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Freedom of Master's Degree Students to Study in Health Curricula: Switching to Optimized Blended Learning as a Solution!

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Summary

Objectives: The Grenoble (France) Master's degree in health includes 17 sub-specialty programs, 120 separate teaching units (TUs) and caters for up to 400 students per year. We present the pedagogical transition to blended learning based on flipped classroom initiated in 2010 to overcome the pedagogical limitations of classical lectures.

Methods: The pedagogical organization of each TU is based on the weekly and sequential implementation of five sequences. The first three sequences comprise the learning stages of (1) self-learning on knowledge capsules, (2) interactive on-line questions and votes of interest, and (3) interactive on-site training and explanation meetings. The last two sequences include the evaluation stages with (4) positioning tests, and (5) an anonymous evaluation of the TU allowing access to personalized follow-ups. This pedagogical sequence is completed with a final certification on a tablet computer.

Results: The systematic evaluation and debriefing sessions of TUs gave us a clear SWOT vision of the revised Master's degree in health. The feedback was very positive from students, teachers, and the institution, which encourages us to move forward in this transition. Nonetheless, some of this positive feedback was unexpected, such as the ease of managing mobile learners (e.g. Erasmus, International internship) or personalized reinforcement.

Conclusion: Our results indicate that a switch to blended learning is feasible in a large Master program, with improvements on student/teacher equity and for the institution.

Keywords

Models, educational; health education; formative feedback; academic performance, distance learning

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1 Introduction

The Master's degree in Health Engineering [1] is the only one offered at the Faculty of Medicine and Pharmacy in Grenoble (France). It has been built in 2003 in order to rationalize a combination of previously existing master's degrees. This revamped Master's degree educates more than 400 students and is composed of 17 sub-specialty programs that together comprise more than 120 different teaching units (TUs). This modification helped rationalize teaching resources by bringing teaching teams together so as to eliminate redundancies when a given topic was taught in separate uncoordinated degrees, as it was the case prior to the creation of the new Master's degree. Moreover, prior to the creation of the Master's degree in Health Engineering a student was expected to attend all the lectures then pass final end-of-semester exams in order to validate a given TU, without personal follow-up or adaptation of courses to his/her level and needs. On the contrary, the revamped Master's degree required the design and implementation of quality education criteria to adapt education modalities to the heterogeneity of students' levels but also to offer individualized training that is always qualitative and equitable. One of the major drivers for changing the previous organization of multiple master's degrees was the significant increase of the number of master students, which was a consequence of the increased attractiveness of Grenoble's unique health technology ecosystem. Besides, the teaching team recognized that there was a lack of personalized follow-up of students, as well as of personalized feedback to teachers and institutions. All of those drivers prompted the teaching team to propose and implement this pedagogical transition initiated in 2006 within the Faculty of Medicine, and to create the new Master's degree.

Since the infrastructure and human resources of teachers remained unchanged, it was necessary in 2010 to adapt and develop education and innovative assessment of health training since 2003. The changes in the teaching paradigm were inspired by the one initially described in 1990 by Dean E. Mazur from Harvard [2], with the implementation of a teaching methodology based on the "flipped classroom" model and the theory of multimedia learning using information and communication technologies for teaching [3, 4]. In 2006, the Faculty of Medicine initiated its full transition to a blended learning model based on flipped classroom which has since then been extended to all years of the medical curriculum, then to the Faculty of Pharmacy, and beyond [5]. Other studies have reinforced this change in the educational paradigm, confirming the value of such an optimized approach [6, 7]. This reform allows to make students active in their learning, to ensure equity in examinations for all students by offering the same working conditions regardless of the number of students enrolled, and to introduce new teaching methods to reinforce student learning through understanding rather than by rote. In addition, because of

the significant increase in the number of students enrolled, these innovative education modalities have provided an effective way of organizing teachers' time to ensure the quality of courses but also to focus the teaching contribution to the practical application of knowledge. These education modalities have made it possible to optimize the logistical infrastructure available, without having to build a 400-seat amphitheater. Existing training rooms such as 40-seat practical workrooms and 200-250-seat amphitheaters have been used extensively with usage rates of 12 hours per day. The Information and Communication Technologies for Education and an IT platform dedicated to the Master's degree in human learning were the main tools used in this paradigm shift.

