Flipped classrooms: From concept to reality using Google Apps

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***Abstract*— Flipped classrooms use in-class time to work on learning materials that were previously explored by the students on their own (e.g. pre-recorded presentations, instructional videos, etc.). Any e-learning platform can be used to flip a classroom / course, but they suffer from an original sin -- they can just as well be used to support traditional teacher-centred models, where the course site works as a repository of slides used during plenary classes delivered in lecture halls. Besides this historical handicap, most e-learning platforms offer relatively poor collaborative environments, particularly if we consider the standard sharing facilities of social platforms like Facebook, Google+ (G+), etc. The portfolio of resources included in the Google Apps for Education program, on the other hand, offers a powerful toolbox that can be used to build rich collaborative environments. Ending up with teacher-centred models is much harder in the Google Apps world, where a pervasive collaborative strategy can be made to spread across a teaching and learning framework built as a Google site. This paper presents the essential Google Apps that can be used in this context, proposes a pedagogical model that ensures collaborative, student-centred learning, and describes how a teaching and learning framework can be built using the tools comprised in the Google Apps for Education portfolio. The reusable template offered as a result of this work is available online at http://goo.gl/wllUk.**

***Index Terms* — Education, Pedagogy, Flipped Classrooms, Google Apps.**

I. INTRODUCTION

In spite of all the transformations deployed by national and international educational frameworks that have been developed over the last decade, the ruling models in many academic institutions are still lagging behind the harsh reality imposed by decaying economies, youth expectations, and transformative power of Internet technologies [1-4]. Most traditional teaching and learning models weren't really affected by Moodle, or indeed by any other commonly used e-learning platforms, which can simply be (mis)used as repositories of lecture notes and slides presented in traditional classes.

However, the increasing availability of high-quality educational content, be it in the form of Open Educational Resoures (OER), or through the pervasive world of Massive Open Online Courses (MOOC) [5], seems about to change this world for good -- **flipped classrooms** are now a reality, because the students can easily find recorded lessons or even complete courses in most areas of studies. The flipped classroom, as the name indicates, reverts the nature of the time spent in the classroom -- discussions and other learning activities are now the role, while lectures and other presentations are watched at home or elsewhere, prior to the class.

On the other hand, social networks and other collaboration platforms are now regularly used by the students as part of their learning tools. Many educational Facebook groups exist in a wide variety of areas, and Google Apps are being used by many students to share solutions to exercises and exams. As a result, flipped classrooms and collaborative environments are blossoming everywhere, and teachers have little choice but to adapt to this brand new teaching and learning world.

II. THE GOOGLE PORTFOLIO

The introduction of the beta version of Gmail in 2004 marks the initial step of what is known today as the Google Apps world. This portfolio currently comprises a suite of tools that are able to support highly collaborative working environments, with an emphasis on business and education, where a special service pack is available under the names of Google Apps for Business [6] and Google Apps for Education [7]. In what concerns the specific (higher) education area considered in this work, the following components are particularly worth of mention:

- **Gmail**: Google's email service is the best known app among Google users, alongside with the search engine. It plays a main role within the Google portfolio, and supports far more than just emailing. Gmail can indeed be used to initiate various sorts of collaborative activities, e.g. launching Hangout or Gtalk synchronous communication sessions, starting the collaborative work on any Google document, etc.
- **Google search engine**: The search engine is the one tool that brought Google's brand to its position today, and became so popular that the verb "to google" found its way into various English language dictionaries, including Merrian-Webster [8]: "to use the Google search engine to obtain information about (as a person) on the World Wide Web", first use recognised in 2001).
- **Google+** (or simply **G+**) was launched in 2011 and may be seen as Google's social networking alternative to Facebook. The integration with Google Apps enables this platform to effectively support collaborative work. The boundaries of collaboration are defined through the creation of "circles", which may be used to reflect the organization of classes and student groups.

