Blending a MOOCs with Interactive Teaching

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Key words: Geomatics learning, Massive Open Online Courses, blended learning

SUMMARY

When Massive Open Online Courses became a hot topic in Europe. The Ecole Polytechnique Fédérale de Lausanne (EPFL) decided to take the challenge and launched an internal call for proposals. At the Geodetic Engineering Lab, we saw a possibility to use contact hours for exercises and fieldwork, rather than telling stories and showing diagrams. External students were considered, but the main purpose was to modernise the first year course "Fundamentals of Geomatics" for approximately 250 civil and environmental engineering students.

As the bid was successful, we started with the design of the lectures, followed by the recording sessions in a special studio. Combining photographs, sketches, speeches and quizzes into a video requires a precise script. For one hour of teaching, ten hours of preparation and processing are not always sufficient.

The new formula for the course was implemented during the 2014 spring semester. The two hour session remained in the weekly program, with more assistants and other expectations. Regular students took classical mid-term and final exams. At this stage, an incidence of the teaching method on the level reached cannot be ascertained, but neither a miracle, nor a catastrophe took place.

Simultaneously, the course was made available worldwide via the Coursera platform. Many people watched the short teaser. Some registered, but few of them did all the assignments and qualified for the statement of accomplishment (issued by Coursera, not EPFL).
The activity level of the website was monitored. Some elements of evaluation by the students have been analysed. Reactions are widely spread, from "Bring back the professor!" to "Why not 100% MOOC?". Surely, the second edition will bring a more balanced feedback and motivate some improvements.

Having opted for a blended approach, the active promotion of this course outside - Western Africa comes first to mind - depends on partnerships with local universities.

RESUME

Lorsque l’ouverture des « cours massifs ouverts en ligne » est devenue un sujet brûlant en Europe, l'Ecole Polytechnique de Lausanne (EPFL) a décidé de relever le défi et a lancé un appel interne à propositions. Au Laboratoire de topométrie, nous avons vu une possibilité de libérer des heures de contact pour inclure des exercices et travaux pratiques sur le terrain. Les étudiants externes à l’école seront pris en compte, mais le but principal était de moderniser le cours interne de première année « Eléments de Géomatique», qui est donné pour environ 250 étudiants de la section génie civil et environnement.

L'offre ayant été acceptée, nous avons commencé la conception des cours, suivie par les sessions d'enregistrement dans un studio dédié, combinant photographies, illustrations et questionnaires dans des vidéos nécessitants des scripts précis. Nous avons constaté que pour une heure d'enseignement, dix heures de préparation et de traitement ne sont pas toujours suffisantes.

Cette nouvelle formule a été mise en application au cours du semestre de printemps 2014. La session de deux heures est restée au programme hebdomadaire, avec plusieurs assistants auprès des étudiants. Pour l’évaluation, les étudiants internes ont un examen à mi-parcours et un examen final de façon classique. A ce stade de la nouvelle méthode d'enseignement on ne peut affirmer que le niveau global monte ou diminue, mais on peut déjà pressentir que ce ne n’est ni un miracle, ni une catastrophe.

Dans le même temps, le cours a été mis à disposition du monde entier par l'intermédiaire de la plate-forme Coursera. Beaucoup de curieux ont visité la bande annonce. Ensuite parmi les inscrits peu ont fait tous les exercices et prérequis pour obtenir l’attestation de formation à distance (délivré par Coursera, pas par l’EPFL).

Au niveau des réactions pour cette première édition les remarques sont disparates de «Ramenez le professeur!" à "Pourquoi ne pas passer à 100% MOOC?". Assurément, la deuxième édition apportera une réactivité plus équilibrée et quelques améliorations. Ayant opté pour une approche mixte, la promotion de ce cours en dehors de l’EPFL repose sur des partenariats avec des universités locales : l’Afrique de l'Ouest vient en premier à l'esprit.

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1. TEACHING CONTEXT OF GEOMATICS

1.1 Geomatics for civil and environmental engineering

At EPFL, civil and environmental engineering are distinct sections right from the start. Most sections share basic sciences, and the lecture halls are filled according to student numbers. Hence environmental engineers may share "Analysis 1" with civil engineers one year and with mechanical engineers the following year. During year one, only Geology and Geomatics are shared on a topical basis.

