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Implementing Flipped Classroom that Used a Context Aware Mobile Learning System into Learning Process

Mahnane Lamia
(LRS Laboratory, University of Badji Moktar
P.O. Box 12, 23000, Annaba, Algeria
mahnane_lamia@yahoo.fr)

Mohamed Hafidi
(LRS Laboratory, University of Badji Moktar
P.O. Box 12, 23000, Annaba, Algeria
mhhafidi@gmail.com)

André Tricot
(CLLE Laboratory, University of Toulouse Jean Jaures and CNRS, France
andre.tricot@univ-tlse2.fr)

Ouissem Benmesbah
(LRS Laboratory, University of Badji Moktar
P.O. Box 12, 23000, Annaba, Algeria
ouissa2007@yahoo.fr)

Abstract: While some studies indicate that flipped classrooms offer many positive educational outcomes, other studies draw attention to limitations associated with flipped classroom (students' limited preparation prior to class, students' need for guidance at home, students' inability to get immediate feedback while they study at home, and little research has focused on students' learning outcomes, such as: satisfaction and motivation). This paper attempts to address several of these limitations through exploratory studies conducted in an Algerian University. The approach proposed in this paper called Flipped classroom based on Context-Aware mobile learning system (FC-CAMLS) aims to provide learners with an adapted course content format based on their feedback and context. The latter has a significant influence on multimedia content in adaptive mobile learning. The system was implemented in an English Language course. It was expected that the FC-CAMLS increased the management of students' heterogeneity. A quantitative analysis by means of structural equation modeling was performed to analyze the causal relationships between knowledge, skills, motivation and students' satisfaction. The results show that the system has positive effects on students' knowledge, skills, and motivation. Finally, our research provides useful results that the use of the context dimensions and learner's feedback in adaptive mobile learning is more beneficial for learners especially in the flipped classroom.

Keywords: Flipped classroom, context aware mobile learning, learner's feedback, motivation, English Linguistics module, satisfaction
Categories: L.3, H.2, J.4

1 Introduction

In recent years, there has been a change in the way lectures are being delivered to students, going from the traditional approach to flipped classroom approach (Akçayir & Akçayir, 2018) (Hafidi & Mahnane 2018).

The flipped classroom is a new instructional model, in which activities traditionally conducted in the classroom become home activities, and activities normally constituting homework become classroom activities (Sohrabi & Iraj, 2016). In the flipped classroom, the teacher helps the students instead of merely delivering information, while the students become responsible for their own learning process and must govern their own learning pace (Lai & Hwang, 2016). Since classroom time is not used to transmit knowledge to students by means of lectures, the teacher is able to engage with students by means of other learning activities such as discussion, solving problems proposed by the students, and guidance.

While some studies indicate that flipped classrooms offer many positive educational outcomes, other studies draw attention to limitations associated with flipped classroom. For example, the majority of flipped classroom challenges are related to out-of-class activities, such as students' limited preparation prior to class (Sayeski, *et* al., 2015), the students' need for guidance at home (Hwang, et al., 2015) , students' inability to get immediate feedback while they study at home (Cummins, et al., 2016; Fautch, 2015; Hardin & Koppenhaver, 2016) and little research has focused on students' learning outcomes, such as: satisfaction and motivation (Bösner, et al., 2015) (Huang & Hong, 2016).

This paper attempts to address these limitations through exploratory studies conducted in an Algerian University. In this work, the authors implement Flipped Classroom based on Context Aware Mobile Learning System (FC-CAMLS) that used a learner's context and learner's feedback into learning process of English linguistics course.

We also contribute to the literature by analyzing how the implementation of a FC-CAMLS affects students' knowledge, skills, and motivation (Lai & Hwang, 2016). Furthermore, we provide empirical evidence about the relationships among these three variables, and how they all conjointly influence students´ satisfaction.

The reminder of this paper is articulated as follows, section 2 presents a theoretical framework to introduce the basic concepts in the field of flipped classroom and context awareness. Then, the design of the proposed model is provided in section 3. In Section 4 we present the main characteristics defining the teaching experience that was carried out, describing in detail the procedure followed, the development of the measurement scale, and the method used to test the scale empirically. Finally, the paper concludes in Section 5 with a discussion of the theoretical and the limitations of the study and future research directions.

2 Research background

This section gives a brief background on flipped classroom model and context aware learning mobile.

2.1 Flipped classroom model

The concept of flipped classroom was first used by (Lage, et al., 2000) and later popularized as an active teaching method by Bergman and Sams (2012). Both research studies consider that inverting or flipping the classroom implies the acceptance that many of the activities that before were normally developed inside the classroom now take place outside it, and *vice versa*. Implementing the flipped classroom as an element of the Internet of Things (IoT) into the teaching-learning process, (Hafidi & Mahnane, 2018) reveal statistically significant relationships that explain why individuals choose the flipped classroom and why they continue to use it. In line with that, and based on theories of self determination and motivation-opportunity-ability, (Lai et al., 2016) suggest that teachers' continuance use intention for the flipped classroom is highest when challenge motivation, perceived self-efficacy, and supportive teaching resources are all sufficient and mutually reinforcing. The study survey results (Awidi & Paynter, 2019) examined the effects of the flipped classroom on several aspects of the student learning identifying those associated with student confidence and motivation. They found a high level of correspondence between the perceptions of the students and those of the course coordinators with the following three aspects of the flipped classroom: access to information, assessment and feedback and knowledge construction. Focusing on the relationship between activity-based learning and the flipped classroom, (Schwarzenberg et al., 2017) conclude that the design of the flipped classroom should consider the effect of different implementation features and select the most appropriate ones for a particular context. In doing so, they observe that the flipped classroom increases the opportunities for peer instruction when in-class activities promote active learning helping to reduce the effects of individual students' prerequisite knowledge. As a result of the above considerations, it seems clear that the flipped classroom can embody many forms and there seems not to be a single best theoretical framework to be implemented (Akçayir & Akçayir, 2018). However, the previous literature has mainly referred to online videos. Therefore, it is reasonable to think that other elements such as the use of the context aware mobile learning should also be considered as potentially essential aspects for the success of the flipped classroom. The quantitative research carried out in this study, presents a theoretical framework which to analyze how the flipped classroom affects knowledge, skills, motivation, and satisfaction in higher education.

