Smart Enhanced Context-Aware for Flipped Mobile Learning: SECA-FML

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1 Introduction

Today the development of information and communication technologies has changed the way of teaching and learning [1]. The mobile technologies use has given learners the opportunity to test new learning methodologies. And especially the use of mobile devices that offer much more benefits compared to the fixed devices [2].

In parallel with this development, the learning methods have known a great change, starting from distance learning (D-learning) [3], E-learning, which is defined by Urdan and Weggen [4] as "the delivery of content via all electronic media, including the Internet, intranets, extranets, satellite broadcast, audio/video tape, interactive TV, and CD-ROM," and finally arriving at mobile learning (M-learning). Figure 1 illustrates the different forms of distance learning.

1.1 Mobile Learning

Mobile learning is a kind of e-learning training adapted to the mobile uses of learners. It has recently appeared and enables the delivery of remote training on other media than computers. Thus, thanks to the various applications developed, the learner can continue his training, wherever he is by his mobile device, whether it is a smartphone, a multimedia player or a mobile tablet. The technical capacities of

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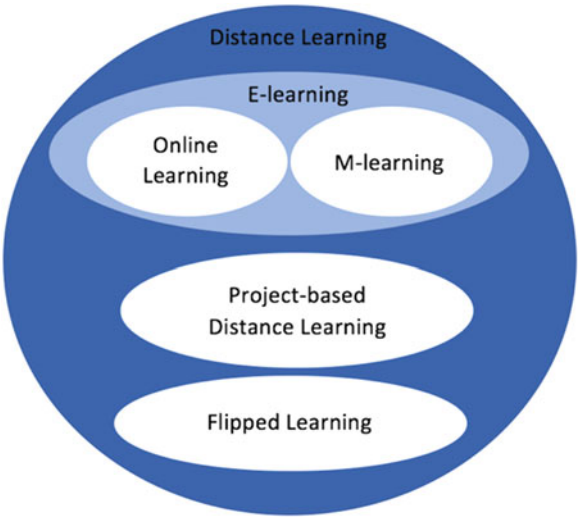

Fig. 1 Distance learning forms

these supports make them a remote learning tool since they are generally able to read most of the media used in e-learning such as texts, videos, sounds, or images.

In the literature, m-learning is defined as a method that allows for acquiring knowledge and skills using mobile technologies anywhere and anytime throughout the day [5]. It can be distinguished "by rapid and continual changes of context, as the learner moves between locations and encounters localized resources, services and co-learners" [6]. Mellow [7] explains that m-learning is "a means to enhance the broader learning experience, it is not a primary method for delivering courses/distance learning." The main difference between e-learning and m-learning is that the first one takes place in front of a computer or in Internet labs, while the second takes place at any location [8].

1.2 Flipped Classroom

The Flipped Classroom (FC) or flipped learning is a learning strategy that reverses the roles of the teacher and the learner. Students are equipped with the learning content before class. According to Bergmann and Sams [9], the flipped classroom is a method created to provide online classes outside the classroom and move homework into the classroom, where students can discuss the subject in depth.

Figure 2 shows a comparison between the traditional classroom and the inverted or flipped classroom.

As the flipped classroom offers several advantages for learners and teachers, it also has disadvantages (Table 1):