Bachelor studies at EPFL
To understand the current stage of the MOOC "Geomatics", some peculiarities of the Swiss and EPFL contexts need to be considered. First of all, any holder of a Swiss highschool certificate (or a foreign diploma deemed equivalent) may join any programme of a Swiss University (with a few exceptions). Hence some EPFL students have been moderately exposed to maths and technology. In the absence of an entrance exam, filtering takes place during the first year and the success rate has recently fallen below 50%. Consequently, lectures have replaced some practicals, because of their higher demand for supervision and equipment, partly wasted for students unable to complete the programme. Simultaneously, the selection at the end of year one has become more crucial, because year 2 and 3 form a cycle to complete within a maximum of 3 years: 30 credits after 1 year (easy), 60 credits after 2 years (easy), 120 credits after 3 years (not so easy). Experience shows that motivation is the main factor of success for our students, rather than their scholar past, and we consider that engineering skills must play a role in the selection process.

The MOOC wave - our point of view
As soon as MOOCs became a topic, the direction decided that EPFL had to play a leading role in Europe. A dedicated recording studio (Figure 3) was installed in the fancy "Learning Center". Incentives were advertised to support professors willing to create on-line lectures, with budgets enabling the employment of assistants specifically for that task. We decided to put a bid for our first year lecture dealing with the fundamentals of geomatics designed for approximately 250 students in civil and environmental engineering. So far there has been no pressure from the direction to save on teaching expenditures for contact hours, neither in the short, nor in the long term. Our main purpose was to re-introduce practicals in year one, with assistants and equipment, while replacing some *ex cathedra* lectures by interactive video sessions. In other words: "lectures at home and homework in the lab, respectively in the field". That is, the course is made for our own students in the first place, not for a worldwide audience. The latter was never excluded, but would be considered in a second step, in partnership with local institutions. We do not intend to reach the students directly in their village, for three main reasons. Firstly, shortcutting the local education system will not strengthen our partners. Secondly, the practical components of the course require more

hardware than a computer and an Internet connection. Thirdly, many students need a recognised training certificate, and we do not want to enforce a system deemed inappropriate for ourselves. In this respect, EPFL has a rather conservative approach: for most courses there are compulsory assignments during the semester and students must pass classical exams. Distant learners may obtain a statement of accomplishment issued by Coursera based on assessments made by EPFL teachers. However the ID of the students is not formally checked, and such certificates are not endorsed by the Registrar.

1.2 First steps of e-learning

While the advent of MOOCs has been largely reported in the media (Martin, 2012), it was preceded by more discrete options for e-learning. To enhance this 1st year lecture, Internet based techniques have been included for almost a decade. The concept was quite similar: replacing standard exercises and solutions by personalised ones. That is, when logging on the Internet site of the course, students are assigned different numerical applications, and their solutions are evaluated automatically, taking error margins into account. This concept called "Exomatic" was presented at earlier FIG meetings (Gilliéron et al, 2006; Deshogues et al, 2010).

2. MOOC DEVELOPMENT

2.1 Content and scenario

The content of the MOOC “*éléments de géomatique*” is composed of 8 lessons with the following topics: overview of geomatics, geodetic reference systems, basics of cartography, levelling, measurements (angles, distances) with total stations, GPS and digital elevation models. The goal of this course is to give an overview of geomatic engineering, to present the methodology for geodata acquisition and representation and to learn some calculus processes used in surveying.

The structure of this MOOC is based on the original content of the course “*éléments de géomatique*” proposed to the students at EPFL. However it is not a one to one match of the different sections. First of all, the duration of the MOOC is shorter (8 to 10 weeks instead of 14 weeks) and secondly the balance between the theory, quizzes and exercises is quite different. Replacing face-to-face lectures with videos is a complex process, which implies a new thinking about the way to teach and to transmit knowledge through a series of lessons. A teacher cannot simply take a classical presentation prepared for an *ex cathedra* lecture, and record it in front of the camera. For each lesson, a new scenario is required to transmit very precise messages. Furthermore, these messages must be attractive, so that the students will find the appropriate way to learn on their own (Kop, 2011).