2.2 Context aware mobile learning system

In the literature, it has been acknowledged that there is no consensus on the definition of context (Alegre et al., 2016). Also, we highlight that Dey's (Dey et al., 2001) is the most acknowledged one, considering it as "any information that can be used to characterize the situation of an entity", where "an entity" can be a person, place, or object that is considered relevant to the interaction between a user and an application,

including the user and applications themselves". Dey (Dey et al., 2001)) also defined a system as context-aware if "it uses context to provide relevant information and/or services to the user, where relevancy depends on the user's task".

For this work, we selected scientific articles on the context aware mobile learning system which were published in journals indexed in the Scopus database.

In the first search, 106 articles were found (up to 2013). Each article then was examined to check whether it was suitable for the purposes of the study. During this examination, inclusion and exclusion criteria were adopted. Articles were included when they covered the context aware mobile learning as a primary component, and not simply mentioned. Following our application of the criteria, 59 articles were found to be compliant with the purposes of the study, as shown in figure.1.

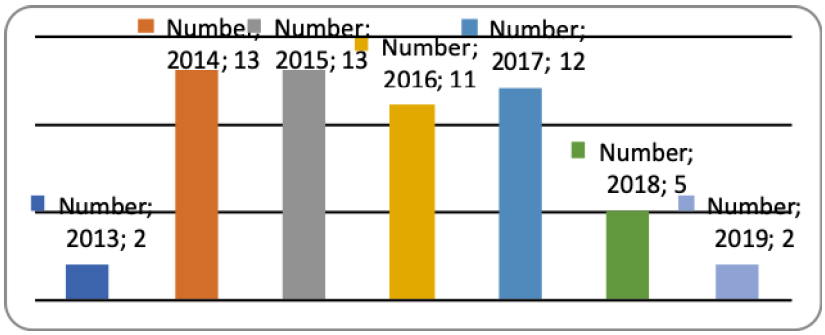

Figure 1: Number of articles published by year

According to our reviewed studies, 20 categories for context aware were created for the context (Profile , Location , Time, Needs , Social-interaction , Physical-activity , Technology, Concentration-level, preferences, Knowledge-level, Knowledge-background, Learning-Style, Motions, Learning-Progress, Activity-Type, Teaching-method, Learning activity, Satisfaction, Disability, Learning-resource), as shown in Table 1.

Categories	Number of articles	%
Profile	**36**	61,01%
Location	**41**	69,49%
Time	**22**	37,28%
Needs	**13**	22,03%
Social-interaction	**15**	25,41%
Physical-activity	**12**	20,31%
Technology	**18**	30,50%
Concentration-level	**1**	1,69%
Preferences	**13**	22,03%
Knowledge-level	**12**	20,33%
Knowledge-background	**5**	8,47%
Learning-Style	**17**	28,81%
Motions	**8**	13,55%
Learning-Progress	**4**	6,77%
Activity-Type	**4**	6,77%
Teaching-method	**1**	1,69%
Learning activity	**2**	3,38%
Satisfaction	**1**	1,69%
Disability	**1**	1,69%
Learning-resource	**2**	3,38%

Table 1: A brief background on Context modeling for Context-aware

We can notice from Table 1 the following points:
- A general context that characterizes all context-aware systems, it includes information that is related to user profile (61.01%), the nature of his physical activity (20.33%), and technology used (30.50%), and the properties of the environment: location (69.49%), time (37.28%).
- A specific context related to the field of e-learning, and which characterizes the situation of a user who has the quality of learner who is engaged in a learning activity: his/her learning style (28.81%), his/her knowledge level (20.33%), his/her preferences (22,03%), …etc.
- The type of adaptation that learning systems provide has to be supported by pedagogical theories that can enhance the learning experience. By reviewing the previous works, it was remarked that most of the works within this area, ignore the contextual information that directly influence the pedagogical side like learning activities type (3.38%), learning-resource (3.8%), concentration level (1.69%), teaching-method (1.69%). Moreover, none of these models considers the learners' satisfaction (1.69%), learners' disability (1.69%), which is a very important aspect that can drive them to stop using the application.

3 Implementing a context aware mobile learning in flipped classroom

As viewed in the previous sections, the main objective behind this research is to address the concept of adaptation based on a learners' feedback and learners' context for determining the optimal format in which the course should be presented. In this paper, we analyze and demonstrate the effectiveness of such a flipped classroom respect to learner satisfaction and improvement of knowledge.