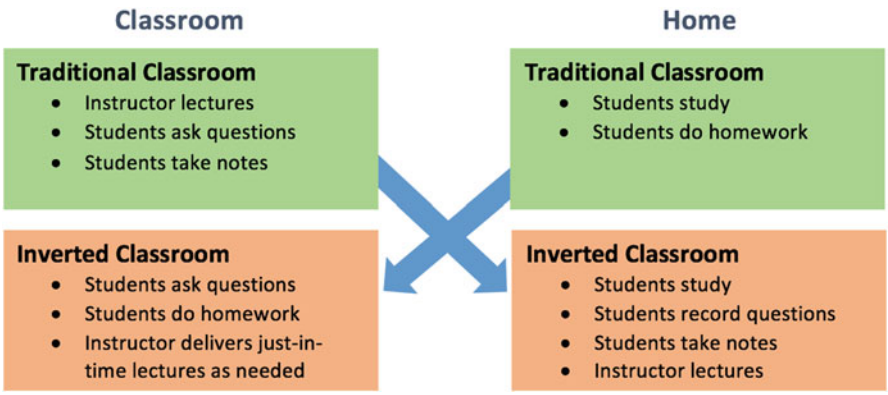

Fig. 2 The traditional classroom and the inverted classroom

Table 1 The advantages and disadvantages of flipped classroom

Learners		Teachers
Advantages	Learners learn at varying speeds Learners are provided opportunities for review Materials are ready and prepared for learners who are absent or sick Parents can view lessons and better assist learners Learners are actively working with their peers	Teachers focus on being the "Guide on the Side" not the "Sage on the Stage" Teachers spend more time supporting learners with practice Teachers are involved with learners learning rather than lecture Teachers spend less time on classroom management of learners' behaviors Teachers collaborate with peers in creating materials
Disadvantages	Learners without devices can feel left out of flipped mobile classroom Higher risk of inappropriate use by learners during school hours due to lack of IT control	More preparation time (Technology, designing tasks . . .) Needs motivated learners More need for monitoring and assessment

1.3 Contextual Learning

In the last few years, learning outside the classroom has become widespread. As a result, an increase in demand for adapted educational content is perceived [10]. We all agree that no single pedagogical strategy is the best for all learners. Learners will be able to achieve the learning objectives more effectively when learning procedures are adapted and personalized to their individual differences and characteristics [11].

This issue leads us to talk about a new aspect of learning that is obviously the contextual learning. This type of learning takes into account the learner context in order to allow him to access content adapted to his needs, characteristics, environment, etc.

When we talk about contextual learning, we have to mention the term "context." According to Dey [12], the context is "any information that can be used to characterize the situation of entities (i.e., whether a person, place, or object) that are considered relevant to the interaction between a user and an application, including the user and the application themselves. Context is typically the location, identity, and state of people, groups, and computational and physical objects."

According to the researchers, the three types of information to be collected to define the context are places, people and things [13]. To classify the context types, a distinction must be made between its dimensions. [12, 14] classify the context dimensions into two categories: external or extrinsic, and internal or intrinsic. As [15] groups the dimensions into two types: physical or logical. The physical dimensions describe the context that can be detected by the device sensors such as light, proximity, etc. While the logical dimensions represent the user context such as his objectives, his knowledge, etc.

Kofod-Petersen and Mikalsen [16] have identified the task context that captures the user activities and goals, the social context that describes the user relationships and roles, the personal context that encompasses the user mental and physical properties, the spatiotemporal context which represents concepts such as time and location and finally the environmental context that deals with the user environment.

Schilit et al. [12, 17] divide the context into three categories:

- *Computing context*: Network connectivity, communication costs, communication bandwidth, and nearby resources such as printers, displays, and workstations.
- *User context:* The user profile, location, people nearby, and social situation.
- *Physical context*: Lighting, noise levels, traffic conditions, and temperature.

Chen and Kotz [18] have added time as the fourth category of context. Schmidt et al. [19] have added the task category and have defined the following dimensions: User, user social environment, tasks, location, infrastructure, physical conditions, and time.

Zimmermann et al. [20] list individuality, activity, location, time and relationships as fundamental categories of context. Individuality is subdivided into four elements: Natural entity, human entity, artificial entity and group entity.

Based on these works, we present a taxonomy of the different context elements in Fig. 3.

In the flipped mobile learning context, there are certain limits that can influence the content quality delivered to the learner, such as the learner's learning style, its equipment and the environment in which the course is delivered. Most of the works carried out dealt with the context problem in the traditional mobile learning environment, this was an inspiration for us to adapt them in the flipped classroom context in which the mobile device used and the environment for consulting the course are unpredictable and uncontrollable.