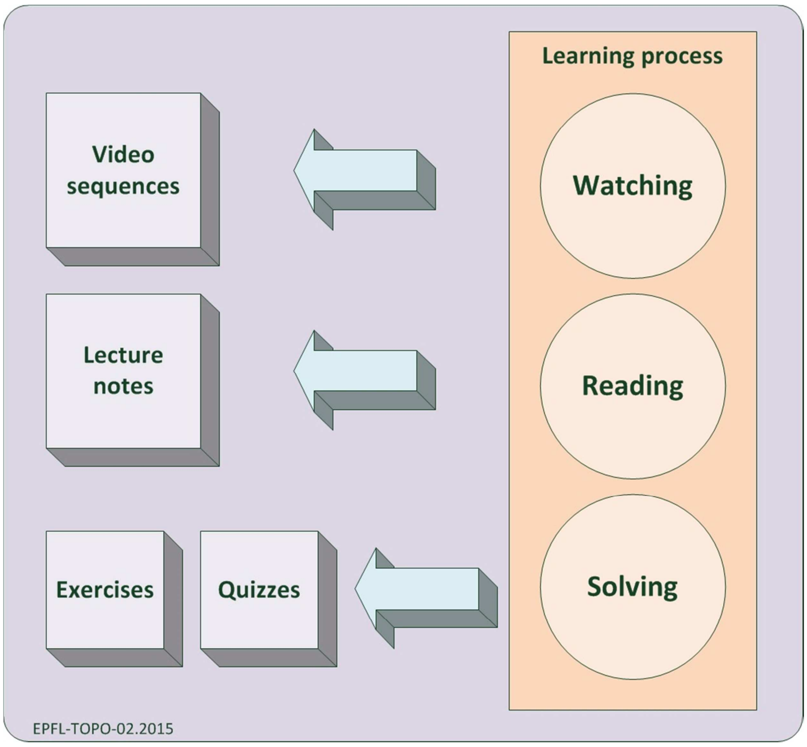

Figure 1: resources and learning process for a MOOC

Explaining all the concepts and theory through video sequences is not always possible and does not make sense in keeping a large number of attendees concentrated. A reference book or lecture notes are valuable supports for the learning process. The video itself gives a first overview of the course content and highlights some of the most important concepts with detailed explanations. Then the students have received the key elements for reading the lecture notes, which will help them to reply correctly to quizzes and to solve exercises (figure 1). This is certainly the most important challenge in designing a scenario for a MOOC: to keep a good balance between the content of videos sequences, the quizzes, the invitation to read lecture notes and to complete exercises with adequate explanations (Alario-Hoyos, 2013).

How can we move from the *ex cathedra* structure to the MOOC approach? The following example will illustrate a typical lesson about levelling. The course material is composed of 4 videos, 1 chapter of lecture notes, 1 quiz and a calculus exercise. The video sequences introduce the concept of levelling, the main definitions for the altitudes, the instrument and its control, and finally the way to measure levelling sections in the field. Some quizzes are proposed to the students and refer to the theory and explanation of concepts given in the lecture notes. At the end a calculus exercise introduces an example of levelling for the built environment with the measurements made with the level along a single section. An additional video will help the student to solve this exercise step-by-step with detailed explanations on the way to process the data. The overall structure is shown in Figure 2.

