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FLIPPING FROM FLIPPED CLASSROOM TO MULTIMODAL MOBILE LEARNING (MML)

Abstract:

Selecting the right training and the right strategy, with the diversification of media and methods, are great challenge for all teaching professionals. Reverse Pedagogy using flipped classroom is a teaching strategy based on a mode where the lecture part of the course is indirectly assigned to students in the form of homework, team projects, video listening or reports to do before meeting the classroom teacher. We have initiated a pioneering work in developing the flipped classroom approach in science and engineering integrating remote laboratory work strategy. In our model, students go through different modes. The proposed Multimode Mobile Learning (MML) model allows students to go through a multitude of modes to enhance their learning. They go from Problem Based Learning (PBL) mode to asynchronous and synchronous distance learning modes by performing team based remote laboratory. The use of mobile Information and Communications Technology (ICT) solutions has led us to describe our model as a Multimode Mobile Learning (MML) model. This innovative learning approach has been introduced in three different Quebec universities having specific context for each institution. Promising results have been obtained showing that the proposed MML model has a wide range of attributes allowing to enhance students learning interests and skills.

Keywords:

Flipped Classroom, Information and Communications Technology (ICT), Multimodal Mobile Learning (MML), Prosit, Remote Laboratory

JEL Classification: I23

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1.0 Introduction

The world of education lives lately stammering evolution for different learning approaches. Under economic and social pressures, and under the influence of vertiginous technological change, the incentives to reform and proposals for new solutions and approaches come from all of the world researchers. Acronyms and new terminologies keep emerging every day. Massive open online course (MOOC), Numerical learning environment (NLE), techno pedagogical Laboratory at Distance (LAD) and many others approaches have well taken place in the records of specialists who are continually called to update their learning approach registry. The inverted class or flipped classroom represents a concept that has the "buzz" in the world of education and is attracting much attention. For (Lage et al., 2000) and (Bishop and Verleger, 2013), flipped classroom comes to perform activities outside the classroom, which is traditionally spent in the classroom and vice versa. In reality, the practice of flipped classroom has different variation among the researchers and users: in class, generally interactive learning activity is promoted, but their designs and their scopes are very different from one experience to the others; activities outside the classroom (preliminary work) also vary, but are generally designed allowing students to have direct access to the course content through a formative work prior to the class meeting.

Figure 1 shows the steps of flipped classroom approach versus conventional learning approach. In flipped classroom, students explore the basic elements of the course through a preparative formative work. Class sessions reinforce learning through dynamic questions and analysis applications.

