Computer assisted interactive learning in medical education: Flipped classrooms in clinical neurology for MD students

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Abstract

In the interactive learning process called "flipped classroom" students are directly involved through personal choices among the learning material. Students learn best when working together actively developing the lesson subject. We set Clinical Neurology university lessons on line, interactive, and with the "flipped classroom" modality. Over 400 videos of the main pathologies were filmed in our university hospital. Diagnostic criteria, exams needed for the diagnosis, therapeutic options were also explained in short movies. All this material was uploaded on the *Moodle* platform and lessons spliced in preparatory exercises and flipped lesson. Three-to-five people student groups using wide screen PCs actively participate to the lesson. The teacher leads the classroom circulating around students' groups engaging them in discussions. Lesson subjects are presented either as quiz series related to symptoms, laboratory and instrumental exams, and treatments or clinical case videos with students asked to propose a diagnosis. Students are also invited to choose among progressive multiple choices leading to clinical diagnoses or treatment strategies. When the group gives an answer, a multi-medial link shows a related clinical case showing how the answer is correct or wrong. The lesson becomes therefore a real-world interactive experience of clinical practice with videos of patients describing their medical histories or of physicians examining patients.

Keywords

Active learning, Flipped classroom, Student centered teaching methods, Cooperative learning, Global university, Global education.

Introduction

Actual educational options, both at school as well as at university, are mainly based upon traditional lectures reading paper textbooks or with slide presentations. In such lessons the student learning process is mostly passive. The new web-based communication modalities allow, both in primary and in secondary school on line lessons stimulating active student participation. On the other hand, in university teaching and namely in the medicine field, a few scattered attempts of on line lessons were limited to traditional lectures (either movies of teachers speaking over slide presentations or more simply slides with audio explanations) posted on a web site. These contents are certainly available everywhere to the students are but they lack their active involvement. Main US (MIT, Cambridge, Massachusetts; Stanford, California) or UK (Oxford, Cambridge) universities just began offering on line courses both for free or with fee. Educational companies, such as *Coursera* (www.cousera.org) or *Udacity* (www.udacity.com), offer free on line courses and such a world-wide spread of university instruction is thought to be a basic step to allow thousands of developing country students to get out of isolation and, probably, of poverty. They are, however, mainly technical courses (computer science, economy) and almost always offering just on line lectures and sometimes auto evaluation tools.

Learning is hugely enhanced with the innovative pedagogic process called "active learning" where students are directly involved through personal choices among the instructional material offered by the teacher. In this way students build up their own path to achieve and understand lesson goals (Michael, 2006; Duncan, 2005; Robertson, 2000). Students are not passively offered the learning material, but they are led to understand and learn it both developing individual skills as well as working in small groups. The lesson is offered to small student groups (of 3-5 students) where students talk with each other becoming naturally more active (or even better: interactive). Students think about the provided information and the proposed problems and show their thoughts to the group or to the entire classroom (Armstrong, 2012). Obviously, when an individual student reaches an impasse, he or she is stuck, calling on teammates can provide additional resources and successful learning paths. Seeing how others approach problems can be very valuable, especially for students whose performance is low. The differences between passive and active learning are summarized in the Dale's cone of learning (Dale, 1969) (Fig.1).

Figure 1 – Dale's cone of learning

As student attention is drawn into analyzing different situations, teacher circulates around the classroom and engages students in semi-Socratic dialogs where students are asked to explain their thinking. Semi-Socratic dialogs are often used to help students resolving cognitive conflict. Such a reversal of the traditional perspective has been called the *flipped classroom* (Mazur, 1997; 2009): the teacher is no longer the only knowledge holder and the student becomes a part of teaching no more as a passive listener but as a creator of personal experiences with didactic goals. Even the classroom environment should be redesigned to better promote active, collaborative learning. Classrooms, besides offering the technology for web navigation, should be set to facilitate group formation and teacher-to-student interactions. To this regard an interesting project is the *Scale Up Project* (Beichner, 2006; Beichner et al, 2006).