The pedagogical re-organization allowed the detection of students' level of knowledge in TUs and provided a means to propose learning paths that were adapted to those levels. Similarly, offering autonomy and adaptation of individual learning tasks in a free but structured format allowed for greater equity in training by providing the time and personal organization necessary for each student's learning. For involved teachers, the creation of the single Master's degree has made it possible to overhaul the content of TUs and to rationalize the two years of master's studies. This has also provided a basis to standardize the content in terms of levels, with the removal of contents that were too basic and hence unsuitable for the master's level. In this paper we summarize the results from the formal feedback we collected on the implementation, advantages, and limitations of these innovative education modalities.

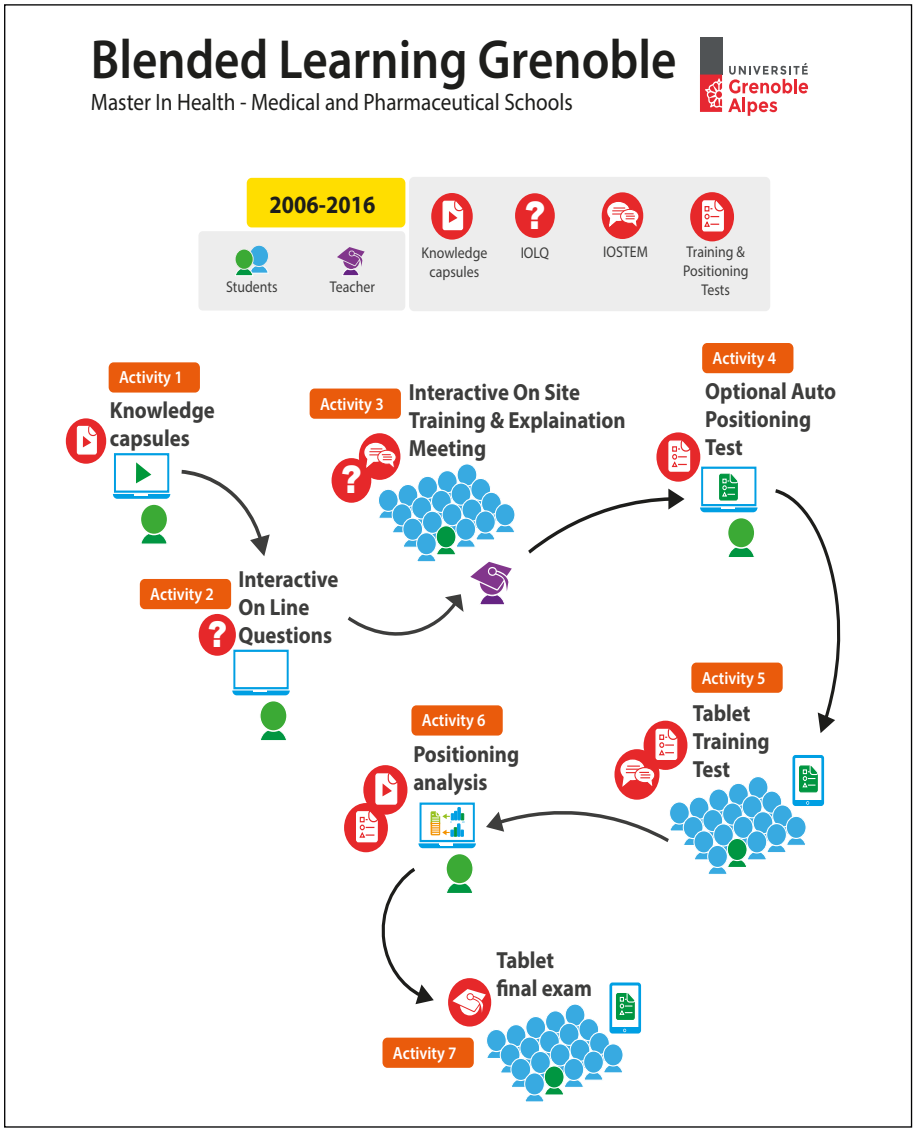

Fig. 1 Blended learning model based on flipped classroom.

2 Methods

2.1 General Information on the Teaching Methods Used in Grenoble

Since 2006, medical curriculum in Grenoble has relied on the principle of blended learning based on the flipped classroom principle (see figure 1). We therefore mix distance and face-to-face times for learning, but also for continuous evaluation. The lecture part of the course provides the transfer of knowledge that is completed without the presence of the teacher, whilst the work on the application and the explanation of the course (illustration exercises, assignments, problems, and other activities) is done in person by the teacher in a classroom. This original model has been declined and adapted to the needs of the Master' degree.