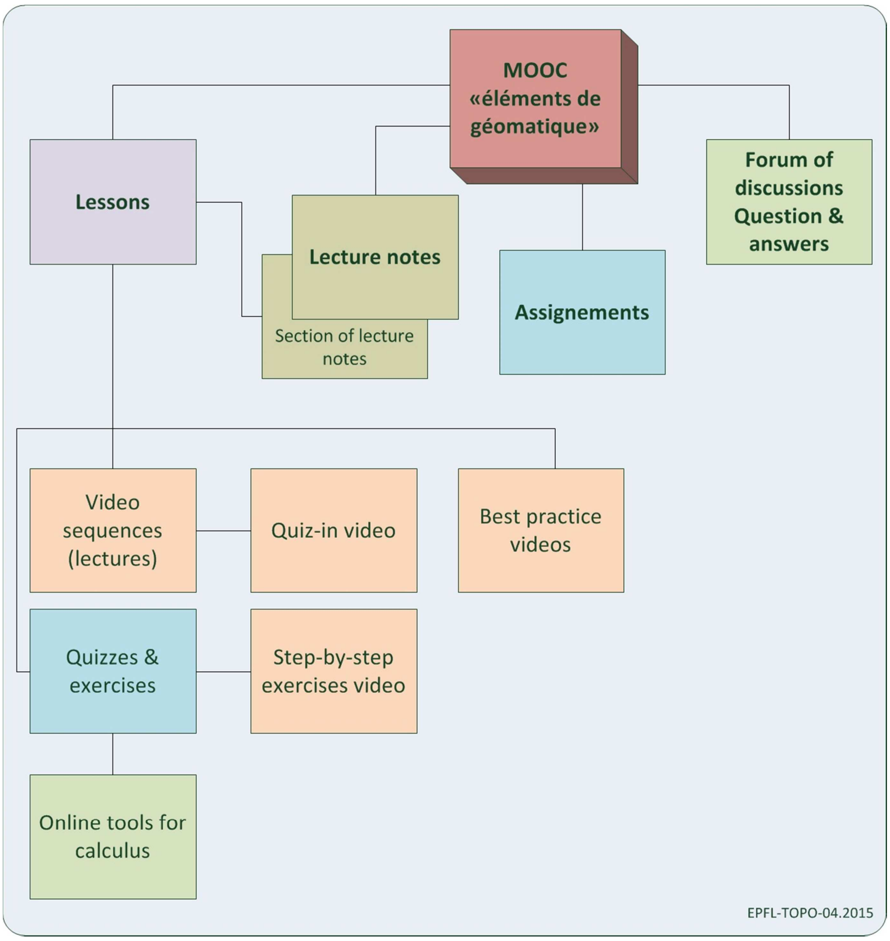

Figure 2: structure of the MOOC "*éléments de géomatique*"

2.2 Creation of resources

Lesson

In the classical *ex cathedra* way, students are listening to the teacher during one or two hours about a specific subject. For instance in this course "Eléments de géomatique" one session was entirely dedicated to Geodesy. Now it's clearly impossible to just record a one hour video with a teacher speaking continuously: we would be sure to lose the audience after a couple of minutes.

Hence we decided to cut each lesson into subsections of fifteen to twenty minutes. To stay with our example in the geodesy chapter the lesson was cut in four parts of fifteen minutes each.
For the realization of a single video a series of slides are created. The slides pick up only the essentials from the course book, because we assume that the whole lesson is not covered by videos. Those slides are used in the recording studio which contains three record channels (Figure 3). With this recording system, some illustrations can be added all along the speech and the viewer can see exactly how these examples should be resolved step-by-step. The

dataflow process is show in Figure 4.

Figure 3: The recording studio

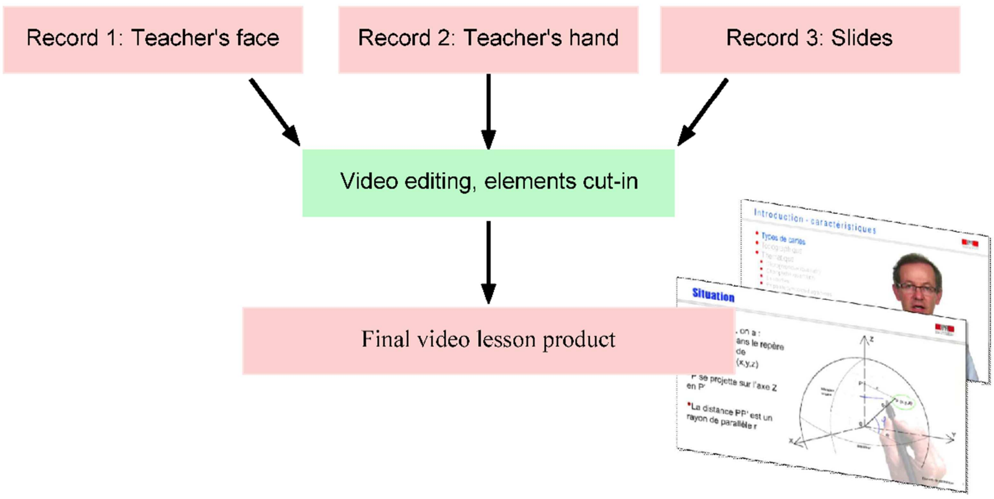

Figure 4: Dataflow for classical lesson video creation

A specificity of Geomatics is its application in the field. Especially in land surveying, many practical works use a level or a theodolite outdoor and it's hard to transcribe those experiments only with drawings on a video. So we created special outdoor videos, like if the student was in the field with the teacher. The teacher handles the instruments and explanations are added by a recorded voice. The recording process is shown in figure 5.