- **Google Hangout** and **YouTube**: Hangout supports video conferencing and screen sharing among up to 10 participants. The integration with YouTube enables "on-air" sessions that are broadcasted live and recorded to a YouTube account.
- **Google Groups**: In spite of the "private communities" that were introduced with G+, the Google Groups discussion fora are still an excellent tool to set up question and answer (Q&A) pages supporting collaborative class / group work.
- **Google Drive** and **Docs / Slides / Spreadsheet**: Google Drive is an online storage service similar in concept to DropBox. The shared folders feature facilitates collaborative working, but its main advantage over the competing alternatives lies in the integration with Google's "office processing" tools, namely for text processing, presentation slides, and spreadsheets. The documents created with these tools can be shared at various access levels (from public to individual users, including lists of users defined as G+ circles) and permission levels (enabling viewing only, commenting or editing).
- **Google Sites** was introduced in 2008, and offers a simple solution for creating web sites based on a wide variety of templates. This Google tool is the foundation of the framework that is proposed in this paper, bringing together the individual tools that support the pedagogical requirements presented in the following section.
- **Google Calendar**: This app is used to schedule all course activities, and its integration with the remaining Google apps enables it to play a main role in the preparation of collaborative activities (e.g. it can be used to book and launch Hangout sessions for synchronous work meetings).

III. THE PEDAGOGICAL MODEL

There is no such thing as "one" best teaching and learning model. Many models have been proposed since B. F. Skinner's "The Science of Learning and the Art of Teaching" was published in 1954 [9], and anyone interested in education sciences is well aware that context specific reasons will dictate the characteristics of what may be considered a good model (and indeed "the" model may change as the work in a given course unfolds...). However, if we look for the intersection of most "good" models in the recent past, we're likely to find two recurring adjectives: *active* and *collaborative*.

It is well known that knowledge retention is far more effective when students learn by doing something, instead of just listening or watching; on the other hand, learning is very much a group activity. Moodle is a well-known example of this combination, since it was "designed to support a **social constructionist** framework of education" [10]. The same happens with student-centred models, where collaborative, active learning activities play the main role. The pedagogic principles underlying the teaching and learning framework proposed in this paper may be summarised as follows:

- **The classroom is seen as place to organize discussions and other collaborative activities**: Plenary lectures are not forbidden, but they should preferably be seen as the exception, not the rule. All lectures and other presentations should be recorded and made available prior to the date when the corresponding topics are to be considered.
- **The learning process is intrinsically collaborative**: Individual work is not forbidden, nor to be avoided, but the predominant form of learning is the group work. It can take place in the class as a whole, but it is mostly undertaken within each group of students (e.g. through assignments, lab work, etc.).
- **The presence of the teacher cannot be restricted to the classroom**: The ubiquitous 24/7 teacher is not yet a reality, and it is not likely to become one, at least in human form, but there is much to improve in this area by appropriate use of electronic communication means.
- **A teaching and learning model must be a dynamic framework**: The appropriate balance between individual and group work, and between active and passive learning activities, varies from one course to another, and varies also as any given course progresses. The same happens with the support required from the teacher, and all these factors should be dynamically adjusted to maximise the student success rate.

IV. A T&L FRAMEWORK / TOOLBOX

A wide variety of tools may be selected to comply with the pedagogic principles that were presented in the previous section. The Google Apps portfolio is not the only solution to build such a framework, but it is one of the best alternatives for three main reasons: 1) it offers an integrated platform where all the tools fit into each other; 2) it is entirely free of charge; and 3) the Google Apps for Education programme offers a complete package that includes improved institutional Google accounts (30 GB instead of the regular 15 GB associated to personal accounts). Table 1 relates the main teaching and learning requirements and their best matching Google Apps.

Notice that more than one app in the Google portfolio may provide the best match to a given teaching and learning need (e.g. G+), and that a single app may offer a best match to more than one teaching and learning need. The following section will propose a complete framework based on the Google Apps portfolio. What is important at this stage is to realize how the integration of these tools is

TABLE I.
TEACHING AND LEARNING NEEDS X GOOGLE APPS.