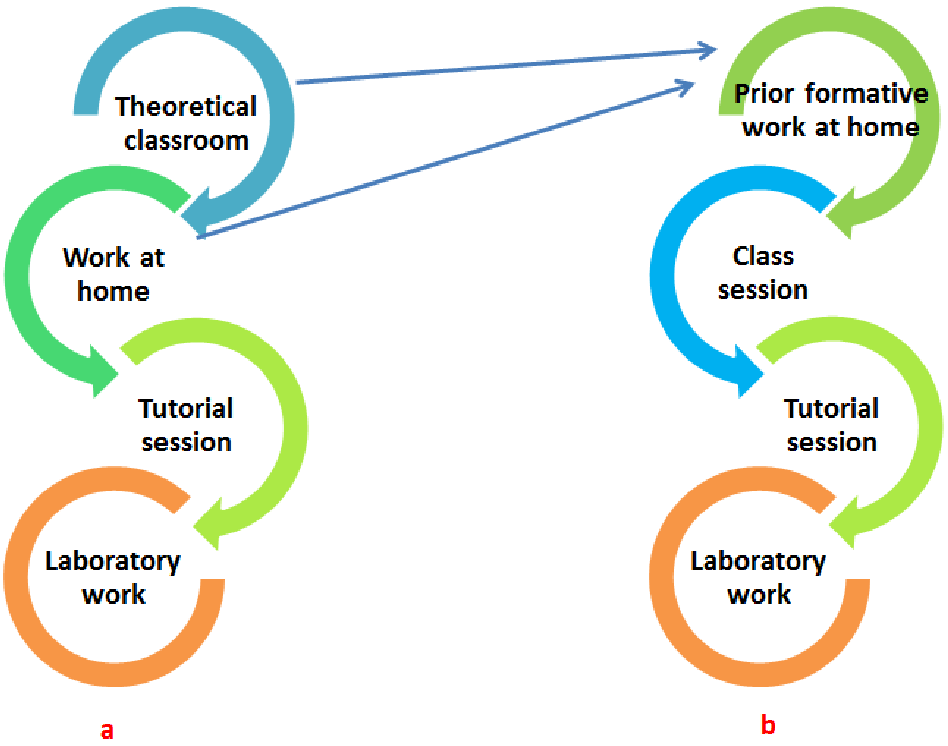

Figure 1: Steps of conventional or classical classroom (a) versus flipped classroom (b)

Motivated by the promises expected from this new form of learning, an innovative project is lunched at three different universities (École de technologie supérieure-ÉTS, Université du

Québec À Montréal-UQÀM, Université du Québec À Trois-Rivières-UQTR), bringing a different vision to the implementation of the flipped classroom in general and especially in science and engineering classes.

2.0 Multimodal Mobile Learning (MML) Approach

Two basic ideas have motivated our choice. The first idea is related to the ‘competence of problem solving’ taking an important place in educational preoccupations. To improve this competency, Problem Based Learning (PBL) (Barrows, 1996) takes preferred place in active approaches and is adopted in pedagogical reforms at several universities (Felder and Brent, 2003), (Mauffette et al., 2004) and (Ryberg and Nørgaard, 2013). The second idea is related to the value of ‘establishing links between what is taught with real applications’ and the ‘direct environment of the student’ to motivate and give meaning to their learning.

These two ideas directed us to introduce the course in the preliminary work outside the classroom through authentic problem situation (PROSIT). The Information and Communications Technology (ICT) facilities led us replacing the traditional textual PROSIT presentations by video clips that are more comfortable and friendly to understand the problem and validate the authenticity of the situation. The presentation by images is supposed to strengthen the motivation. (Tardy, 1975) has already identified various functions of the image in learning such as psychological function of motivation, illustration or designation function with the association of a pictorial representation of the word and the designated object and inducing function as the image is accompanied by an invitation to students in describing and narrating.

The second idea implemented is derived from the constant need, recommended by specialists, to link theory to practice (Mills and Treagust, 2003). In this context, we took advantage of our experience in the development of remote laboratories (Maarouf et al., 2012), (Nerguizian et al., 2012) and (Saad et al., 2013) introducing practical work that students remotely perform in the preliminary work. Changes made to the conventional model of the flipped classroom permitted us to see that our enhanced model offers and integrates together several learning modes while providing mobility through media resources remote laboratory work. Our learning approach is called Multimodal Mobile Learning (MML).

Figure 2 shows the steps of the enhanced flipped classroom approach called MML versus conventional learning approach. This model is used at ÉTS.