The simulation of instruments was an early step in e-learning for surveying. At the turn of the last century, several computer-based programs had been designed to learn how to handle a level or a theodolite (e.g. http://simusurveyx.caece.net/). Such programs are useful when students are numerous and instruments scarce. However, for this course, made for an audience not dedicated to land surveying, we focus on the understanding of the logistics in the field rather than the detailed handling of the instruments.

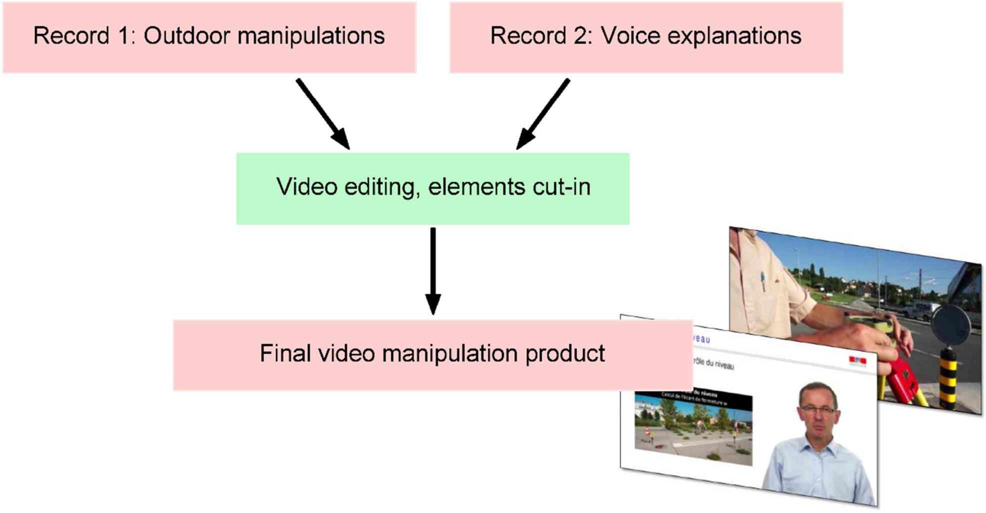

Figure 5: Dataflow for outdoor procedure video creation

Quizzes

For us, quizzes only contain questions about the fundamentals of the course. We assume that one quiz contains a maximum of eight questions. One question is usually a specific definition related with the course or the student must find the good comment for an affirmation.

For the creation of quizzes the structure has not radically changed. Before the MOOC we already used multiple choice questionnaires. So now the principle is the same but the online implementation allows us to correct them automatically. Questions are related with specific points for each chapter of the course. Usually we have four choices for each question with at least one correct answer.

Exercises

Before the MOOC, if the student wants to train with exercises, he should come to a dedicated training session. During those sessions, teachers and assistants are in class to help at any moment if the student is stuck at a particular point. The teaching staff could see the global understanding level directly, and adapt the next session in accordance with this level.

During the MOOC, the biggest challenge is to catch the attention of the students during an entire exercise session of approximately one hour, given that assignments have been overhauled. Usually each question uses the result of the previous one, so if the student made a mistake in the first answer he will probably fail the rest of the exercise because intermediate results are not provided automatically. It is part of our pedagogical approach of surveying to control intermediate results and to be critical about them. This learning process is bringing good skills in calculus and application of algorithms. In order to help the student, we added a lot of resources for self-corrections, in the form of pdf files and videos.

When creating the resources, we focused on the time required to solve the exercise, with a maximum of forty-five minutes. As for quizzes, each exercise is composed of six to eight questions. For each question the student must use a specific formula related to the course topic. As mentioned earlier, an answer is sometimes induced by the previous one, hence the student must be rigorous to complete the whole exercise.

This year, we planned to implement a peer assessment exercise. This consists in creating a map with an online web service (see section 4.1). At the end of the exercise, each student is publishing his own map and is requested to assess at least two other works from different students, in order to be graded himself. For this purpose, the student who published his map has to specify his hypothesis of work. Then the classmates, chosen as evaluators, have to reply to a questionnaire with respect to assessment criteria.