T&L needs	Google Apps
Storage	Drive, YouTube
Collaborative work	Doc, Slides, Spreadsheet, Drive, Groups, Google+
Communication	Hangout, Gmail, Google+
Self-study	Search engine, YouTube
Scheduling	Calendar, Gmail
Organization	Google+, Sites
Assessment	Hangout, Forms (spreadsheet)

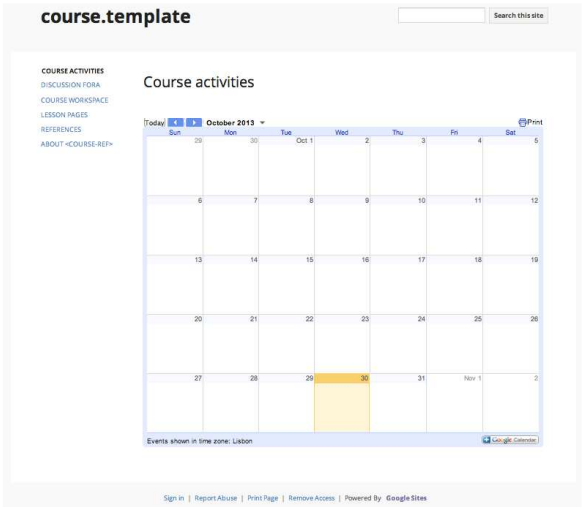
able to meet the pedagogic principles that were presented in the previous section.

Some of the associations shown in table 1 are relatively obvious, but additional comments may be useful in some cases. Google Drive is able to meet the storage needs of most teaching and learning activities, and it is also able to support collaborative work through folder sharing. On the other hand, collaboration is intrinsic to most Google Apps, and notably to those addressing text processing, presentations, and spreadsheets -- all the documents created with these apps can be shared for viewing, commenting or editing, either within the limited scope of each group, or progressively up to the wider public level. The Google Groups discussion fora offer additional means to support collaborative work. G+ introduced the concept of private communities, which may be seen as a discussion forum integrated into this social networking environment. Actually, most of the remaining tools in the Google portfolio might in one way or another be linked to this entry in table 1 -- they were not included for the sake of simplicity, and to concentrate ourselves on those tools that are most commonly used at this level.

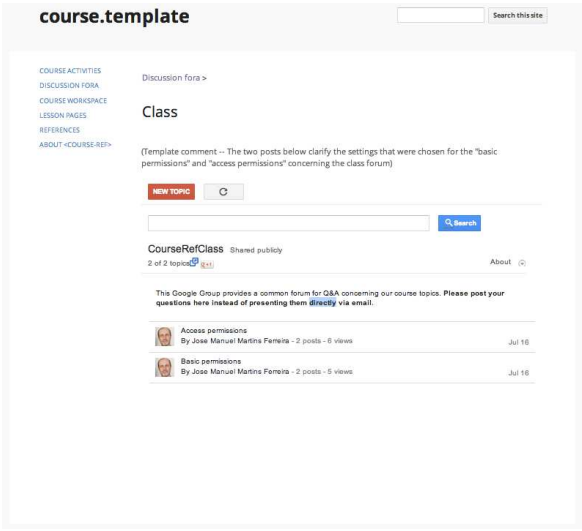
Hangout and Gmail are able to support most communication needs of teaching and learning activities, the former enabling synchronous communication by videoconferencing, and the latter supporting asynchronous exchange of information. However, and for the same reasons presented in the previous paragraph, most of the remaining tools might also be considered useful for this purpose. Google+ is particularly worth mentioning because it is increasingly used as a meeting point serving both needs.

The remaining entry that is worth of particular mention in table 1 relates “Organization” to G+ and Google Sites. G+ is particularly important from an organizational point of view, since the concept of “circles” can be used to identify the granularity of communication boundaries within the course -- its lowest level comprises the student groups, where a reserve of confidentiality applies (e.g. in what concerns discussions addressing grading activities). The class is the intermediate “circle”, since the one level above corresponds to public access, which in turn can be used to disseminate the outcome of some activities. Once the course circles (or “student groups” in general) have been created for the class, the boundaries of communication and information flow have been defined, and we can proceed to create a coherent aggregate of tools in the form of a Google Site. The site is indeed the ultimate organizational aspect, since it will bring together the various tools needed to implement the required teaching and learning environment -- a social constructivist model will make ample use of tools like Google Groups and / or private communities in G+, while a less constructivist model may emphasize the use of YouTube playlists containing pre-recorded lessons. Flipped classroom approaches are likely to combine both, since communication is important either inside or outside the classroom, and YouTube can be used to host the collection of presentation videos offered to the students.