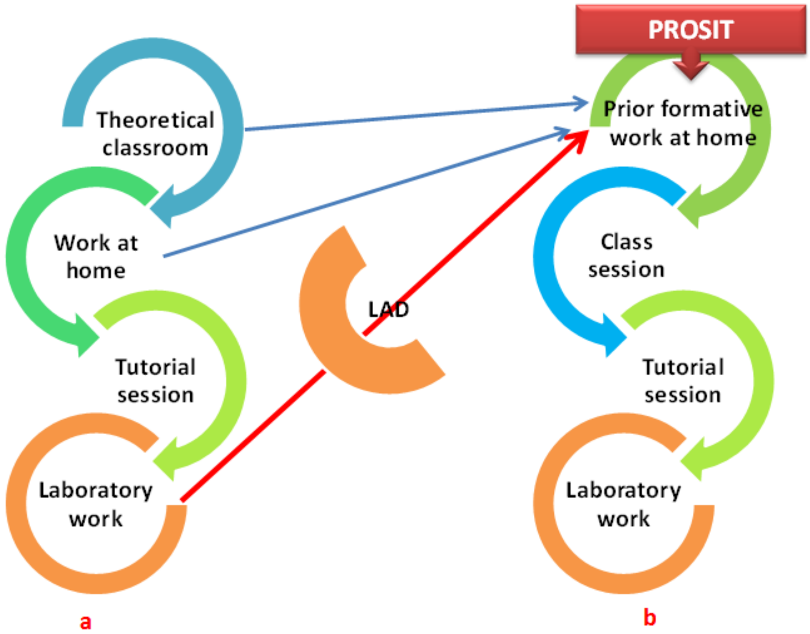

Figure 2: Steps of conventional or classical classroom (a) versus MML (b). The arrows shows the modifications from classical to flipped classroom

Major activities of the Multimodal Mobile Learning approach at ÉTS are presented in Figure 3. The introduction of the approach by the PROSIT put the student close to the Problem Based Learning (PBL) mode. The initial problem (PROSIT) will serve as a guiding line throughout the course. The student will be invited to go and explore the theoretical basis to treat this problem. Unlike PBL, the resources are provided and supported by quizzes helping and validating student's learning. The student works at distance in asynchronous mode and is then called to perform a team laboratory work (LAD) remotely. A concise report is delivered in Moodle to justify the measurements performed in the light of what was learned earlier. At this stage we are in synchronous collaborative and remote mode. In class, we are in face to face mode and activities are then directed to answer questions, repeat the weaknesses identified in the reports and quizzes, and then treat other additional problems. The classroom session ends with quizzes using clickers allowing students and teachers to check the level of knowledge, comprehension, competences and skills. Considering the flexibility introduced by the remote laboratory and the facilities offered by smartphones and tablets, the Multimodal Learning (ML) approach could be described as a Multimodal Mobile Learning (MML) approach.

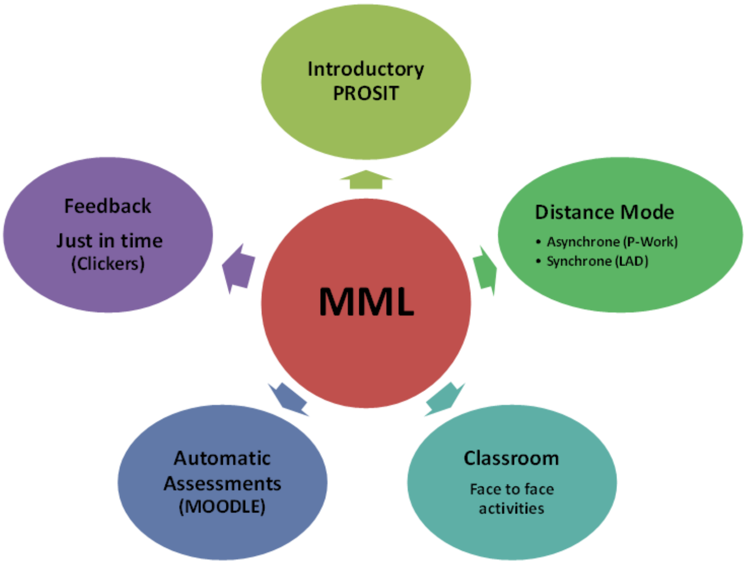

Figure 3: Major activities of the Multimodal Mobile Learning (MML) at ÉTS

3.0 Proposed Implemented Steps for Multimodal Learning Approach at ÉTS

Adopting the approach of reverse teaching is certainly beneficial for learning, but its implementation is overwhelming and demanding. The Figure 4 describes the steps necessary to develop a course using this approach.