2.2 Pedagogical Model Used for the Mediatization of TUs in the Master's Degree

Within this framework, teaching is organized in sequences of consecutive activities with three learning activities and two evaluation activities per week (see figure 1). In the first activity, the student must study scripted knowledge capsules (KCs) and make summaries of each one. The second activity is devoted to questions related to the KCs of the previous activity. Learners will either post their own questions or vote for others' questions but always using the Interactive On Line Question (IOLQ) module. Questions are accessible to all groups so that everyone can try to answer or check them with a "like" to quantify a question's interest. At the closing date of the module, questions are sorted in descending

order of interest and then sent to the teacher-in-charge so that he/she can prepare his/her Interactive On Site Training and Explanation Meeting (IOSTEM). The third activity corresponds to the first face-to-face contact with the teacher in charge of KCs. It is a one or two-hour IOSTEM which allows learners to better understand the content of KCs and how to put it into practice as a true health professional.

The first three activities are therefore focused on knowledge acquisition, whereas the following two activities (4 and 5) are focused on practice acquisition and the last two activities (6 and 7) offer training quizzes. Activity 4 is fully autonomous and allows students to test and re-test as many times as needed. The fifth activity is organized according to the same modalities (on a tablet, in dedicated, connected, and supervised rooms) as the final examination of activity 7. Activity 6 has two overlapping steps, the first one being an anonymous pedagogical evaluation of all these activities. Successful completion of this anonymous evaluation is mandatory to move to the second step that provides a personalized result of the tests. Finally, the last activity of the Grenoble organization is the final exam performed on a tablet with a random display of questions and items. The exam is corrected immediately and securely by the examination server. Each sequence is organized for a volume of KCs adapted to the number of European Credits Transfer System (ECTS) (dematerialized lectures are not an unaccounted-for surplus of work for students).

2.3 Optional Innovative Pedagogical Activities Offered to the TUs of the Master's Degree

Some TUs benefit from optional innovative educational and evaluations activities, such as an initial positioning test. This test allows creating three groups of levels of increasing difficulty, from low to medium to high. The same global content is then proposed, but in three different forms depending on the group level. Students in the high level group will not waste their time and those in the low level group will be able to receive more attention from teachers. This has been put into practice for the "clinical research initiation" TU. This approach has been widely developed with the introduction and dissemination of digital desktop tools and the widespread use of tablets during digital exams.

Another activity allows the detection of errors in the Multi Choice Questions (MCQs) used during evaluations and allows the selection of KCs in self-catching only those related to the erroneous responses of the student's MCQs.

A digital skill file repository is also proposed in particular for the "Information and Communication Technology (ICT) in health" teaching unit. Over four months, this activity allows students to produce personal digital content at their own pace, put it into an e-portfolio, and finally self-assess it. This implementation allows a high degree of autonomy in the student's production over a long period of time and is often associated with a collaborative approach. It is secured through a personal repository with official digital identification provided by the university system. Thus, each student progresses at his own pace and can give feedback to the teacher of his own skills. Thus, the majority of mediatized TUs now use dematerialized exams to validate knowledge.

Finally, another peer review activity complements the range of innovative activities on collaborative student productions. Each student produces a standard compulsory content which is made anonymous and distributed to two other students in order to be evaluated and justified according to a predefined grid.

Two final activities contribute to improving the evaluations of TUs. A systematic anonymous evaluation following the same structure of questions for all students is focused on the organization of TUs. All students must complete this evaluation before the final test. These systematic individual assessments are the basis for a debriefing session with the responsible teachers, student delegates, and health administration to propose changes for subsequent sessions.

3 Results

Grenoble Alpes University has opened many teaching units in digital training and blended learning based on flipped classroom, particularly at the medical school and the faculty of pharmacy. Several teaching units also use digital learning and flipped classroom in health engineering masters. Of the 120 TUs offered by these master programs, 10 follow this format at least partially, mainly for transversal TUs and in the fields of medtechs, statistics, and biotechnologies. Each year, new TUs are converted to this model for different reasons, essentially based on the good will of the person in charge of the TU and the students' request. As all TUs are systematically evaluated, this feedback, combined with the biannual debriefing sessions involving students, teachers, and administration staff, allowed us to build and define the SWOT of this model as presented in Table 1.

We analyzed one transversal TU of the master's degree, the "Basic BioStatistics and Modelling Tools" TU offered to all first-year students of the Master's degree. Between 90 and 220 people apply every year to follow this TU. In 2019-20, there were 118 registrants including at least five ghost students who did not participate in any learning or assessment activities. Up to 80% (91/113) of the students completed the TU form. Table 2 shows the results of the systematic evaluation realized by students of the first year of the Master's degree.