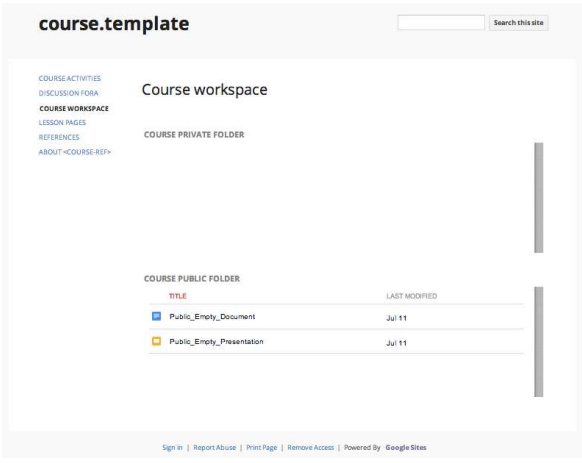
The following images illustrate the main entries in the navigation menu of the proposed framework:



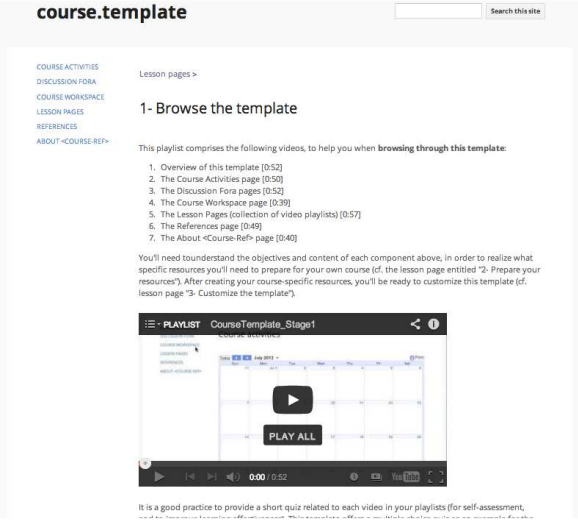
a) Entry page: The course activities calendar.



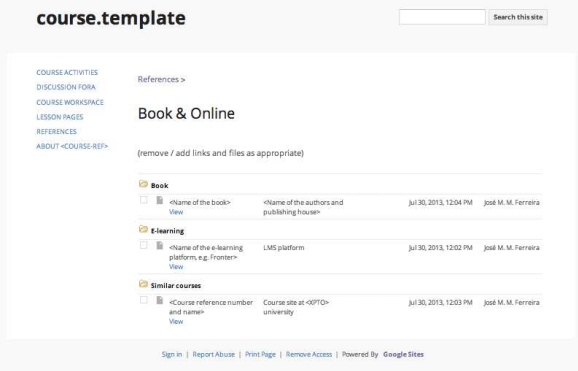
b) Discussion fora: The class discussion group (also available for each group of students).



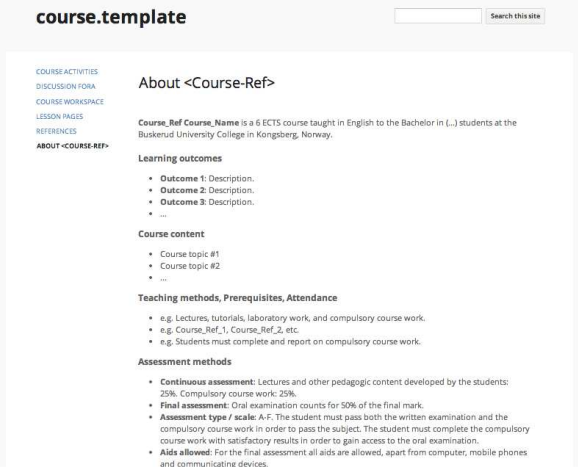
c) Google Drive folders used to build the course workspace (authentication required to access private folders).



d) Lesson pages comprising YouTube playlists (followed by quiz forms under the playlists).



e) References offering recommended reading sources.



f) Course syllabus.