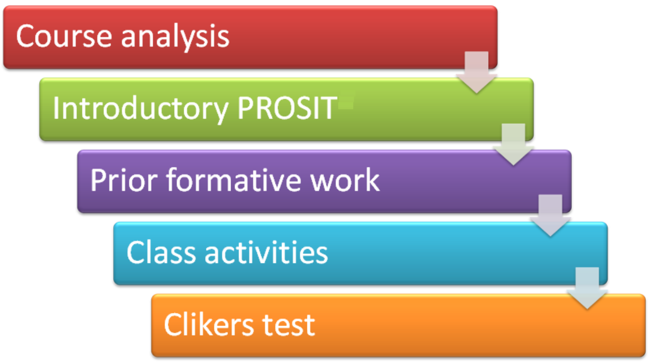

Figure 4: Steps of Multimodal Mobile Learning (MML)

3.1 Course Analysis

In this step (Figure 5), the initial course plan is analyzed to identify the targeted knowledge and skills, and decision is made on activities that student must do before the class meeting and during the face to face class meeting. All these activities and student's evaluation procedures are ensured based on educational and pedagogical alignments.

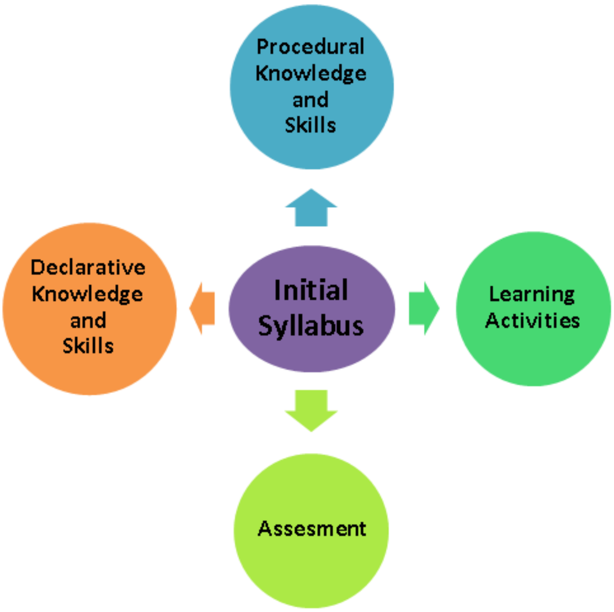

Figure 5: Course analysis activities

3.2 Introductory PROSIT

From the targeted knowledge and skills, a narrative appropriate problem situation is created serving as a guideline for all further activities. The story is described accurately. For PROSIT filming, the script of each participant is prepared involving the choice of actors, staging, rehearsal exercises and final recording of each PROSIT with an experienced shooting team. All these actions are described in Figure 6.

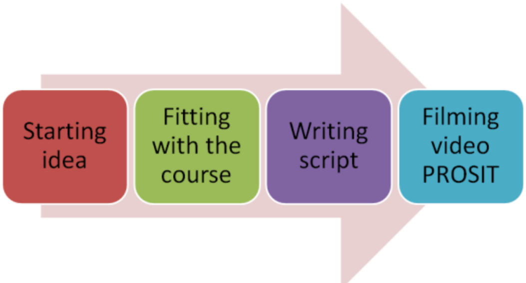

Figure 6: Introductory PROSIT video

3.3 Prior Formative Work

Prior formative work consists of video clips, quizzes and LADs. Some video clips are recorded presenting the concepts of the course. These records are made by the teacher of the course who introduces the concepts directly or in the form of a discussion with the students. The course itself is divided into an order of consistent and distinct short sequences. For each sequence a series of formative quizzes are developed allowing students to verify whether they understood the key elements of the sequence. These quizzes are placed on Moodle allowing automatic evaluation of the responses, giving a significant portrait of student's difficulties and guiding the intervention of the teacher in class. Remote Laboratory work (LAD) requires a long design, development, testing and validation time. The design is made in the light of knowledge and skills learned in screenwriting and distribution activities. The work aims to establish a link between theory and practical reality. The work is also in line with the initial PROSIT description.