Our aim, therefore, is to exploit the different context elements in order to give the learners a course content format adapted to their environments in a mobile situation

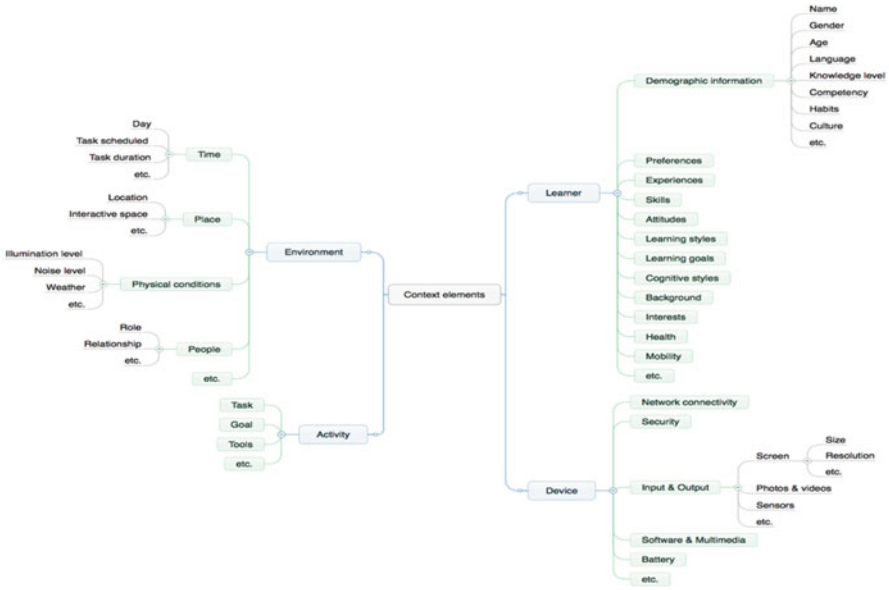

Fig. 3 The context elements

and in the context of flipped classroom. And this by presenting our approach called Smart Enhanced Context-Aware for Flipped Mobile Learning SECA-FML.

The rest of this paper is organized as follows: In the second section, we will present the various recent works that have been carried out in relation to the mobile learning, the flipped classroom, and the contextual learning. In the third section, we will situate our contribution in relation to the works already cited. Through the fourth section, we will describe our proposed approach while explaining how it works. Finally, we will conclude in the last section.

2 Related Works

In this section, we will present the works carried out in the mobile learning, the flipped classroom, and the contextual mobile learning.

Hung et al. [21] developed e-library activity worksheets that assisted the students concentrate on their outdoor ecology observation activities. The e-library delivered resources to clarify their observed descriptions, while the automatic scoring and feedback systems were helpful in supporting the students' persistent effort.

Shih et al. [22] carried out a study at the Peace Temple of southern Tainan with the inquiry-based mobile learning system. They used pre- and post-questionnaires along with observations and focus group interviews.

Reynolds et al. [23] developed a web-based museum tracks for university level students to access mobile devices in the Victoria and Albert Museum in London. The tracks were used in multiple ways to explore the museum environment and collections.

Sharples et al. [24] conducted an evaluation of MyArtSpace which is a combined mobile phone and web-based service to support learning between schools and museums. The study showed that MyArtSpace had a positive impact on school museum visits, and recognized areas for improvement in the both technical and educational aspects of the service.

Flipped classroom approach has become a popular pedagogy in many education institutes around the world. The basic notion of flipped classroom approach is to deliver the teacher's lectures before class through online resources, in order to free-up the in-class time for active learning and problem-solving activities [25].

The work of Bergmann and Sams [26] offers significant guidance when commencing a flipped classroom study. Nevertheless, it should be noted that the real strength of this pedagogical approach is not the instructional videos but the in-class time that is left to be redesigned and evaluated. This time allows many more opportunities for active, experiential learning to test higher-order cognitive skills.

Hamdan et al. [27] offer a comprehensive review of FC studies conducted in the USA, exploring the applications of the FC in the USA in compulsory schooling and higher education. The authors state that the FC features four pillars: a flexible learning environments that are conducive to active learning strategies, a shift in learning culture from a teacher-centered classroom to a student-centered one, an intentional design of content in order to allow students to develop as much as possible in a variety of skills and competencies, and professional educators who can cope with the demands of entirely active classrooms and mastery-based learning.

Lage et al. [28] discuss the FC as a method to allow lectures, experiential learning, collaborative learning and independent study to all occur simultaneously without having to increase staffing fourfold. When comparing the FC and the traditional classroom, Lage et al. explain that in order to fully realize the potential for staff-student interaction within the FC, a low cohort size may be required. The logistical problems caused by facilitating groups of any real size by either fully experiential methods or completely individualized experiences would potentially be significantly challenging. Additional space and resource requirements would need to be considered in order to allow large groups to work in a truly flipped manner.