3.1 Description of a flipped classroom

In figure 2, we present a general architecture, which is based on two principal components: Out-of-class activities and In-class activities.

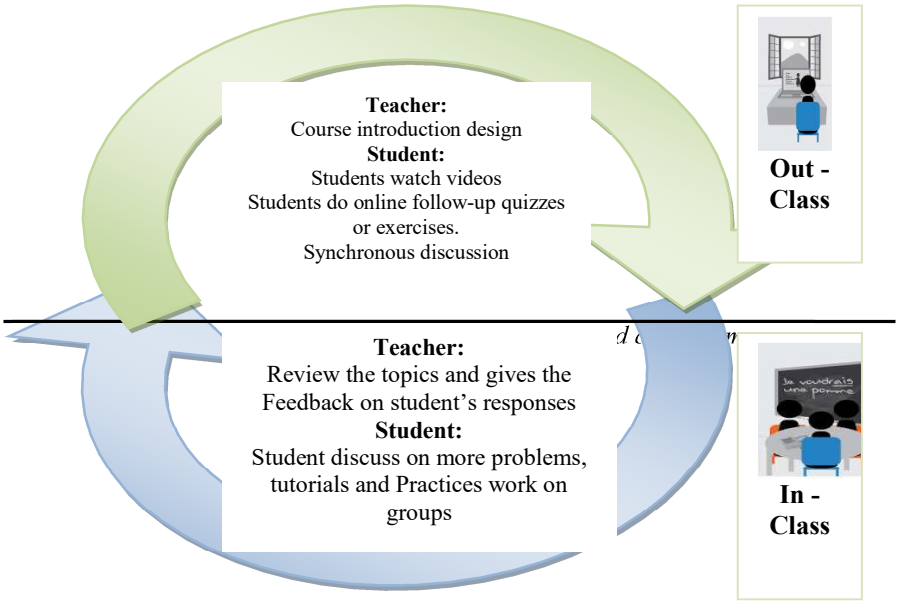

Figure 2: A general architecture of a flipped classroom

a) Out-of-class activities

Before the beginning of the course, the teacher posted the English Linguistics module to the Context Aware Mobile Learning System (CAMLS). This CAMLS was configured as a learning space in which both the teacher and the students could interact sharing additional resources, resolving any questions, publishing news, attending events about the module content.

Once the term had started and one week before the start of each of the module's topics, the students had access to a series of videos about the main content of that module. The number of videos ranged from three to six depending on the topic, and their average duration was five minutes. All of them were made available by the teacher. Students were allowed four or five days to watch and summarize the videos,

and to answer an online questionnaire about their main contents. The online questionnaire contained information related to the students, the device they had used to complete the questionnaire, the aspects of the topic they had found the easiest and the hardest to understand, the first question that they wanted the teacher to clarify in class, and the time they had devoted to watching the videos and completing the questionnaire. The online questionnaire also asked the students to write a quiz-type question about the concepts contained in the videos of each topic.

b) In-class activities

By means of questionnaires used in the out-of-class- activities, , the teacher identifies the students' main comprehension problems, and redesigns the teaching activity in accordance with their doubts and questions just in time before actually beginning on the topic. For the experience developed in the present study, a week after the deadline given to the students to upload their summaries and to complete the online questionnaires, the teacher collected all the information, transferred it to a datasheet, and analyzed the information obtained from it. Subsequently, during class time, he commented on the feedback he had received, answered some of the students' first questions, and explained to them how he would adjust the lectures in order to develop in depth the concepts the students had identified as being the most complex. The time at the start of each topic devoted to this feedback ranged from 20 to 30 minutes. Next, the student-centered learning activities aim of solving problems and practical exercises related to the module contents.

3.2 Description of a context aware mobile learning system

In figure 3, we present a general architecture of a context aware mobile learning in flipped classroom, which is mainly based on three principal layers: Interface layer, Behavior layer and Semantic layer.

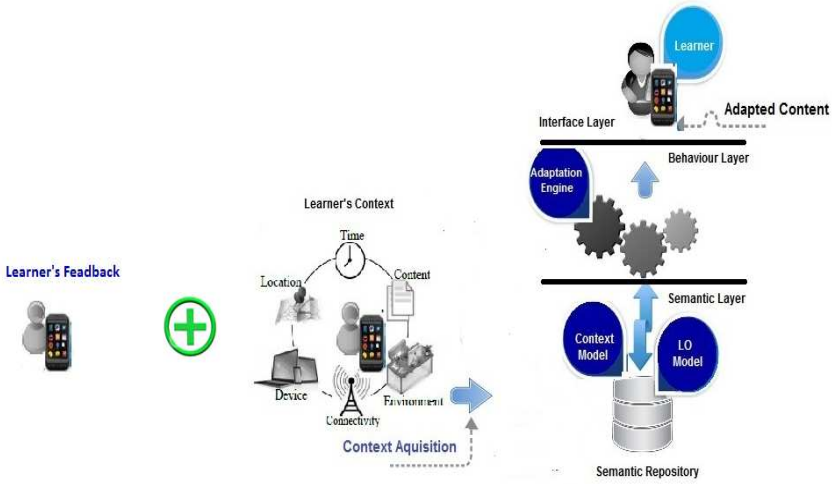

Figure 3: A general architecture of a context aware mobile learning in flipped classroom

3.2.1 Interface layer

Interface layer shows the retrieved learning resource. The components of this layer implement the functionalities required to permit learners to use the context aware learning system. It provides the learner with the personalized learning, which generates from the behavior layer.

