3 hours. Among the problems raised was that users could not know when whom was online thus, among the participants on the learning platforms available. Authors such as [19], insist on the alignment of business and information technology. Lack to this, the authors say that the system used by users is never adopted, but rather, it feels like a new environment. 81% felt that the mobile learning applications did not resemble class learning. For example, they all mentioned lack of the social aspect where a learner can ask a fellow learner or a tutor a question during the learning session. Conversation analysis (CA) would allow a chat in the virtual classroom. The author explains that the main aims of CA are to characterize the orders of organization in 'talk-in-interaction', and to uncover the methods which interactants use to develop mutual understanding and achievement of these orders of organization in interaction. It (CA) involves four phases; (1) getting or making a recording of natural interaction; (2) transcribing the tapes, in whole or in part; (3) analyzing selected episodes; (4) reporting the research. [20] Explains five guidelines for a math teacher in what she describes as "math-talk". Four of them are; 1) The use of rich math tasks, which translates to rich content quality within the proposed architecture, 2) Justification of solutions, which guides the teacher – student quality communication and architecture feedback system, 3) Student – student quality communication, and social engine quality control, such as group work, 4), A translation of formal communication mechanisms in arithmetic related communication. In the teacher-student communication, [29] found three characteristics of teacher talk in universities during a lecture discourse. Two of them are architectural communication, such as chats quality matter and assessments need to relate to objectives expected to be learned by the student. Authors [21], [22], have signalled related aspects on the business architecture of learning. With a clear indication of such kind of social based concepts for a SCSOMLA, the elusive techno-pedagogical bridge in learning cited as a core problem in failure to mobile learning success, an extension to [23] work, has been demonstrated in similarly closed (this type of classes are exclusively conducted in computer labs where everyone in the classroom is using a computer with a dedicated software for classroom management.) boundaries of four walled learning experiments and tested on some lessons using technology and classroom interaction. This would see the respondents of the questionnaires get a classroom oriented approach while using a smart phone to learn. Based on 1) General description of the technique and why it should work, 2) How general are the effects of this technique?, 2a) Learning conditions, 2b) Student characteristics, 2c) Materials, 2d) Criterion tasks, 3) Effects in representative educational contexts, 4) Issues for implementation, 5) Overall assessment [28] lists ten such learning techniques. They are; 1) Elaborative interrogation, 2) Self-explanation, 3) Summarization, 4) Highlighting/underlining, 5) Keyword mnemonic, 6) Imagery for text, 7) Rereading, 8) Practice testing, 9) Distributed practice, 10) Interleaved practice. Potentially all these facets can be implemented in a Mobile Learning architecture in a generalized fashion. However, according to the authors, not all are suitable. Indeed they identify only two effectively suitable techniques that are applied to learning and that were adopted for this work. They are distributed practice and practice testing, in line with sample institutions. This combination of theory, research, and practice makes cooperative learning one of the most distinguished of all instructional practices [24]. In cooperative learning, the instructional use of small groups so that learners are able to work together in a manner that enhances both group and individual learning [25]. Cooperative learning, according to [26], is represented with five element. They are: 1) Positive Independence (sink or swim together) - Each group member's efforts are required and indispensable for group success, 2) Face-to-Face Interaction (promote each other's success) - Orally explaining how to solve problems 3) Individual and Group Accountability (no hitchhiking! no social loafing) - Keeping the size of the group small. Also, here giving an individual test to each student and randomly examining students orally by calling on one student to present his or her group's work to the teacher (in the presence of the group) or to the entire class. Groups are observed and the frequency with which each member-contributes to the group's work. A helpful practice is assigning one student in each group the role of checker. The checker asks other group members to explain the reasoning and rationale underlying group answers. Finally, having students teach what they learned to someone else, 4) Interpersonal and Small-Group Skills -Social skills must be taught and include; Leadership decision-making, trust-building, communication, and conflict-management skills, and 5) Group Processing - Group members discuss how well they are achieving their goals and maintaining effective working relationships. Member actions are also described as either helpful of not helpful and finally, make decisions about what behaviors to continue or change. Supported for such learning techniques in SCSOMLA, given the strong social structure, not only will guide the social interaction as recommendations suggested by the authors but would pedagogically root the architecture. Thus summarily, clearly, pedagogy influences the design of the social architecture to avoid a techno-centric approach in designing mobile learning architectures. From the general SCOSMLA, conceptually, the high-level synchronous collaborative service-oriented architecture of the learning environment is described with the following services:

1. Assessment – Supports testing of the learners
2. Content – Supports access to learning material
3. Feedback – Supports the relay of performance of the learner after an assessment is taken.
4. Mark – Supports the marking of a learner's assessment.
5. Collaborate – Supports the social interaction between the learner and the teacher within the class.

2.2 The Conceptual Architecture

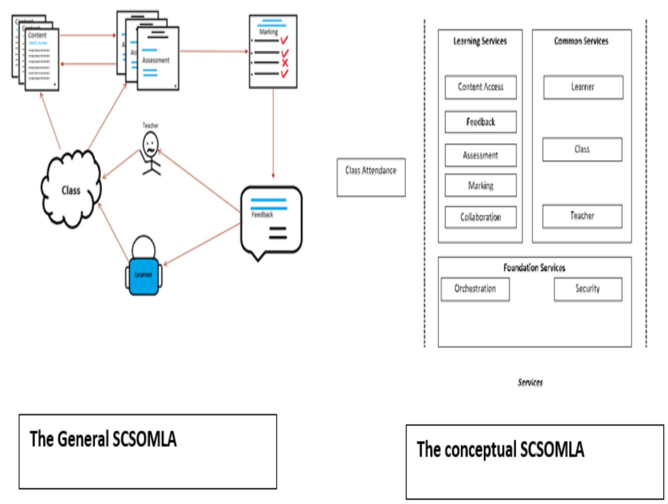

Figure 2: *The general SCSOMLA (left) and the conceptual SCSOMLA (right)*

2.2.1 Common Services

Learner – Manages the learner throughout the course including class registration, performances, completion. Also manages against rules suspension and resumption of classes.
Teacher – Manages the teacher throughout the course of interacting with the student in class.
Class – Managers the class throughout the course. This includes numbers of students and scheduling of classes.

2.2.2 Foundation Services

This are a result of the architectural requirements from the business rules (Orchestration), to access of class, results, and tracking what everyone is doing (Security). While business process modeling (BPM) in systems engineering is the activity of representing processes of an enterprise, so that the current process may be analyzed or improved [27], the architecture makes use of business process engineering and software engineering techniques as shown in Figure 3 (a) and Figure 3 (b).