Figure 1: Main entries of the Google template proposed for flipping a classroom.

The template proposed in this paper meets all the requirements identified in the preceding paragraphs and is available as a public Google template at http://goo.gl/wllUk.

V. CRITICAL ANALYSIS

The template discussed in this paper was used in two courses offered at the Buskerud and Vestfold University College during the Fall semester of 2013/14:

- DFDS-3101 Digital Systems (3rd year BSc students): https://sites.google.com/site/josemmfdfds3101/
- SESH-6201 Software / Hardware Co-Development of Embedded Systems (MSc students): https://sites.google.com/site/josemmfsesh6201/

The response was unmistakably positive, but its representativeness is limited by the small number of students in each course: 11 in DFDS-3101 and 10 in SESH-6201. The official feedback forms (using an appreciation scale of maximum A to minimum F) were used to collect student responses, and the return rate was 100% in the MSc course, and 91% (10 out of 11) in the BSc course. The results may be summarised as follows:

- In response to the question "How would you judge the course's overall quality based on the grading scale A-F?", 8 out of 10 forms returned by the BSc students rated the course as A (one form returned B, another form returned C).
- In response to the same question, 8 out of 10 forms returned by the MSc students rated the course as B (one form returned A, another form returned C).
- The open response fields brought into evidence that the students were particularly appreciative of the quick response enabled by the forum, and the technological innovation associated with the course site template (incl. the use of recorded lessons).

The different qualifications level between BSc (1st cycle) and MSc (2nd cycle) students may help to explain the difference in the ratings, as well as various other factors that relate to the subject areas that were addressed in the two courses. However, the author believes that the main reason for this difference is due to the heterogeneous background of the MSc students (6 nationalities in a class of 10 students), which was an obstacle to collaboration, whether or not any form of elearning support was provided.

It is important to emphasize that the course template proposed in this paper is not free of limitations, and should not be seen as a universal solution that is capable of replacing Moodle, Blackboard, or any other e-learning platform. The proposed template does not support any form of automatic grading (although the quiz forms return the percentage of correct responses and store this information in a spreadsheet), and the mechanisms for submitting student deliverables are limited (the students can upload files into the course's Google Drive space, but they are not prevented from doing so if the deadline is exceeded).

Google's Course Builder platform wouldn't face these limitations, but its set up wouldn't be as easy as the plain use of Google Apps. On the other hand, on September 10, 2013, Google announced its collaboration with the MIT / Harvard EdX open source platform, instead of continuing to support the development of Course Builder [11]. While there was a limited overlap between the proposed porftfolio of Google Apps and Course Builder, its discontinuation as a product reinforces the interest of the template described in this paper.

VI. Conclusion

The competitive advantage of the solution proposed in this paper, in relation to ready-made alternatives such as Moodle or other Learning Management Systems (LMS), is that it is intrinsically collaborative -- every Google app offers embedded features that promote collaboration and exchange of information. On the other hand, the integration of the various tools comprised in the Google Apps portfolio offers a powerful framework that ranges from basic communication to video streaming tools. Flipping a classroom becomes much simpler when these features are present. On the contrary, there's always something missing when we use a standard LMS platform, or a combination of non-integrated platforms such as Facebook, Twitter, AnyMeeting, etc.

The template proposed in this work is much closer to a MOOC (massive open online course) environment than the ready-made alternatives referred in the previous paragraph. Students and academic staff working in a highly collaborative, flipped classroom context, will find it much easier to adapt to the new reality of MOOCs. A quick look at the platforms used by some of the main MOOC players, e.g. Coursera and EdX, brings into evidence that they are much closer to the proposed framework than to a standard LMS platform. Migration to a MOOC platform will therefore be facilitated, both in terms of work methods and of the content used to populate the proposed course template.

The proposed framework offers effective support for distance learning environments, but it lags behind any MOOC in what concerns behind-the-scenes features such as data logging / data analytics [11]. There's good and bad in the MOOCs world, but one thing may be taken for granted -- they are here to stay, and they will affect the higher education landscape. Adapting our teaching and learning practices to cope with the transformative power of MOOCs and other distance learning environments is therefore of vital importance.

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