The form always ends with a free field of expression in which students provide comments that are considered to identify areas for improvement. Examples of these comments include: "During the positioning tests, we are not asked about R-Software, so why so many R's during practical works, why not give us directly some tracks to interpret?", "Online courses not very fun", "The videos of the courses, some of them not very clear", "Practical works: it's complicated to concentrate in amphitheater and sometimes you don't have time to do the exercise by yourself, think about it", "The ANOVA course was not dynamic enough unlike the other courses which were more participatory", "More application exercises", "The IOSTEM allows you to 'review' and repeat some important points, so perfect", "The teacher answers all the questions asked and tries to really understand where the difficulties are for the students, which makes IOSTEMs very

Table 1 Master in health SWOT focused of the blended learning teaching units based on flipped classroom switch.

STRENGTHS	Learning autonomy & freedom of learning Learning equity Multi-Platform access: Windows, Linux, MacOS, Android, iOS. Not downloadable content Available 24 hours a day, 7 days a week Helps in preparing for the final exam Personalized evaluation feedback: learning analytics More interaction between learners but also with teachers Fewer passive face-to-face sessions, such as in lectures Automatic copy correction, teaching analytics
WEAKNESSES	Dependence on IT tools and networks Need for security of exam servers Re-learning to teach, leave their comfort zone of lectures Additional in-service training required for teachers and the administration Learn how to adapt your courses in IOSTEM Obsolescence of the technical and content-related on-line learning modules
OPPORTUNITIES	Public policy favorable to the development of innovative solutions Trend at the student and institutional levels in the demand for innovative and disruptive pedagogy
THREATS	Teacher: significant initial investment in the transition to blended learning Teacher: significant initial investment in the preparation of IOSTEMs Digital tool dependency Wi-Fi network dependency Secure VLAN needed

Table 2 Summary of the final evaluation of the Master's Bio-Statistics TU (n=91)

n (%) [CI95]	Positive (Very Good and Good)	Negative (Insufficient and Very Insufficient)
Quality of knowledge capsules	75 (82.4%) [74.6 - 90.2])	16 (17.6%) [9.8 - 25.4])
Quality of the supports used in IOSTEM	68 (76.4%) [67.6 - 85.2]	21 (23.6%) [14.8 - 32.4]
Quality of the explanations obtained in IOSTEM	73 (84.9%) [77.3 - 92.5]	13 (15.1%) [7.5 - 22.7]
Interactivity during IOSTEM	74 (88.1%) [81.2 - 95.0]	10 (11.9%) [5.0 - 18.8]
Interest of courses in your professional project	76 (83.5%) [75.9 - 91.1]	15 (16.5%) [8.9 - 24.1]
Organization of this TU	67 (73.6%) [64.6 - 82.7]	24 (26.4%) [17.3 - 35.4]

interesting and helps people in difficulty", "All misunderstood notions were addressed. The session is very interactive and it is easy to start asking questions".

4 Discussion

Blended learning based on flipped classroom is not an obstacle to learning or teaching at the Master's level [8]. Flipped classrooms are available both at Master's degrees and for medical training [5]. After nine years of using this "flipped classroom" approach, the ~200 annual master students feedback relating to KCs and to IOSTEMs are between 66% and 75% positive. Even the usually undervalued subjects, such as biostatistics, succeeded in mobilizing learners to become active participants. The switch to blended learning could equally be applied to large or small ECTS. The blended learning approach is particularly adapted to TUs that provide prerequisite content. This allows teachers to be focused on higher value-added steps such as skills and abilities [5, 9].

4.1 Master's Students

Free access to KCs and on-line interactivity modules are a training advantage regardless of the terminal (computers, tablets, smartphones, connected objects...). These scripted KCs, in small sections of five to 15 minutes, allow students to listen without extraneous noise (such as what occurs amongst students in a classical lecture room) and to be rapidly focused on the subject of the KC. Screen-based materials do not change much in the reading of courses compared to paper-based materials [10]. In comparison to the tension of a large amphitheater, where inhibiting the participation of learners to ask questions is often observed, the on-line capability to ask questions coupled with the anonymity of results allows learners to more frequently ask relevant questions. Moreover, the capacity to submit a written question provides time for reflection and allows the learner to pose a more thoughtful question [11]. Finally, offering learners to vote or not on the questions asked by the others in the group also

allows them to practice by trying to answer the question by themselves. Thus, there is an added pedagogical value for the learners in preparing written questions.