Chen and Chao [29] propose an approach for developing a paper-based learning support environment, which the traditional books on mobile phones and the web discussion forum are integrated to improve the student's ability to acquire knowledge. The learners receive contextual messages based on their learning status.

Petersen and Markiewicz describe the PALLAS system [30]. This system offers a personalized language learning on mobile devices. It takes into account the dynamic and statistical parameters of context in order to provide learners with personalized resources. The contextualization is ensured by the use of the learner profile (age, skill, level, native language, interests, courses were taken, and user group) and his environment (location, time and day, mobile device used, and weather).

Ghadirli and Rastgarpour [31] present the adaptive and intelligent tutor by an expert system. This system promotes the learning abilities of learners by considering their learning styles, in order to recommend the appropriate content for their situation.

The research work of Tortorella [32] proposes an adaptation and personalization approach for mobile learning. This approach is based on a combination of the learner's learning style and its environment context, as location, movement, brightness, and proximity, in order to provide the learner with the most appropriate course content format (Text, Presentation, Audio, and Video).

3 Positioning of Our Contribution

The contributions made at the contextual mobile learning are related to context awareness in a traditional environment. However, several forms of learning or teaching have recently emerged, as already mentioned in the flipped classroom.

In the FC context, certain limits may influence the course or the quality of the content delivered to the learner, such as the learner's learning style, its equipment and the environment with which the course delivered is primarily concerned:

- *Learning style:* Constitutes a range of competing and contested theories based on a common concept that learners would differ in how to acquire their knowledge.
- *Mobile device*: The software components supported or installed on the learner's device.
- *Environment*: The situation of the learner at the time of learning and the conditions that surround him.

Most of the work carried out deals with the problem of context in the traditional mobile learning environment, this was a motivation for us to adapt them in the context of the flipped classroom in which the mobile device used and the environment for consulting the course are unpredictable and uncontrollable.

Our contribution called Smart Enhanced Context-Aware for Flipped Mobile learning is to take into account the different dimensions of the context (learner, equipment, and environment) in order to provide the learners with a course content format adapted to their needs within the context of flipped classroom.

4 Smart Enhanced Context-Aware for Flipped Mobile Learning SECA-FML

4.1 Approach Presentation

The proposed model is interposed between the mobile learning platforms and the different learning methods (Project-Based Learning, Flipped Classroom, ...). As part of our contribution, we focused on the flipped classroom or flipped learning method (Fig. 4).

The course content formats proposed (Text PDF, presentation PPT, video MP4, and audio MP3) require the capabilities of the mobile device (technical and software features) to be taken into account. Consequently, an improvement of the preceding approaches is proposed by adding another context element, namely the device context, in order to meet the limitations imposed by the latter on the display, connectivity, battery, etc.

In the context of the flipped classroom, the problem of the course content format is strongly posed, because not all learners have the same methods of acquiring knowledge. In addition, learners' device features may not support the same course content formats. Also, a specific format may not be adequate in a well-defined location (Audio in a conference room or text in a dark place).

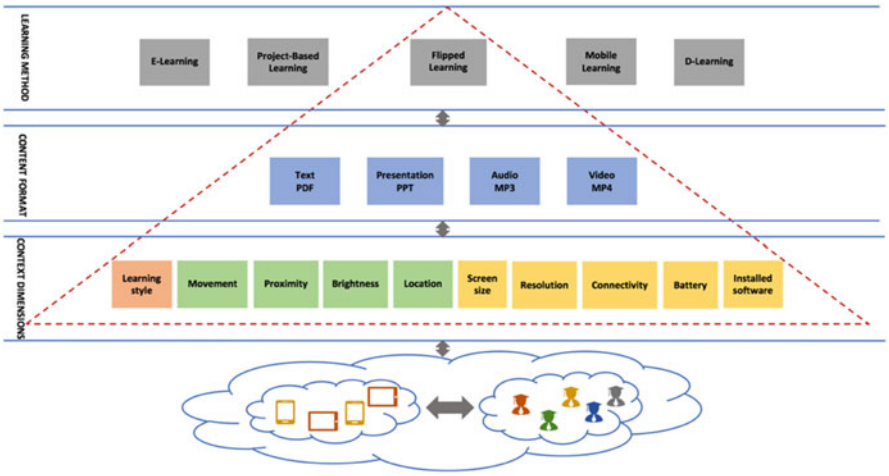

Fig. 4 SECA-FML architecture

4.2 Approach Architecture

Figure 4 shows the architecture of our approach called Smart Enhanced Context Aware for Flipped Mobile learning SECA-FML.