In the case of remote use of one laboratory equipment in the premises of the institution, work can only be performed by a single team. For this reason, access is well planned and controlled and appropriate control access software is prepared to meet this need.

3.4 Class Activities

In class, we are in face to face mode and activities are then directed to answer questions, repeat the weaknesses identified in the reports and quizzes, and then treat other additional problems. The classroom session will conclude with quizzes-clickers allowing students and teacher to check the level of knowledge and skills. These quizzes are prepared on the basis of targeted knowledge and competences from the beginning of the course. Student responses to clickers are anonymous allowing them to assess their learning without embarrassment and permitting the teacher to correct eventual collective errors. The literature describes many positive contributions of these tests with clickers on the commitment and effectiveness of learning (Bartsch and Murphy, 2011).

4.0 ICT Tools

For the development of various media and interaction between teacher and students, various digital tools are used. Figure 7 shows the ICT tools structure.

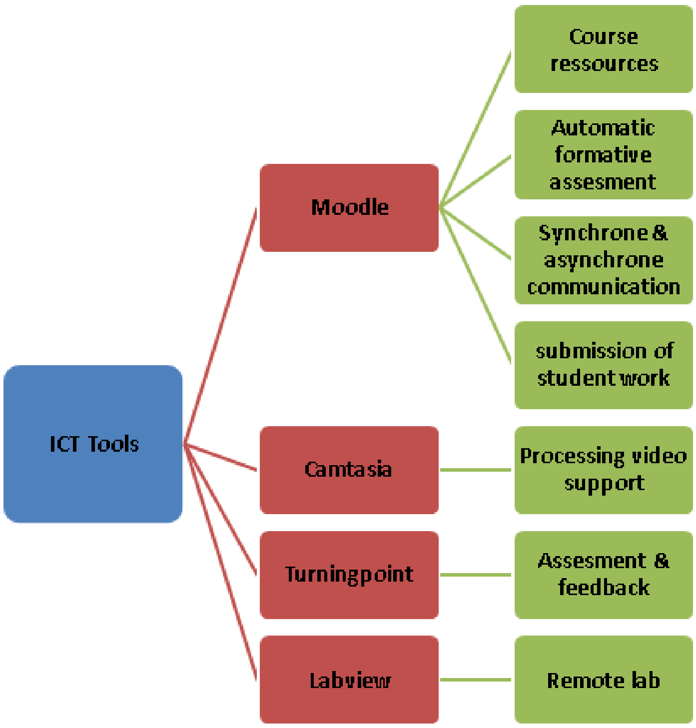

Figure 7: ICT tools structure

Enormous work is used to prepare scripts, record videos and do the editing. The practical software used is Camtasia providing the required work facilities needed. The development of the Quizzes is a delicate task and HotPotatoes software is used that allows preserving the quiz made for other uses. Moodle is the digital environment used to exchange with students, offering the possibility of auto correction of Quizzes. Moodle also allows opening Forum and submission of assignments and reports.

LabVIEW is used for the development of remote labs (LAD) and Turningpoint is used for quizzes evaluated with clickers.

5.0 Results of Flipped Classroom in Science and Engineering Courses

The proposed MML approach can be used in different learning context. In the framework of FODAR (Fonds de développement académique du réseau de l'université du Québec) projects funded by Quebec University, three varied experiences using MML were implemented in biological science and electrical engineering.

5.1 Signal and Systems Course in Flipped Classroom Mode (UQTR)

This experiment was conducted in the department of Electrical and Computer Engineering at UQTR for the course of linear signals and systems. The first half of the semester, the course was taught in a conventional manner where students sat and listened to the teacher. In the second half of the semester, the course was recorded on videos and made available to students on the web prior to attending the classroom. The classroom session was mainly reserved for questions and solving practical applications related to the subject. To do so, students were placed in small groups. Facing the change from conventional teaching, some students were anxious being out of their comfort zone. However, the majority of students did appreciate the recorded videos. Indeed, they reported that usually, they do not have time to grasp all the material during regular classroom period. They now have the chance to revisit the material at their own pace. It is also worth mentioning that for the first time, all students attending the class had the chance to express themselves; even the more reserved ones. Moreover, it was possible to identify parts of the theoretical foundations that were not well understood in contrast to conventional teaching; and take the necessary time to understand them. For example, in mid-exam results, students have failed some problems where the subject matter seemed to be well understood. This could have been identified using the flipped classroom mode. At the contrary, in the final exam, students were able to identify traps that they usually make when compared to previous years.