2.3 Online implementation

For the online implementation, the Coursera platform gives a large toolset, both for lectures and quizzes. For lectures the most useful tool is given by the possibility to add some quiz-in-video. This allows to insert a time stop after a specific video sequence and to write a question with an html editor. The result inside the video is shown in figure 6.

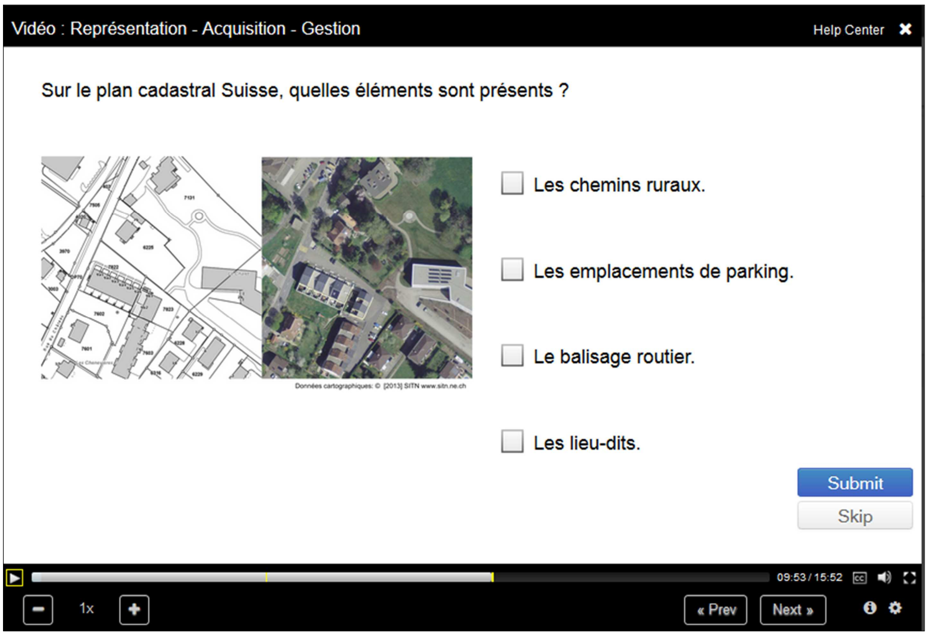

Figure 6: Quiz-in-video implementation.

For exercises and homework the platform provides us with many other tools. Usually with one ‘quiz’ for the platform we can add as many questions as we want.

Next, inside each question, we can choose among many pre-programmed formats, such as:

- *RadioButton*: The student chooses the only correct answer among propositions.
- *DropDown*: Similar to *RadioButton*, but elements appear in a selection list.

- *Checkbox*: The student can select multiple items among propositions.
- *SingleNumericQuestion*: The student can write a numerical answer through a prompt.
- *ShortAnswer:* The student can write freely through a prompt.

Experience has shown that the best way is to stay with *RadioButton* and *Checkbox* questions as shown in Figure 7. Because when it is necessary to write something, even if it's a small numerical number, there is always a risk than an error occurs.

In addition, the display order may be randomized, so that every attempt can be composed differently. For even more surprising effect in quizzes, variations for each question can be added. Finally, by combining randomization and variations, each attempt is totally unique.

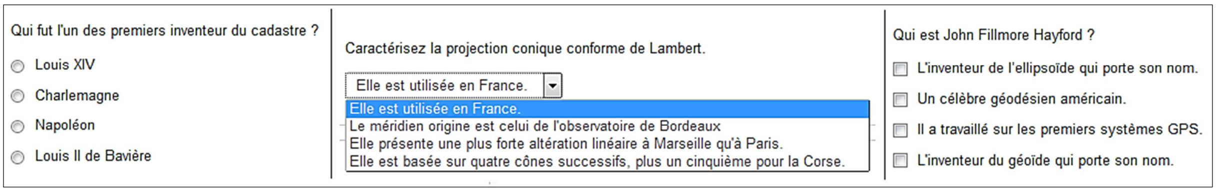

Figure 7: Example of *RadioButton*, *DropDown* and *Checkbox* questions.