Our approach is based on three layers: Learning methods, content formats, and context dimensions.

1. *Learning methods:* This layer is made up of the different learning methods, namely: E-learning, Project-Based Learning, Flipped Learning, Mobile Learning, D-Learning, etc. Our approach is therefore concerned by the method of Flipped Learning or Flipped Classroom.
2. *Content formats:* In this layer, we find the different course content formats available for learners according to their contexts: Text PDF, presentation PPT, video MP4, and audio MP3.
3. *Context dimensions:* This layer contains the different context dimensions supported by our approach. Each dimension is assigned an appropriate score. After the combination of the different scores, the format with the highest score will deliver to the learner:

   (a) *Learning style*: The learning style of the learner is based on the Index of Learning Style (ILS) developed by Felder and Silverman [33]. This index classifies the learner's learning styles on four dimensions: Active/Reflective, Sensing/Intuitive, Visual/Verbal, Sequential/Global. For each style, we assigned a score that matches the result of the ILS questionnaire passed by the learner.
   (b) *Movement*: Detects the movements of the learner during the learning process. It is measured using the mobile device accelerometer. For example, if the device has detected that the learner is running, in this case, the use of audio format is favored.
   (c) *Proximity*: In this dimension, the proximity sensor is used to detect the proximity of the device with the user. If, for example, the device is held close to the face, the audio format would be favored.
   (d) *Brightness*: The ambient light sensor detects the amount of ambient light in which the mobile device is located. For example, with a very bright or dark environment, the audio format is preferred.
   (e) *Location*: The GPS sensor is able to read the position of the device in terms of its geographical location and returns the longitudinal and latitudinal coordinates. The learner can define by default a specific format for a specific place (Text format in a library).
   (f) *Screen size*: Calculated based on the mobile device diagonal. The use of a mobile device with a small size disadvantages the printed formats.
   (g) *Resolution*: The screen resolution is the number of pixels displayed horizontally and vertically on the screen. It impacts the quality of the visible content display.

(h) *Battery*: Represents the value of the battery charge. Detecting a low battery disadvantages the use of formats that consume more energy (Video).
(i) *Connectivity*: In this parameter, there are two types of Internet connection: limited or unlimited. Detecting an unlimited Internet connection disadvantages the use of formats that consume much more Internet connection.
(j) *Installed Software:* This element is responsible for verifying the software installed on the mobile device, which is required to read the proposed formats. After calculating the final score for each format, we verify the existence of the software responsible for reading this format. If the software not installed, we choose the format of the score ranked the second and so on.

4.3 Approach Functioning

The proposed approach has been implemented in the format of a mobile Android application. It consists of two spaces: teaching space and learning space.

Figure 5 illustrates the use case of the application for the learner and the teacher.

1. *The learner*: To consult the list of courses available on the application, the learner must create an account so that it can authenticate. The creation of an account is done in two steps: The first is the part of the personal information (Name, first name, level, ...) and the second part corresponds to the phase of the response to ILS questionnaire. Learner information is stored in his space and can be changed at any time. Once the account is created, the learner can select a lesson, each lesson is divided into chapters. The list of lessons is not the same for all learners, it varies according to the level of each learner. By clicking on a lesson's chapter, the learner will have this chapter in the format most appropriate to its context.
2. *The teacher*: Through its space, the teacher can manage learners and courses by removing, modifying, and adding each course in four formats (PDF, PPT, Audio, and Video). The teacher also has the opportunity to manage the various tests associated with the lessons.

5 Conclusion and Perspectives

The concept of context awareness in mobile learning has become increasingly critical view that learners learn in a mobility context. However, and with the arrival of the flipped classroom, this notion has not yet taken its place in this new method of learning.