The diagram of Figure 8 summarizes different steps of the UQTR model adopted.

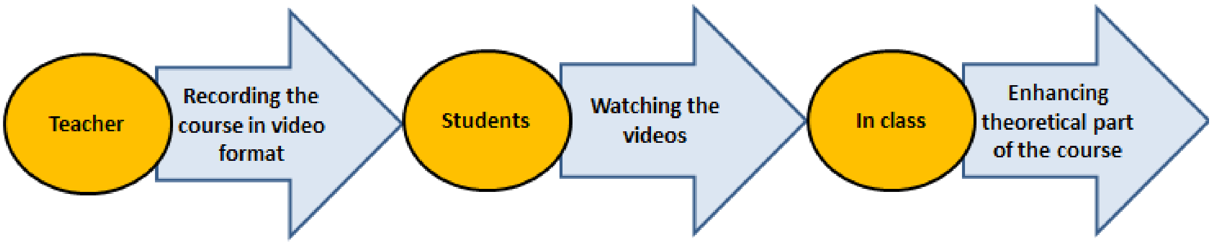

Figure 8: Flipped classroom model adopted at UQTR

5.2 Analog Electronics Course in Flipped Classroom Mode (ÉTS)

This experiment was conducted in the department of Electrical Engineering at ÉTS for the course analog electronics. For this pilot experiment, we sought to strengthen the approach by relying on the results of educational research.

In recent years many studies have been conducted to determine the technical and personal abilities required of engineers by today's industry. From (Mills and Treagust, 2003) report about engineering education, two critical issues are needed and addressed by the authors:

- Engineering curricula are too focussed on engineering science and technical courses without providing sufficient integration of these topics or relating them to industrial practice. Programs are content driven.
- Existing faculty lack practical experience, hence are not able to adequately relate theory to practice or provide design experiences. Present promotion systems reward research activities and not practical experience or teaching expertise.

These concerns led us to strongly consider the practical side of our experience on flipped classroom. It was decided to introduce the preparatory work (before the classroom session) by a video describing a practical problem situation (PROSIT). In addition, we used our expertise in the development of remote labs (LAD) suggesting the students to perform a laboratory experiment during their formative preliminary work. Students start their course by viewing an authentic problem situation (PROSIT) designed and built by the teaching staff in accordance with the subject of the course. Then they are asked to explore the course resources in different formats (video, documents, etc.) containing the basic elements of the course allowing a better understanding and analysing the problem of PROSIT. Thereafter, a series of quizzes are available through Moodle allowing students to evaluate themselves and the teacher to check later their achievements. Students are then asked to perform a team laboratory work remotely. The team access a laboratory set up via Internet and conducts an experiment related to the PROSIT and the course subject. The team delivers a concise report justifying measurement and experiment results on the basis of what was learned from the previous course resources. At this level, students are working in collaborative mode and remote mode.

In class, in face to face mode, activities are directed to answer questions and address weaknesses identified in the reports and quizzes. Then students are assisted by the teacher to solve other additional problems. The classroom session will end with quizzes using clickers allowing both students and teacher to check the level of knowledge and skills and eventually to address remaining weaknesses.

The diagram of Figure 9 summarizes different steps of the ÉTS model adopted.