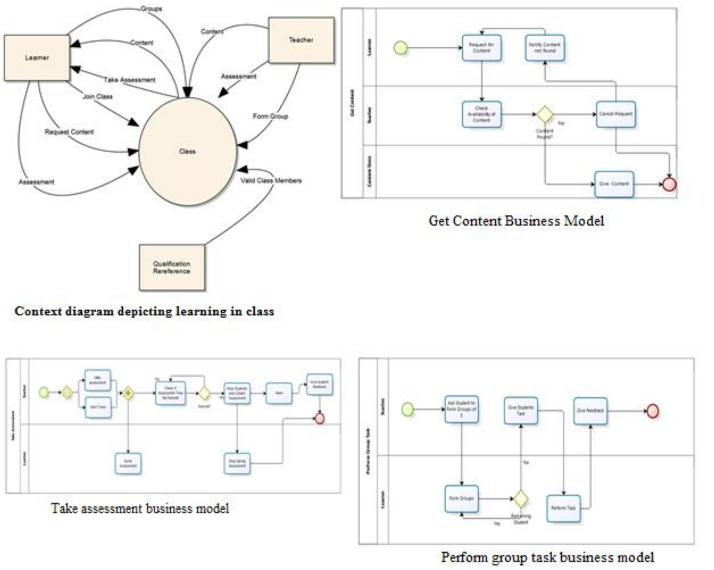

***Figure 3 (a)**: Business processes modelling for the classroom activities and services*

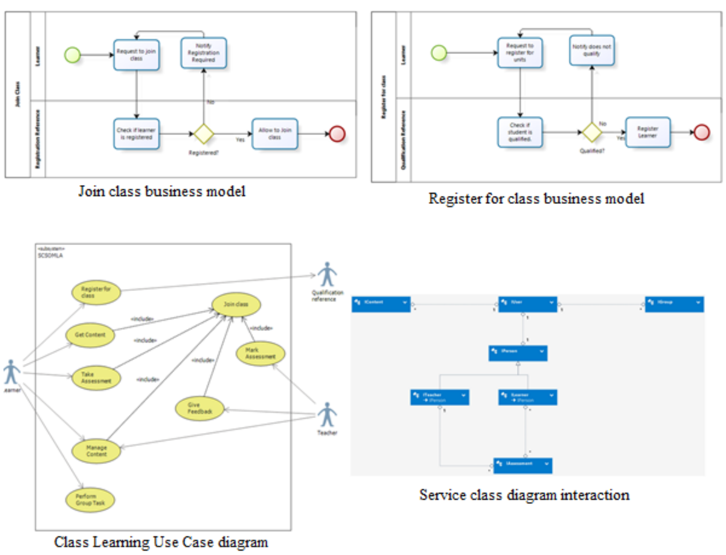

***Figure 3 (b)**: Business process enginering and Object Analysis and Design for class activities*

3 Results

After an appropriate design of the architecture was discovered was developed, deployed and evaluated. The results are presented. The implemented architecture yielded Figure 4 (A) Login Page where after users have been registered, they have to login the system as a security check. This is done by asking for a password and a user name. When the user entered the correct credentials, he proceeded to join classes and groups. This is done by selecting the class or group that the user intends to join as in Figure 4 (B) below. On selecting the class one wanted to join, they users (learner and teacher) were presented with a blackboard where all class conversations takes place. In the blackboard, spell checking capabilities and text prediction are set to assist the user when typing. Since, the spell checking and text prediction are in English, this was, communication between users is standardized as in Figure 4 (C [i]) and C[ii]). As the learner and the teacher interacted in class room, when there is need for material exchange, the architecture offered a Content Wall where all the content is displayed as in Figure 4 (D). Among the material that could be sent, a learner was expected to take assessments following investigated pedagogy. These assessments could be handed to students from the Assessment Form, and once the learner completes the assignment, they can submit it to the lecturer for marking via the upload content section as showed in Figures 4 (E) and (F) below.

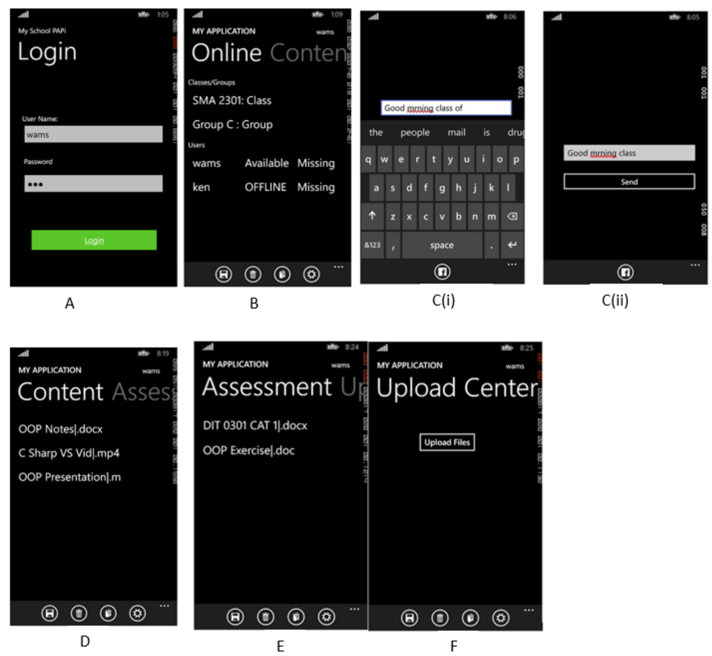

***Figure 4**: User interfaces of designed and tested architecture implementations.*

To evaluate the architecture performance, 3 constituent colleges and 1 high school (the high school was evaluated during tuition studies for students.) class used the system (the system is a mobile application that implements SCSOMLA.): In the 3 colleges, there were 4 classes of students, each class with 30, 20, 28, 36, numbers of students and in the high school, 1 class was used as a test sample and had 16 students. This gave a total of 130 test subjects. From the social nature of the architecture, all work was done collaboratively by formation of groups as a starting point in form of classes. Participation of users in a Mobile Learning environment is highlighted as the amount of time the users and performing activites within the mobile learning application was analyzed by use of system logs.