3. FIRST SESSION ON "ELEMENTS DE GEOMATIQUE"

3.1 Course management

For students on campus, the change consists mainly in a reduction of *ex cathedra* presentations, replaced by videos with quizzes to monitor the progress, and in an increase in time devoted to hands-on exercises and discussions with the teachers and the assistants. For the teachers, the work invested in the creation of the videos is not offset by any reduction in the number of contact hours. On the other hand, the time devoted to distant learners was very limited. Typically, no responsive web-based forum was maintained, because this is not necessary for regular students.

3.2 Added value for EPFL students

The first motivation for the development of a MOOC on geomatics was the growing number of students attending the course at EPFL. As presented in section 1 we have introduced e-learning and online resources for a long time, but practical exercises were not proposed to the students due to the limited number of contact hours. Since the introduction of the MOOC we were able to reduce the number of *ex cathedra* lectures sharply and to spend more time with the students during field and calculus exercises.

The surveying part comprises two main exercises:

- GPS measurements: students use low-cost GPS receivers and measure coordinates of geodetic points located on the EPFL campus. They compare the coordinates collected under different conditions with the exact (cm level) coordinates of the reference points.

– Levelling: students use a levelling instrument to determine the altitudes of points marked specifically. They must be able to check their results via redundant measurements and to evaluate their accuracy.

Figure 10: practical exercises with students on the EPFL campus

Giving access to practical surveying operations during a basic course in geomatics is very appreciated from the students. This is an excellent opportunity to better understand some of the concepts developed in video sequences and lecture notes. The organization of such outdoor activities requires a large teaching staff in order to coach all the groups of students. With a total number of students of 250, we have organized weekly sessions with 12 groups of 3 students (Figure 10). Thus it takes 7 weeks until all students have completed an exercise in the field.

For students not involved in fieldwork, one weekly hour of contact remains to answer their questions and to give them complementary explanations according to the messages exchanged on the forum. This time shared by the teaching staff and the students is also a good opportunity to receive some direct feedback about the content and understanding of the MOOC. Unfortunately, this availability meets a modest echo as only a small proportion of students seize this opportunity. Several reasons contribute to this result.

– The course is worth 2 credits in a semester of 30.
– As the grades are partly based on group work, their spread is limited.
– The slot in the timetable is not optimal: Friday afternoon.
– The grade for the course is averaged within a block of practical courses. While many students fail in the block of theoretical courses, few do so in the other block.

In the end, this course is not perceived as essential in the filtering process of the first year. When optimising their scheme for collecting credits, the students allocate time and efforts accordingly.

Of course, all these reasons did hold before the MOOC and they ensured a modest attendance at regular exercise hours. By stimulating the spirit "I learn when I want to", the MOOC does not value the availability of assistants. On the other hand, it could be a sign of success: with an increased autonomy of the students, contact hours may lose importance without harm. Only the comparison of the level reached at the end of several years will tell (Ross, 2014).

3.3 Participation and accomplishment

The online platform is recording a lot of statistics on the activity of participants, which is useful for the monitoring of progress during each individual lesson. For example, a more complex exercise could be identified as critical by a lower rate of participation, which can help teachers to bring some hints or additional information.

The analytical tools are counting the numbers of learners by types of activities: visited the course, watched a lecture, submitted an exercise and browsed the forums. The figure 11 shows an example of the monitored activities on a weekly basis.