State of the art

Clinical case video archive. The main pathologies usually presented in a Clinical Neurology course, with the possible comparisons useful for the differential diagnosis, have been filmed from both the inpatients as well as the outpatients of our university hospital. Each clinical case history is usually summarized in a short (2-3 min) video. These videos last only a few minutes not to overload lesson flow. This activity started one year before the first on line interactive course and is continuing nowadays by more than 4 years. Also the diagnostic criteria, the laboratory and instrumental exams needed for the diagnosis, the therapeutic options with their limits and side effects have been explained in short (2-3 min) movies by filming the clinical activity of a neurologist or of a neurophysiological or laboratory technician, or by interviewing patients about treatment efficacy and side effects. Their exam results have been collected in digital format. Disclaimers needed to show patients' pictures for scientific or didactic aims have been obtained, following the current laws prescription about privacy policies (Italian law, June 30th, 2003, n. 196). More than 300 videos have been prepared from our patients. Missing clinical cases have been obtained thanks to the collaboration with other university hospitals; from online video services such as Youtube, Vimeo and others; or from electronic textbooks (showing them with the needed copyright disclaimers). All this material has been processed in formats or playlists uploadable on a Youtube account which allows an easy and suitable on line use with full compatibility with mobile device. At the same time Youtube allowed us to protect our videos: our contents are not included in Youtube search results in order to be compliant with the patient's privacy policies and the videos are accessible only through our *Moodle* website.

Preparatory exercises. In order to actively participate to the in-class lecture, students must roughly know the subject. For this reason each on line lesson has been divided in two parts: the preparatory exercises and the lesson itself, both implemented on the *Moodle* website (Fig. 2).

The course format adopted is the Grid Format, where each single section is showed in a separate page. The main page of the course is a collection of boxes with significant images that point to each single lesson.

The first section is used for basic instructions on how to use *Moodle* and for sharing some initial information about the course. The second section is filled by simple quizzes, one for each lecture, where the unique question is " Are you here today ? ": this is a simple way to get quickly students' attendance to the lecture. The quiz is available only at the start of the lecture for a short time, so that the students can assert their presence answering to the quiz.

Figure 2 – General view in the *Moodle* website of the first lessons of the course. Note the two parts of each lesson, preparatory exercises (left); flipped lecture (right)

From the third section we have the course lessons. The "Exercises" are the homework the students have to study before the lecture. It includes a PDF file of an handout with an extended summary of the lecture subject and a series of *Moodle* quizzes and multiple choice tests that analyze and develop this subject. The PDF format was chosen because can be simply printed and managed even without the web. The quizzes are typically composed by a short number of questions, where most of them contains a single question; this is useful for creating a better feedback for the students which fail the quiz. A new explanatory video, or other resources which can help to understand the mistake, are, in fact, embedded into the feedback to the response. On the other hands, by giving the correct answer to a quiz, students activate a link to one of the videos showing how to examine a patients, which exams are needed for the diagnosis, how to do the tests needed for the diagnosis, which drugs to give the patient. Multiple choice tests allow the students to build up the mental process leading to the diagnosis. When the student proposes a diagnosis a clinical video of patients saying their clinical histories shows the student whether the proposed diagnosis comply with the lecture subject. Clinical histories of patients with the disease object of the lecture or of other patients with similar diseases are also compared to this regard. The *Moodle* section also include images of clinical exam results or videos where physicians or technicians explain parts of the lesson in order to provide a complete overview of the subject.

Students are encouraged to read, see and practice such material before the interactive classroom. Students coming to class already acquainted with the material are able to perform in-class activities at a higher level. Students knew the lecture subject in advance by the course program posted on the university website at the beginning of the academic year. They could therefore practice with the lecture material in the days before. In addition during the week preceding the Clinical Neurology lecture, the teachers of the basic science courses (anatomy, physiology, biochemistry and pharmacology) give the students the scientific bases to better understand the lecture subject. In our courses, in fact, basic science and clinical medicine teachers acts concurrently to better develop the subjects of each course.

The interactive flipped classroom. The lesson proceeds then in the classroom. Students are divided in small groups (3-5 students) with one laptop or portable PC with earphones for each student. After connecting to *Moodle* the teacher, along with the students, takes care of the main concepts of each part of the lesson (parts concerning the diagnostic-therapeutic flow of clinical practice: patient's history, patient's clinical evaluation, laboratory and instrumental exams, differential diagnosis, treatment). For each part, a page resource is shown for a quick read and discussion. The page resource can be a composition of text, images or video depending on the lesson subject.

Then each single part of the lecture goes on in two different ways. (1) Presentations of videos showing clinical case histories where students are asked to describe the symptoms they have seen; the possible diagnosis and differential diagnoses; the laboratory tests required for the diagnosis; or the possible treatments or their side effects. In this case videos are used as a basis for the execution of the students' assignment, that is to write down the analysis of the presented clinical case. (2) Students are asked to build up a flow chart to reach a diagnosis or propose a treatment strategy. On the web site the words (or brief sentences) needed for the flow chart are presented and the students have to choose them and write them in the correct sequence building the flow chart thanks to a *Moodle* activity based on "*mindmap*". The two types of assessments (assignment and "*mindmap*") can be found freely mixed into the same lesson following the specific teacher strategy. This linear structure is effectively understood by students, minimizing the impact of the web tools on the classroom.