3.2.2 Semantic layer

It contains the semantic representations of the learning process components. The learners' context is determined and organized in figure 4.

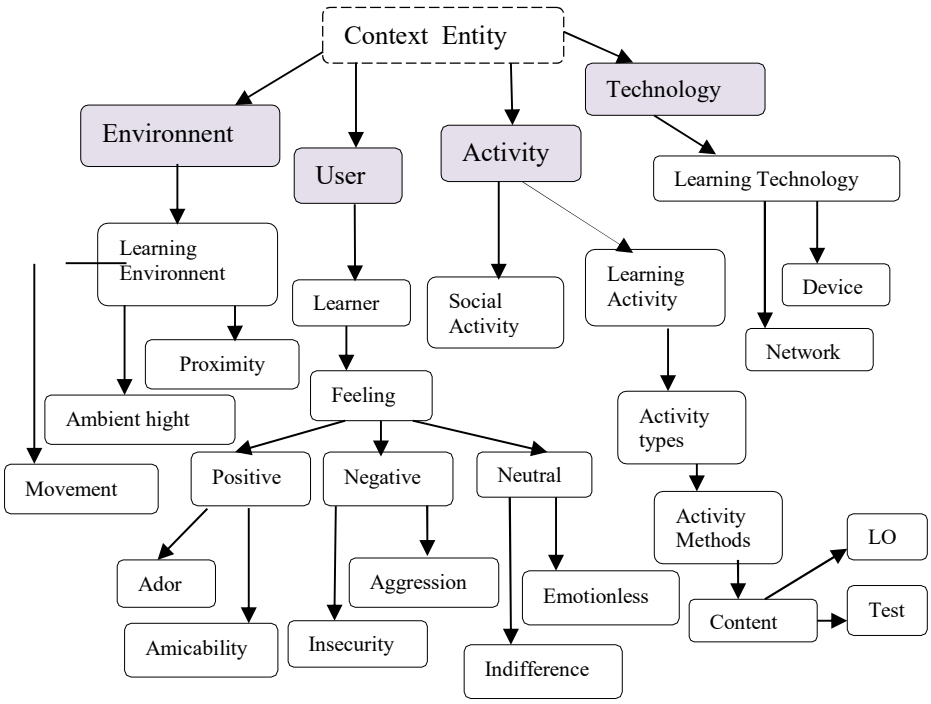

Figure 4: Hierarchical design of the proposed context model

- The contextual information includes data about the relative location of the device to the user gathered from a proximity sensor, the overall motion of the device gathered from an accelerometer, the amount of ambient light in which the device is located gathered from an ambient light sensor. The gathered data is in a native format to the device. This raw data from the sensors is processed, and the results are stored on the mobile device.

- The users' feeling presents the different terms and words that can be expressed by the user. Three types of feeling are distinguished (positive, negative and neutral). Positive feeling means that the user has no difficulty to understand a learning resource, negative allows the system to understand that the user has

difficulties with a learning resource, and in this case the system will recommend other learning resources as well as other users who have positive feelings in this course, and neutral expresses that the user is not interested to the learning resource.

3.2.3 Behavior layer

A user's feedback may not be the only factor in determining a particular course content format. The context and surroundings in which the device and user are located, provides additional factors to consider when determining the optional course format.

a) Adaptation based on learners' feedback

This sub section covers the extraction of information about users' feeling from the messages they write.
The procedure to classify each message, step by step, is shown in algorithm 1:

Algorithm 1: message-classification

Input: TermP= {Interested, Happy, Contented, Good}
TermN= {Bored, Annoyed, Tired, Nervous, Sad}
Output: sentiment type;

Begin
- *Preprocessing the message to convert all the words into lower-case. Afterwards, it detects idioms and joins the words involved in each of them.*
- *The message is divided into sentences. Dots are the only punctuation marks considered as separators at this step.*
- *Tokens are extracted from each sentence. At this time, only whitespaces are taken into consideration to separate tokens.*
- *Emoticons are detected. In order to detect them, the classifier searches in the text all the emoticons stored in two text files, containing positive and negative emoticons, respectively using TermP and TermN.*
- *During this second tokenization phase, all the punctuation marks (including commas, semicolons and so on) are considered as separators leading to obtain the final sets of tokens for each sentence.*
- *The next phase consists of assigning a score to each token: 1 if it transmits a positive sentiment, 0 if it is neutral, and -1 if it is negative.*
- *The messages were classified as neutral when the numbers of positive and negative tokens were equal.*

End.

b) Adaptation based on learners' context

Today, mobile phones are equipped with many sensors which can gather information about their environment and surroundings. These sensors can be used to identify the user's motion, location, activities and needs, which in turn can affect the optimal course content format.

The sensors considered in this adaptive mobile learning system represent those found in the majority of Smartphone's currently on the market.

- **Proximity sensor**: The proximity sensor is used to detect how close the device is to the user. The sensor data from the proximity sensors is commonly represented by the device in a Boolean value, a 1 or 0 for either in close proximity or not. If the proximity sensor is active (i.e. a close proximity has been detected), it means viewing the screen is not possible, hence the system should default to the audio format as the optimal course content format.