Through this paper we have proposed the Smart Enhanced Context-Aware for Flipped Mobile Learning approach SECA-FML. This solution allows learners to have a course content format adapted to their situations in the context of flipped classroom.

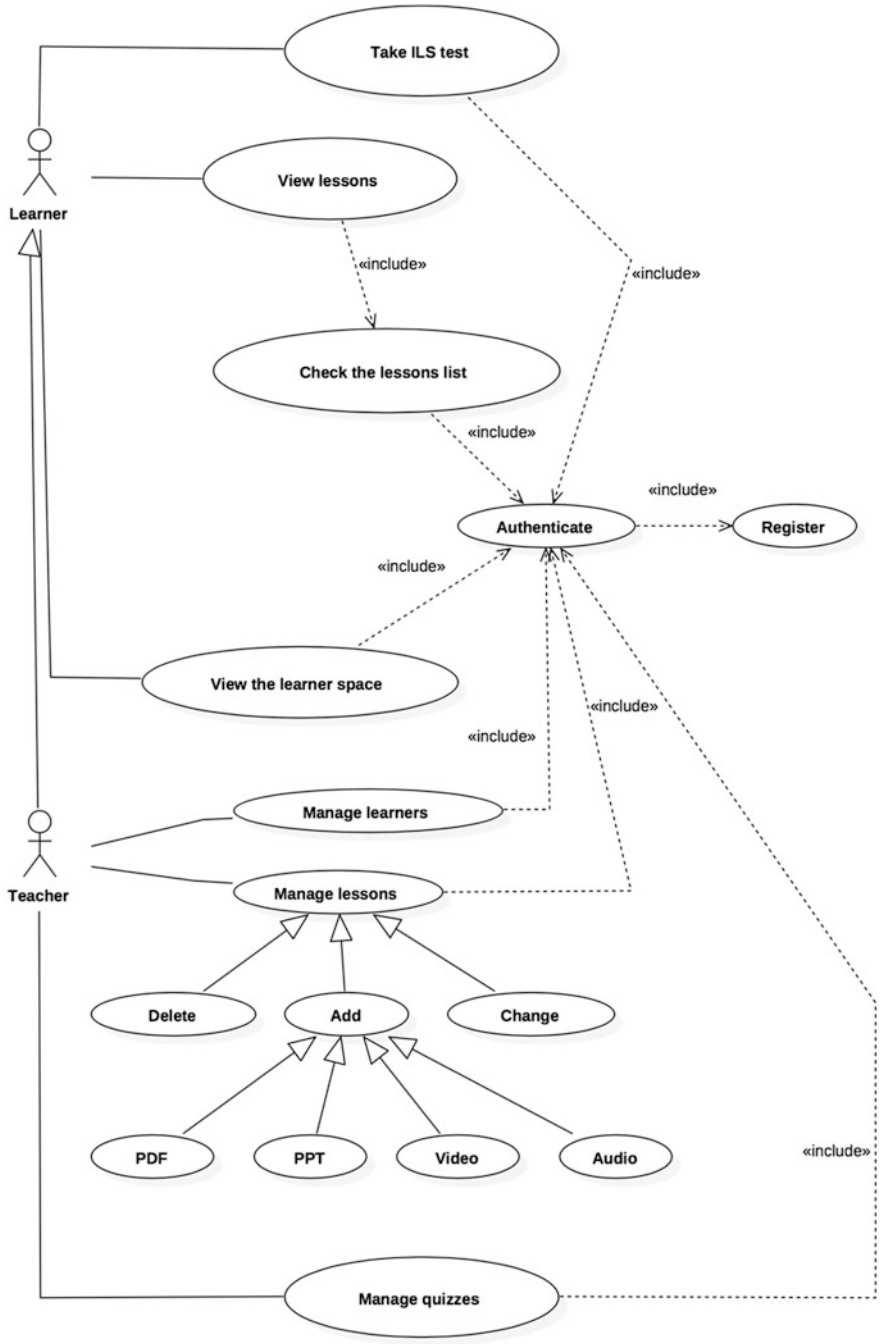

Fig. 5 SECA-FML use case diagram

To validate our model, we have developed an Android mobile application which is in test phase and the results will be the subject of our next paper.

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