Another advantage of this blended learning approach is the freedom of learning time and learning location (e.g. Erasmus, International internship), which also leads to a reduction in the stress of accessing amphitheaters and reduced travel costs. The students are required to travel to the classroom only for activities devoted to the face-to-face exchange of skills and abilities. In addition, the "new" autonomy such as collaborative work can be more complicated to manage for the students if it is always needed to travel to a central location [12]. For this purpose, intermediate steps based on knowledge tests are added during the KCs in order to provide personalized follow-up to learners with positioning in relation with the other students but also with personal progress between tests and personalized advice. The blended format eliminates the time spent in lectures where most of student activity was concentrated on note-taking. IOSTEM time is no longer focused on note-taking but on putting this knowledge into the perspective of a professional application. Students become more active participants, more involved in learning and they improve their knowledge with the skills they acquire.

4.2 Master's Teachers

Concerning the organization of a TU, the switch to blended learning depends on at least two factors: (i) the involvement of the professor in charge to reorganize his teachings and record capsules; and (ii) the possibility of completing the switch because some lessons are not adapted to blended learning (e.g. practical classes that require bench time or very specific technical equipment). Theoretical thinking or prerequisites are perfect candidates for switching to the blended learning approach. The involvement of teachers is also a key element [13], with an initial reluctance and fear of the unknown to make a complete teaching change. The teacher leaves his comfort zone; he must learn again to teach according to these new modalities where classical lectures are replaced with pre-recorded KCs and IOSTEM sessions. The initial investment is important for the implementation of these modalities with a complete overhaul of supports, the scripting and the recording of KCs. The list of questions asked is also a heavy task in the first years, to correct inaccuracies or errors in KCs (the questions are the first evaluative feedback of KC quality). This list of questions is transmitted by different means of communication (platform and email) and sorted by the number of votes, allowing the teacher to better prepare his answers to priority questions. The free feedback and comments of the systematic evaluation are always thoughtful and they allow a reasoned exchange during the final semi-annual debriefing session. The obligation to prepare closed-ended questions for positioning tests but also for certification tests requires the teacher to organize himself beforehand in order to provide "turnkey" tests that also include corrections to the questions. The Learning Management System also provides analytics to categorize MCQs and provide a balanced draw of MCQ series for subsequent events. There is no more correction delays or variability in the correction. Statistical analyses of the corrected copies also make it possible to update potential correction errors. Finally, the summary tables of the tests can be automatically sent to the semester jury of the master.

4.3 Master's Institutions

The use of new digital tools for managing positioning tests and terminal tests has also created a major change in the administration. Assessment procedures for the blended learning approach require less paper logistics and also less exam supervisors. Also, there is no need to specifically anonymize paper copies, there are no longer heavy piles of paper copies to transmit for correction, the time for correction is reduced and there is less risk of losing the paper copies. But there is an important constraint on the need to work in conjunction with the faculty's digital services to ensure optimal and interference-free Wi-Fi access. For this point a virtual local area network (VLAN) is required to secure proofing and transmission of digital copies.

5 Conclusions in the Context of General Pedagogy in Other Institutions

The development of student autonomy is a central concern of trainers setting up blended pedagogy, whatever its form [14]. Promoting autonomy in the technical, methodological, social, and language fields looks obvious in these training courses. On the other hand, the psycho-affective, informational, cognitive, and metacognitive aspects seem to be less taken into consideration. Some very specific training contexts may require the use of blended learning in order to make the school career more equitable. For example, access to knowledge of minority populations [15]; or, closer to Grenoble Master's degree in Health Engineering, equity in competition [16].

The development of blended learning in recent years has led to regular pedagogical innovations adapted to different learning contexts. As the paradigms are different in each case, it seems difficult to find a recipe that can be adapted to each learning situation. However, the panel of existing methods, ranging from the simple revision of knowledge on digital media to completely reversed teaching [17, 18] allows any motivated teacher to be able to engage students.

There are some additional advantages of switching the educational paradigm to a blended learning approach, including an easier follow-up of students with an activity such as internships, Erasmus internships, or professional public in continuing education, just since it becomes feasible to forward a TU or a piece of a TU to students in other cities or even other countries. Thus, this facilitates exchanges of TUs or courses within the master but also beyond. As a consequence, it may be considered that switching to blended education is ethically beneficial, as "equithical" training.

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