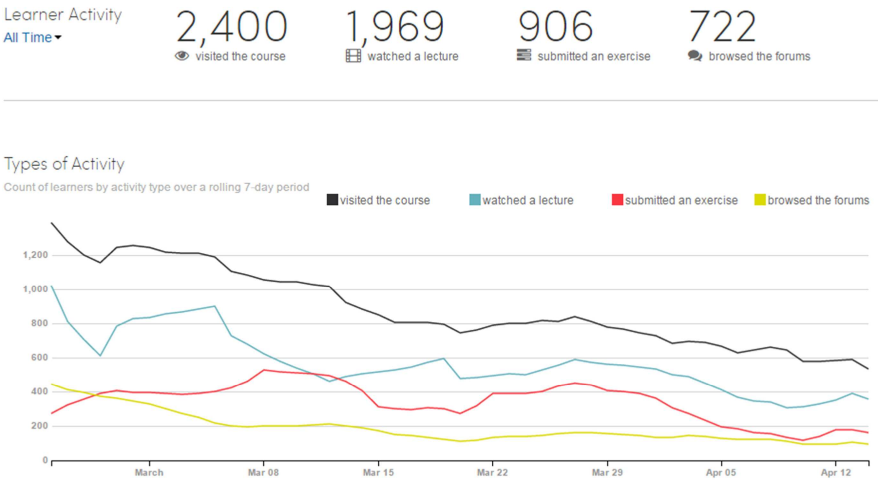

Figure 11: Monitoring of learners activity

The participation to the first session (spring 2014) of the MOOC "*éléments de géomatique*" can be summarized as follows: about 3'500 learners have joined the course, 2'500 visited the course content (e.g. watching a minimum of 1 lecture), 1'000 have submitted an exercise or more and 800 have browsed the forum. The participants are coming from 130 different countries and 45% of them are from Europe, 28% from Africa, 18% from North and South America and 9% from the Asia-Pacific region.

At the end of the course we have delivered 107 statement of accomplishment (50% with distinction) issued by Coursera. Compared with the participation, we can evaluate that 10% of the learners who submitted exercises have received this statement. It represents only 4% of the total number of people who visited the course at least once during the session.

4. STATUS AND FUTURE PROSPECTS

4.1 Evolution of online resources

Like any type of teaching resources, the content of a MOOC is evolving according to the needs of students and pedagogical trends. After the first session some students were asking for better explanations for solving calculus exercises. For that reason we have decided to create new videos with a full description of the algorithms used for processing surveying data. The help of new figures with adequate explanations will be useful for a step-by-step approach of the problem. New videos have been created for levelling and coordinate transformations exercises. They have been implemented during the spring 2015 session.

An exercise using online mapping tools has been introduced this year. The availability of open geographic data from public administrations and the recent development of online mapping platforms give an excellent opportunity to create attractive geo-visualization labs. The students will create their own maps on a web platform like ArcGIS online. They will combine several thematic layers of open data extracted from the Système d'Information du Territoire Genevois (http://ge.ch/sitg/donnees/demarche-open-data) while respecting the basic rules of cartography. The results will be evaluated by a peer assessment process involving students.

4.2 Towards certified MOOCs

MOOCs have the great advantage to share knowledge and teaching resources with a broad community. However it remains difficult to assess the work of students outside formal academic programs. At this stage, the EPFL Registrar delivers credits and certificates only to students enrolled.

Remote students do not pass exams at EPFL. However their quizzes and assignments are graded under Coursera. That is, according to their results, they are eligible for a statement of accomplishment delivered by Coursera. Of course, the market value of such certificate is not well defined.

To go one step further, EPFL has signed an agreement with academic partners located mostly in Western Africa (http://moocs.epfl.ch/moocafrique). Advanced study programs based on MOOCs are established. On each campus of the network, students may pass an official exam. If they succeed, they will receive a certificate of achievement from the University in charge of the MOOC (e.g. EPFL for *élément de géomatique*). This certificate will summarize the course content, the number of credits and the final grade. This process of certification organized by a network of academic partners is certainly the appropriate way to strengthen the development of these new teaching techniques and to make the students confident that their effort will be officially recognized.

5. CONCLUSION

Generating a change in the pedagogical approach was the main motivation to develop a MOOC for the basic Geomatics course. Stimulating autonomous learning of the theory and re-introducing field exercises, rather than mere presentations of instruments, requires a major shift in the involvement of teachers and assistants.

After a first implementation, we consider the results with mixed feelings. While compulsory fieldwork sessions are generally welcome, the attendance at contact hours dedicated to coaching calculus exercises was low. Certainly, both the enthusiasm and plain rejection associated with novelty will fade. Some improvements of the material and programme have already been made for the second edition currently on. A future comparison of the level reached at the final exam will give indications about the global efficiency.

In a second step, the MOOC may be included in a study program shared by several partner universities, located mainly in Western Africa. This will be an excellent opportunity to create common resources, with a particular focus on use cases selected within the network of partners. In this context a new MOOC on geographical information systems is under preparation at EPFL with partners from Western Africa and Vietnam.

When considering our experience, one should keep its particular context in mind. The process and the outcome strongly depend on the purpose. Such would the case for, say, a MOOC designed to teach about a very specific topic to a worldwide audience of highly skilled professionals.

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BIOGRAPHICAL NOTES

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