- **Accelerometers**: An accelerometer on the device detects the overall motion of the device. An increase in the device's motion is considered as less favorable towards a printed media format since the user is, for example, the score of the audio format increases with detected movement, while the score for the video, presentation, and text format decrease the more movement is detected. The score for video format is not affected as much in contrast to the score for text and presentation format, since it is much harder to read text than it is to watch a video of a presenter when the screen is moving. Therefore, the score for the video format is only decreased by a factor of one half of the movement.

- **Ambient light sensor:** The ambient light sensor detects the amount of ambient light in which the device is located. Such information can affect the course content format in that a very bright or dark local environment favors the audio format rather than a text, video or presentation format. The value for ambient light is taken directly from the mobile device's sensor as raw data. Ambient light sensors usually produce a value of near zero for darkness and increase in value the greater the Lux. Since text, video and presentations are difficult to see in very bright and dark environments, the score of the text, video and presentation format decreases the poorer the light condition becomes. As very bright or dark environments favor an audio format, the score of audio format increases with a poor light condition.

c) Combining context and learners' feedback

Algorithm 2 describe how to calculate each format score based on the format scores calculated from learners' feedback and context information, gathered from the accelerometer, Proximity and ambient light sensors. The format score that yields the highest value is recommended for content delivery.

Algorithm 2: calculation of the optimal format
begin

Audioformat= learner. Feeling + Ambient. Light+ movement+ Proximity
Videoformat= learner. Feeling - Ambient. Light- (movement/2) – (Proximity/2)
Presnetationformat= learner. Feeling – (Ambient. Light/2) – movement - Proximity

Textformat= learner. Feeling - Ambient. Light – movement - Proximity

End.

4 Experiment

4.1 Participants

The teaching experience presented in this paper was conducted at the Faculty of Letters, Human and Social Sciences in the University of Annaba (Algeria). The participants were 390 students (Second Year LICENCE) enrolled in the English Linguistics module. This module consists of 30 teaching hours during the 15 weeks of the course. During this time, seven topics related to the module were dealt with as well as an introductory topic zero which was devoted to familiarizing the students with the Flipped Classroom method and with the necessary information they would need to appropriately follow the course. Table 2 lists the distribution of the course time across these seven topics.

Topics	**weeks**	**hours**
Flipped Classroom	**1**	**2**
What is Linguistics?	**1**	**2**
History of Linguistics	**2**	**4**
Schools of Modern Linguistics	**2**	**4**
Major Objectives of Linguistics	**3**	**6**
Sociolinguistics	**2**	**4**
Psycholinguistics	**2**	**4**
Applied Linguistics	**2**	**4**

Table 2: Distribution of the course time

4.2 Research hypotheses

Figure 5 shows the research model and hypothesis of each construct in this study. The model treats skills, knowledge and motivation as key factors affecting satisfaction.

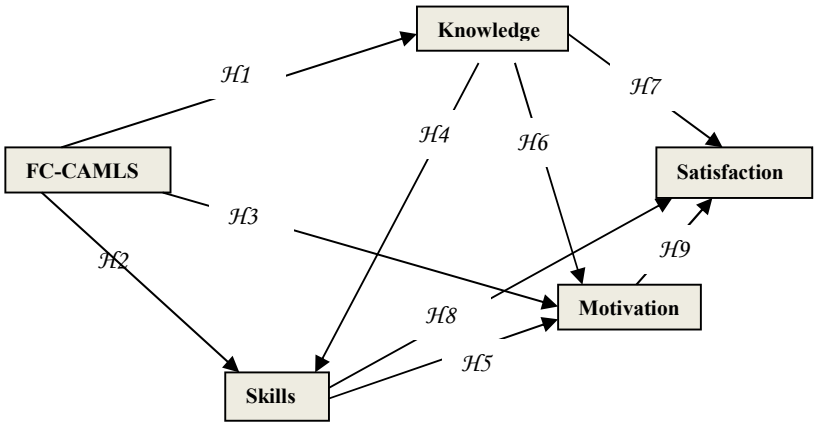

Figure 5: Research model

Firstly, flipping the classroom helps students to better understand and prepare the material and to learn more about the course (Baepler et al., 2014; González-Gómez et. al, 2016; Sahin et al., 2015). More recently, (Akçayir & Akçayir 2018) revealed that the most frequently reported advantage of the flipped classroom is the improvement of student learning performance. Based on these considerations, we hypothesized that:

H1. **FC-CAMLS** *directly and positively affects students' knowledge.*
The literature shows that the flipped method helps students improve their ability to learn on their own (Baars & Wijnia, 2018; Butt, 2014; Cárdenas et al., 2019; Chen et al., 2014; Kim et al., 2014) as they can cover the material at their own pace, with emphasis on those aspects they are finding troublesome (Roach, 2014, Kim et al., 2014). They therefore understand where they need help (Butt, 2014), and can go back over any material they may have missed (Bergman et al., 2013). Other authors point to the existence of a positive relationship between flipping the classroom and the students' ability to apply the knowledge they have acquired (Botma et al., 2015; Roach, 2014). Finally, the literature also notes that flipped classroom positively influences students' ability to analyze and synthesize the course material (D'Alessio et al., 2019; Kim et al., 2014; Kong, 2015). Considering all the above, we hypothesize that:

H2. **FC-CAMLS** ***directly and positively affects students' skills.***
To focus on the relationship between flipped classroom and students' motivation, we would highlight the seminal study of (Elmaadaway, 2018), which indicate that students in a flipped classroom experience appear to be more engaged and to feel more responsible for their learning. More recently, (Loveys & Riggs 2019) evaluated student motivation in two core undergraduate science courses observing significant decreasing failure rates and higher levels of motivation with course materials. In view of the above, we hypothesize that:

H3.* FC-CAMLS *directly and positively affects students' motivation.
Research suggests the existence of a clear relationship in which knowledge influences skills.
(Hasan et al., 2017) pointed out that there is a significant influence of knowledge on both students' listening comprehension and reading comprehension. (Murillo-Zamorano & Montanero, 2018) analyzed the competence of a sample of economics and business studies in orally presenting academic content. These findings indicate that the existence of appropriate knowledge does indeed influence students' skills. Thus, we hypothesize:

***H4. Students' knowledge directly and positively affects students' skills in* FC-CAMLS.**
The literature has also explored the relationship between skills and motivation. There has been much research focused on the impact that the skills developed by students have on their level of motivation. For instance, (Shernoff *et al;* 2016) reviewed a set of studies analyzing the association between motivation and certain skills, finding that such aspects as the existence of encouraging types of relationships among students or the students' ability to be autonomous yields to a higher level of motivation. More recent research by (Connolly & McGuinness, 2018) has also explored the digital literacy skills of young people in the European context, investigating where and how digital skills can support the inclusion, motivation and participation of young people in the digital world. In accordance with this line of reasoning, we state the following hypothesis:

***H5. Students' skills directly and positively influence students' motivation in* FC-CAMLS.**
Recent literature has found an association between these two elements in which knowledge directly influences motivation. For instance, (Shernoff et al; 2016) found students' motivation to be flexible and influenced by their learning environment, and therefore considered that the knowledge acquired in such a learning environment could influence how engaged the students are. (Zhao et al. 2018) investigated whether knowledge diversity would impact students' motivation in small-group learning in a science classroom. They confirmed that mixed knowledge groups had significantly higher behavioral, emotional, and social motivation and better group performance than did the low-prior-knowledge groups. Based on the above arguments we expect that: For this reason, we state that:

***H6. Students' knowledge directly and positively influences students' motivation in* FC-CAMLS.**
Despite the existence of a great deal of literature studying a wide range of elements that influence students' levels of satisfaction, to the best of our knowledge there has been no explicit quantitative research on how acquired knowledge impacts on satisfaction. However, we believe that the relationship between these two variables is worth studying. (Lombardini et al; 2018) argue that further research should focus on the relationship between the degree to which a course is flipped and its impact on learning outcomes and students' satisfaction. Based on the above arguments we expect that:

***H7. Students' knowledge directly and positively affects students' satisfaction in* FC-CAMLS**

The relationship between the skills developed by students and their satisfaction has been dealt with extensively in the literature (Lin et al; 2008); (Lopes & Soares; 2018). To be more specific, (Lin et al; 2008) proposed a flipped classroom with a smart learning diagnosis system providing evidence that students had stronger problem-solving abilities enhancing their perceptions of pleasure derived from this. (Lopes & Soares; 2018) studied a flipped classroom environment with a student's centered approach and identified that class success rate was higher than that obtained in the traditional class in terms of students' skills for being more responsible for their own learning process. In line with the above arguments, we therefore posit:

***H8. Students' skills directly and positively affect students' satisfaction in* FC-CAMLS.**

Finally, we examine whether motivation is related to students' satisfaction. The existence of a positive relationship between these two constructs is well documented in the literature (Kahu, 2013; Chen et al., 2014; Eom et al., 2016). Gray & DiLoreto, 2016) also found a positive effect of students' motivation on students' satisfaction. Based on the above arguments, we stated more formally:

***H9. Students' motivation directly and positively affects students' satisfaction in* FC-CAMLS.**

4.3 Data analysis

We applied Partial Least Squares (PLS) techniques to analyze Structural Equation Modeling (SEM) systems, using the statistical software package *SmartPLS* (Ringle et al., 2005) for this purpose. The reason to use PLSSEM rather than other methods involving covariance structures are the following (Barroso et al., 2010; Hair et al., 2014): (i) using PLS does not require a great number of observations; (ii) in PLS, the data do not have to have a normal distribution; and (iii) this is an exploratory analysis aimed at developing a new theory. The following subsections will present the results in two parts – first examining the measurement models, and then focusing on the structural model.

4.3.1 Measurement models

The reliability and validity analysis showed our first- and second-order measurement models to be correct, as shown in table 3.

Construct	Construct code	item	Cronbach's α	Factor loading	Composite reliability	Variance extracted
FC-CAMLS			0.814		0.827	0.570
Out-of-class activities	Ou	5	0.858	0.842	0.887	0.764
In-class activities	In	2	0.812	0.832	0.924	0.842
Knowledge	Kn	2	0.794	0.926	0.912	0.832
Skills	Sk	6	0.882	0.735	0.892	0.579
Motivation	Mo	2	0.764	0.883	0.882	0.814
Satisfaction	Sa	3	0.841	0.883	0.889	0.789

Table 3: Test results of internal reliability and convergent validity.