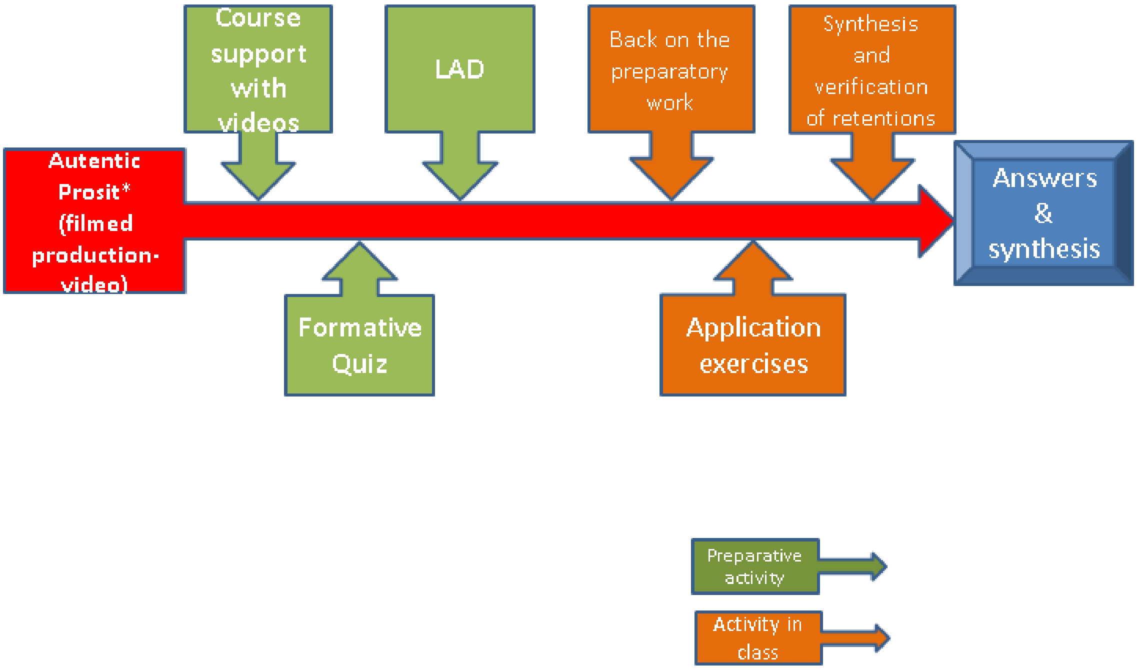

Figure 9: Flipped classroom model adopted at ÉTS

5.3 Physilogy Course in Flipped Problem Based Approach –UQÀM

This experiment concerns the physiology course at UQÀM. The course is given with the PBL approach. The introduction of reverse or flipped pedagogy aimed to give students the opportunity to learn some basic concepts before addressing the treatment of the problem situation (PROSIT). In this experiment, two pilot groups were initiated for preparative work before starting the PROSIT analysis. Two other witness teams have continued to work in conventional PBL approach. For pilot groups, student's team is invited to explore course resources in various forms containing the basic elements of the course and to better understand the problem of PROSIT. Thereafter, a series of quizzes are given through Moodle allowing students to evaluate themselves and the teacher to ensure the achievements of students. Students are then asked to perform a team laboratory work remotely and deliver a concise report to justify their measurement results in the light of what was learned in the previous steps. To assess learning outcomes, the same knowledge test was given before and after PROSIT analysis.

The experiment was performed with 48 students. 2 groups of 12 students were submitted to the test and 2 groups were not and as such were defined as control. The overall satisfaction of the 2 tested groups was excellent. The students really appreciated the LAD using their own material at home. In addition, the results obtained from quizzes performed before the final synthesis clearly demonstrates statistically significant better knowledge retention for the tested groups compared to the control groups (84% of good responses for the tested groups compared to 64% for the control groups).

The diagram of Figure 10 summarizes different steps of the UQÀM model adopted.