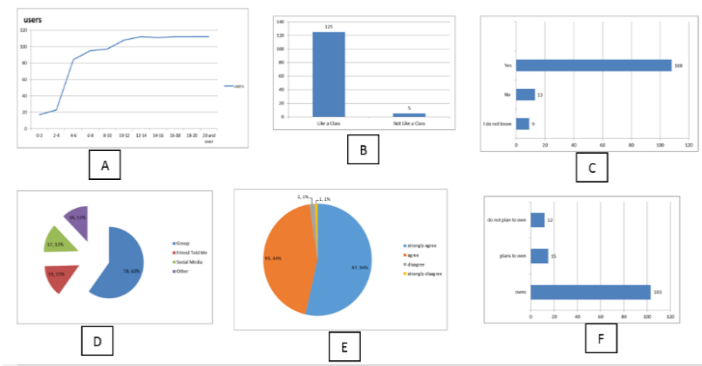

Figure 5: *Evaluation perfomance of implemented architecture.*

In 5 minutes, as Figure 5 (A) indicates, out of a common exam, there was a sustained participation of the students with the mobile learning architecture. This was high high improvement as compared with the previous data collected. As seen, even after 10 minutes, there was an increase in the number of students and activities. The author attributed this to the class-like environment that was offered by the architecture. Testing to see how many users felt they were in a traditional four walled classroom, 96.1% of the users could associate the activities and the mobile learning application with the traditional classroom as Figure 5 (B) shows. It was noted that there was an increase in knowledge about existence of mobile learning applications in th various organizations. There was 32% increase in the knowledge of existence of a mobile learning application with the institutions (83% - 51%). Chart in Figure 5 (C) and (D) revealed that most users got to know about the system due to the groups created and from whence they got to know about the mobile learning platform (SCSOMLA). Other reasons the users became aware of the mobile learning application was through being told be friends about work that had be shared in a group, for instance. Of the 125 users who felt that the systems did mimick an actual four walled classroom, 98% felt that other users were available during learning sessions as indicated by Pie Chart (E). This could be confirmed by the system logs and looking at the participation of use of the architecture. To investigate and draw conclusions on the sustainability in terms of ownership or intended ownership of a smartphone when queried about smartphone ownership, after collecting evaluating the architecture, as highligyhted by chart Figure 5 (F) 90.7% of the respondents either owned or planned to own a smartphone. This was about 23% increase before the evaluation and implementation of the architecture.

4 Discussion and Conclusion

The purpose of this study was to test the efficiency in usage and applicability of todays mobile learning systems and to solve the issues related to failure of adoption of mobile learning platforms, from an architectural perspective. A mobile learning synchronous collaborative architecture, as seen, proves to give the immersive ness of being in a class, unlike tradition Mobile-Learning applications that communication is delayed in checking third party tools. Class communication is archived by chatting between learners and teachers in a blackboard. Some existing e-learning environments were presented, focusing on solutions that were developed especially for mobile devices, showing their advantages as well as drawbacks. Also, a survey was conducted in order to learn details about experiences and expectations of potential users. The responses to the questionnaire published in this thesis helped us to understand the usage of mobile phones among our target group. In addition, they helped us to identify the most important features that have to be available in a successful mobile learning environment. An amiable design for an architecture to solve the problems was developed using software engineering concepts. Being a social network on itself, SCSOMLA was also able to integrate with social networks, such as Facebook, to share content. Also, content transfer within the architecture was archived. Also, by integrating with online stores, such as Windows Store, there was no limitation to the type of content that could be transferred for learning.

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