As one observes in Table 3, for the first-order measurement model, all the loadings were above 0.6. The significance levels of the associated *t*-values were calculated by bootstrapping, using 5000 subsamples with the same number of cases as in the original sample (Hair et al., 2014). All these *t*-tests were statistically significant (Anderson & Gerging, 1988). The average variance extracted (AVE) ranged from 0.570 to 0.842, and the composite reliability from 0.764 to 0.882, indicative of satisfactory reliability of these latent variables (Bagozzi & Yi, 1998). The discriminant validity is also supported by the fact that, for each pair of latent variables, the square root of AVE was greater than their correlation (Fornell & Larcker, 1981).

Table 4 presents the correlation matrix together with the mean, standard deviation, and square root of AVE of each of the eight first-order latent variables.

	Ou	In	Kn	Sk	Mo	Sa
Ou	*0.874*					
In	0.481	*0.917*				
Kn	0.436	0.518	*0.912*			
Sk	0.258	0.623	0.687	*0.761*		
Mo	0.326	0.465	0.712	0.679	*0.902*	
Sa	0.434	0.579	0.637	0.659	0.672	*0.888*

Table 4: Correlation matrix of the constructs

The second-order measurement model related to the FC-CAMLS measurement scale was computed using a *repeated indicators approach* (Wetzels et al., 2009). Following this procedure, the second-order latent variable was specified with all seven of the underlying indicators of the two first-order latent variables: **Ou** and **In**. The values of Variance Extracted (AVE) and Composite reliability for this latent variable were 0.570 and 0.814, respectively (Table 3). The loadings of the first-order latent variables on this second-order latent variable also exceeded the value of 0.6,

with statistically significant associated *t*-values. All the variables are therefore within the limits required to be accepted as reliable.

4.3.2 Structural Model

Given the satisfactory result of the measurement models, we proceeded to evaluate the structural model (Chin, 1998). We first performed a post-hoc power analysis (Marcoulides & Saunders, 2006) using the G+Power3 statistical software package (Faul *et al.*, 2007). The result for our structural model and sample was 0.89. This value is greater than the recommended value of 0.8 (Cohen, 1988). Second, we evaluated the structural model on the basis of the following criteria: (i) the standardised regression coefficients and their associated *t*-values; (ii) the coefficients of determination (R^2) (Falk & Miller, 1992); and (iii) the Stone-Geisser criterion (Q^2) (Geisser, 1975; Stone, 1974). The *t*-values were calculated using a bootstrapping procedure that analyses the significance level of the standardized regression coefficients (Henseler et al., 2009). We also applied the (Falk & Miller, 1992) criterion requiring the R^2 of each of the latent variables to be greater than 0.10.

As one observes in figure 7, the R^2 values (knowledge, $R^2 = 0.289$; skills, $R^2 = 0.593$; motivation, $R^2 = 0.588$; and satisfaction, $R^2 = 0.558$) were all greater than this threshold. Similarly, the Q^2 values ranged from 0.281 to 0.436, suggestive of acceptable levels of predictive relevance (Chin & Newsted, 1999).

The PLS results for the model are shown in Figure 6.

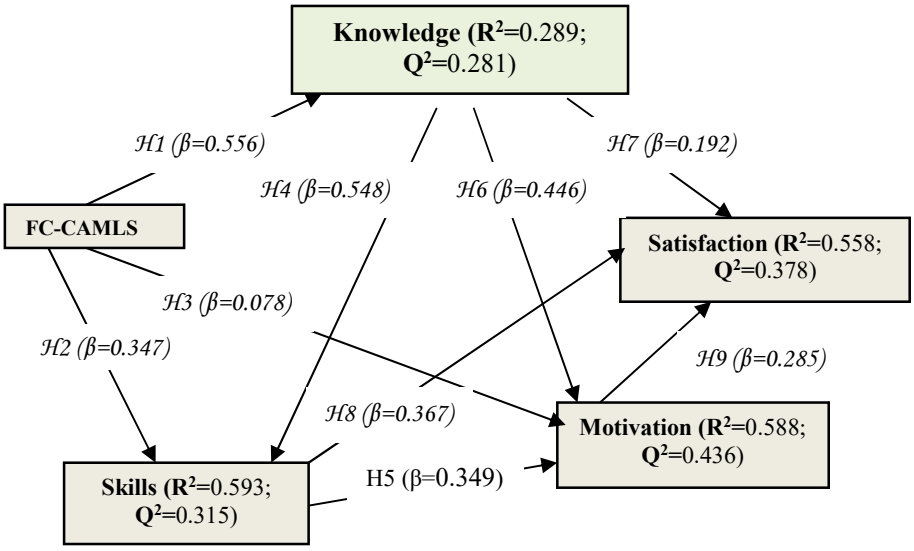

Figure. 6: Results of PLS analysis for the proposed research model.

Analyzing the causal relationships in the proposed models (Table 5), one observes that the influence of the FC-CAMLS on knowledge is significant (H1: $\beta = 0.556$; *t*-test = 7.467; $p < 0.01$). Also confirmed is the significant effect this variable

has on skills (H2: β = 0.347; *t-test* = 3.373; $p < 0.01$), although it has no significant effect on motivation (H3: β =0.078; *t*-test = 0.881). Past researchers (Galway et al. 2014); (Van et al. 2015; Huang and Hong 2016) have provided empirical support for these relationships.