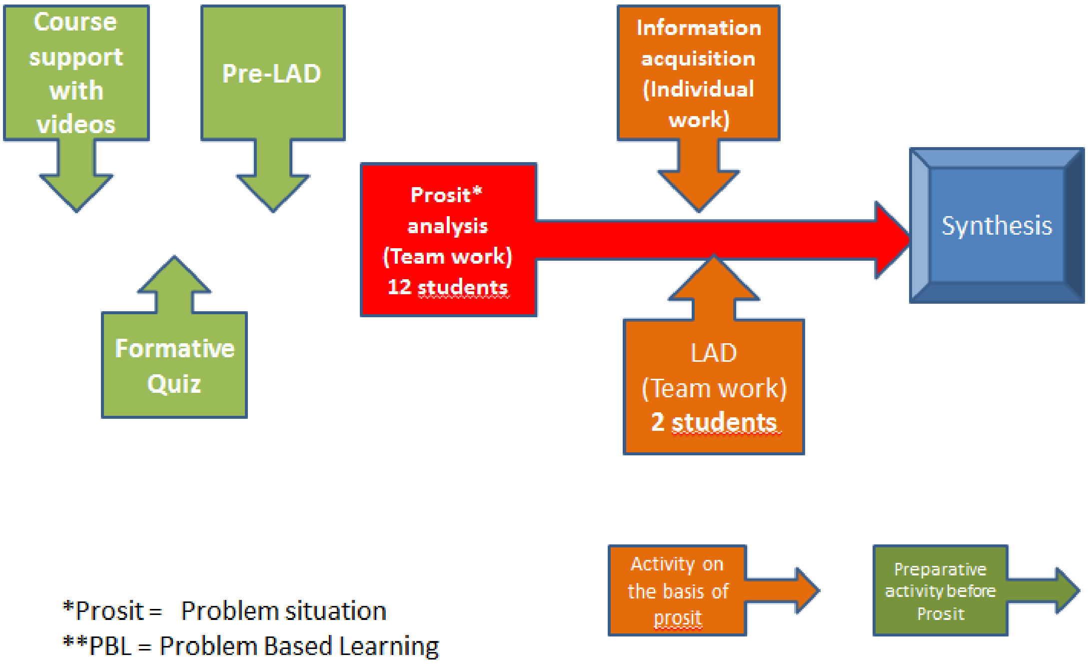

Figure 10: Flipped classroom model adopted at UQÀM

6.0 Discussion and Conclusion

Our developed model based on reverse pedagogy is distinguished by the multitude of modes in which students go through. These modes are enforced by the approaches we have chosen to promote motivation and student engagement which is well documented in the literature for both the PBL and the preparatory work with their formative assessments. The contributions of practical work as well as the synchronous collaborative work of LAD are favorable to support learning. Each mode provides technical feature and can also break the monotony of traditional teachings. The facilities of the Internet and related technologies (laptop, tablet, smartphone) in our model give great autonomy and flexibility to the students. They are allowed to freely organize their activities in time and space even for laboratory that can be completed anywhere. This is what justifies the mobility of our approach that we have called Multimodal Mobile Learning (MML).

Our model is based on efficient approaches to university teaching and largely operates with ICT facilities. We believe that this model strongly follows the trend of techno pedagogical developments. Increasing the performance of ICT will appeal the users with our proposed learning approach. The experiences described in the implementation of our model have showed encouraging results. Students who took the course at UQTR showed great motivation for the method, they particularly appreciated the flexibility of the method and the autonomy of the student being capable to learn at their own pace.

The experience at UQÀM revealed good satisfaction of all students. The comparison tests between two pilot groups and two control groups showed very favorable results with the introduced method.

The experience at ÉTS has shown that students particularly appreciated the contextualization of the problem PROSIT with a video capsule and the final tests with clickers. However, they feel that the time required for the preliminary work is excessive.

The prospects of this work will be to improve the resources made available to students as well as enrichment activities provided in the classroom. We will also explore the possibility of sharing resources between the three institutions projects, particularly in terms of laboratory work. We will reserve a special focus on the evaluation of the contribution of the method and the literature of the educational experience.

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