During the flipped classroom the teacher, rather than standing in front of the students talking from the other side of the teaching desk, continually circulates in the classroom engaging students in discussions about the solutions or diagnoses they propose (Fig. 3).

Figure 3 – In the flipped classroom the teacher stays in between students' groups (left) and circulates around the classroom engaging students in discussions about their assignments

The teacher can also perform a real-time analysis of the answers given by the class. *Moodle* allows showing a student's answer that can be discussed with the whole class on the basis of the correct answer (Fig.4).

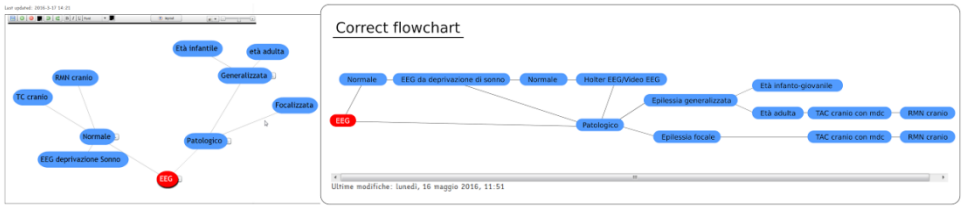

Figure 4 – Comparison of a student's flowchart (left) and the teacher's flowchart (right)

During the first two academic years this lesson modality was used (2012-2013 and 2013-2014) we noticed that only a few students got prepared to the flipped classroom. In each student group there was, in fact, a leader actively participating to the classroom correctly analyzing the various tasks and driving the other students to the solution. Most students copied the results of each test from the leader passively learning the lesson subject. For this reason we decided, in the two last academic years, to give the students a reward of an half/30 if the student gave the correct solution to most of the tests of each lesson. By correctly working out all assignments for the 16 lessons, the student can arrive to the final exam with the starting score of 26/30 (Italian 30-point scale, corresponding to "C" in ECTS grade, and "satisfactory" in the US definition) which can be accepted as such by the student or improved (but also

worsened) facing the usual written/oral exam. By this way most students resulted to join the flipped classroom much better prepared.

Conclusions and future developments

Our lesson modality asked for an active student participation as a thoughtful problem solving activity. The students were no longer simple passive listeners, becoming the actors and creators of their own instructional experience. The interactive discussion within the group and the emotional stress to give the right answer kept student concentration at a top level.

In addition, a simple rewarding mechanisms embedded in quizzes and assignments further stimulated the active attendance. When the students group gave the right answer or reached the right diagnosis, a multimedia link showed a related clinical case taken from our clinical case video archive made by filming both the inpatients as well as the outpatients of our university hospital. Most tasks were organized as direct comparisons of different clinical cases presented with videos of real patients. The flipped classroom therefore became a real-world experience of clinical practice showing videos of patients describing their medical histories or physicians examining patients. Such an experience was aimed to enhance student attention and memory, bringing the students toward their future clinical practice. With reference to the Dale's cone of learning (Fig.1), our interactive flipped classroom simulates and enacts the real clinical experience, enhancing learning and memorization up to 80 % more than a passive lesson modality.

During the flipped classroom the teacher circulated around the room and engaged students in dialogs asking why they proposed a certain solution or diagnosis. Teacher-to-students interactions have been enhanced and the teacher was able to check student choices and solutions in order to finely tune the lesson subject according to student proficiencies.

Our work is a preliminary experience of computer assisted interactive flipped classrooms in clinical medicine and was not designed as a controlled study, with a comparison to a reference group of students following a course done with traditional lectures. However, indirect data on students satisfaction, interest, and performance can be drawn. In our university, the Clinical Neurology course was standalone (4 ECTS) up to academic year 2012-2013, and, thereafter, became part of a larger course integrating Clinical Neurology, Neuroanatomy, Neurophysiology, Neurobiochemistry, Neuropharmacology and Psychiatry (17 ECTS), all to be evaluated on the same exam day. This large course could have, well, discouraged and disappointed the students. However their satisfaction and motivation, as measured by the student opinion questionnaire from the national higher education quality assurance agency (ANVUR), did not change significantly for years 2012-2014 (large course and flipped classrooms) with respect to 2009-2011(short course and tradition-

al lectures), indicating that flipped classrooms were of some help to afford such a change. A second indirect evidence is the increasing number of students choosing Clinical Neurology as a subject for their MD thesis in the last three years, indicating a growing interest for this subject following the introduction of the flipped classroom.

Drastic improvements of the organization of School of Medicine university courses could occur with the progressive involvement of all clinical fields in the on line interactive lesson modality. Other university Faculties can be involved in the interactive lesson modality. The English version of the interactive lessons can be uploaded on the web and become world-wide usable offering university education to developing countries.

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