In order to better understand this last result, we analyzed the mediating effects existing in the relationship between FC-CAMLS and motivation, following the procedure developed by (Preacher & Hayes, 2008) and (Hayes et al; 2011) with a bootstrap of the indirect effect of the sample distribution (Hair et al., 2014). The result was the following: (i) FC-CAMLS→ Knowledge → Motivation = 0.247, with an associated significant statistic (*t-test* = 3.743; $p < 0.01$); (ii) FC-CAMLS → Skills → Motivation =0.121, with an associated significant statistic (*t*-test = 2.287; $p < 0.05$); and (iii) FC-CAMLS → Knowledge → Skills → Motivation = 0.106, with an associated significant statistic (*t*-test = 2.797; $p < 0.01$). Therefore, the total indirect effect (i) + (ii) + (iii) = 0.474. All this leads to the conclusion that knowledge and skills are full mediators in the aforementioned relationship (H3).

Examining knowledge, we found that it positively affects skills (H4: β =0.548; *t-test* = 7.678; $p < 0.01$) and motivation (H6: β = 0.446; *t*-test = 4.838; $p < 0.01$). These results are consistent with the findings of previous studies (Connolly & McGuinness, 2018; Zhao et al. 2018).

We also observed a direct positive effect of skills on motivation (H5: β = 0.349; *t*-test = 3.327; $p < 0.01$).

Finally, we confirmed that satisfaction is positively and significantly affected by knowledge (H7: β = 0.192; *t*-test = 1.881; $p < 0.10$), skills (H8: β =0.367; *t-test* = 2.862; $p < 0.01$), and motivation (H9: β = 0.285; *t*-test = 2.378; $p < 0.05$). Previous studies have affirmed these relationships as well (Lopes and Soares; 2018; Gray & DiLoreto; 2016; Lombardini et al. 2018)

Hypothesis	Path	Coefficient β	T-value	P-value	Supported
H1	FC-CAMLS → Knowledge	0.556	7.467	<0.01	yes
H2	FC-CAMLS → Skills	0.347	3.373	<0.01	yes
H3	FC-CAMLS → Motivation	0.078	0.881	<0.10	no
H4	Knowledge → Skills	0.548	7.678	<0.01	yes
H5	Skills → Motivation	0.349	3.327	<0.01	yes
H6	Knowledge → Motivation	0.446	4.838	<0.01	yes
H7	Knowledge → Satisfaction	0.192	1.881	<0.01	yes
H8	Skills → Satisfaction	0.367	2.862	<0.01	yes
H9	Motivation → Satisfaction	0.285	2.378	<0.05	yes

Table 5: Hypotheses testing results and path coefficients

5 Conclusion

The Flipped Classroom methodology has been conceived as a learner-centered pedagogical approach trying to improve the students' performance. The literature acknowledges the potential of Flipped Classroom over the traditional teaching and learning procedures (Bishop & Verleger, 2013; Strayer, 2012). In most cases, this alternative approach has simply consisted of a reordering of the processes to be carried out inside and outside the classroom by the students (Bates & Galloway, 2012; Roach, 2014; Love et al., 2014; Hung, 2015, O'Flaherty & Phillips, 2015). This narrow focus has been questioned by academics and practitioners (Bishop & Verleger, 2013; Chen et al, 2014) noting that a Flipped Classroom model as the aforementioned could be improved and being more useful by adding a series of complementary tasks to be carried out by both inside and outside the classroom.
Following this approach and in order to attain a successful Flipped Classroom model, we consider essential: firstly, the need for a two-way feedback (teacher to students, and vice versa) as an effective link between the out-of-class and in-class activities. Secondly, the use of a context aware mobile learning system (CAMLS) in terms of moving the lecture to outside the classroom and carrying out a more active learning inside the classroom (Strayer, 2012; Berrett, 2012; Butt, 2014; Huang et al., 2017; Elmaadaway, 2018).

Our research offers strong evidence supporting that a new conceptualization of flipped classroom is possible by means of using a flipped classroom framework based on learner's feedback and learner's context (FC-CAMLS). This is the first time that such a theoretical framework has been tested by means of a partial least squares (PLS) approach for structural equation modeling (SEM) what has allowed us to identify new and key managerial and theoretical implications concerning: on the one hand, the effect of FC-CAMLS on students´ knowledge, skills and motivation. On the other hand, the satisfaction is positively and significantly affected by knowledge, skills, and motivation in FC-CAMLS. This study also confirms the view that this Flipped Classroom framework has a positive and direct effect on students' knowledge and skills.

The research carried out in this study provides useful recommendations and insights for the academia. Our flipped classroom allows greater students' involvement with the teaching-learning process. Furthermore, this approach also ensures a greater flexibility for the knowledge adoption process, allowing students to get in touch with course contents as often as they need, and where and how they want to do it. The Flipped Classroom framework proposed in this research also enhances the students' speed of assimilation of contents which increases both students-teachers and students-students.

6 Future research

Although a rigorous and comprehensive study was conducted, a few limitations associated with this research do exist. First, the authors plan to increase the number of qualitative video lessons, increase the number of courses using flipped classroom. Second, the authors plan to measure continuously the difference between traditional

classroom and flipped classroom based on context ware mobile learning system. Finally, the findings and implications presented in this study must be generalized for external validity because they were obtained from only a single study that examined flipped classrooms and targeted a specific user group in Algeria. Further research is expected to help generalize our findings and discussions to include different settings and contexts in which flipped classrooms are utilized.

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