Using the Web to promote active learning outside of class time

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Abstract
In this paper, the Web is viewed favorably as helping learning in large class settings. The Web's overall advantage is to generate a virtual presence for the students to feel guided outside of class time. Two important aspects of this guidance are presented that promote learning. First, tracking and feedback through maintaining a Frequently Asked Question page, and second, active participation and critical thinking by requiring students to self-mark their assignments.

1. Large classes, active learning, and technology: in and out of the classroom

Teaching large classes is not a new phenomena when considering the academic world as a whole, with courses such as *psychology 101* or *biology 101* having size of well over 100 students for many years. Immediate consequences of teaching large classes are the lack of individual contact with students and more limited feedback on students work. An extra dimension is added to this problem when Engineering courses are taught to large classes. Courses such as *Microprocessor-based design* or *Fundamentals of Software Design* have a practical (hands-on or lab) component which is essential to the understanding of the material presented in class. In such courses, the practical component can unfortunately not be taught by the professor but is put in the hands of Teaching Assistants (TAs) as lecture groups are divided into smaller groups to fit in the lab environment. In such setting, the lack of feedback from the professor is often exacerbated by inconsistencies among TAs. This lack of individual attention and the variability factor introduced by having different people participate in the teaching can be quite devastating for students, especially freshman students just out of high school.

Physical problems with no obvious physical solutions lead to search for virtual solutions. We propose that a virtual presence through the Web will increase the "simulated" direct contact to students. Furthermore, we think the Web can facilitate active learning outside of class time, by making possible the implementation of a self-evaluation approach. The next section presents in detail an example of a Software and Computer Engineering course in which the Web was used for these two purposes. But first, we will discuss the positive impact of active learning on students, and the use of self-evaluation as one active learning strategy.

Active learning has been discussed and presented by many researchers and practitioners as an efficient way of promoting learning (Bonwell & Sutherland 1996)[2]. Active learning is a mindset focusing on keeping students active and involved with their own learning. "Students are simply more likely to internalize, understand and remember material learned through active engagement in the learning process." (Boud 1995) [3] Even if the concept of active learning is quite general, it

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is most often discussed in the context of lectures, presenting ways of moving from traditional lectures to more active lectures. All proposed activities, hints, and tricks (Silberman 1995)[7] have one goal: keeping the student active and mentally participating during lectures. But learning does not only happen during class time, especially in a large class context. That out-of-class time should be well managed to promote learning, and in our view, this should be done via an active participation toward the development of critical thinking.

In a traditional way, active participation can be promoted by the use of assignments. In a less traditional way, active participation toward critical thinking can be promoted by having the students not only do but also mark their assignments. The idea of self-marking has been advocated in the past 10 years (Boud 1995[3], Hobson 1996[5]) as a way of promoting self-criticism. Self-marking is often put in a larger context of self-assessment in which the students set their own goals and monitor their own progress through the semester. "When students assess themselves they develop insights into their own learning." (Gregory et al. 2000[4])

In fact, as reported in Stiggins (1994)[8], in both Bloom's taxonomy (p. 240) and Quellmaz's framework (p. 249) for naming and describing dimensions of learning, evaluation ends the list as involving complex thinking capabilities. Bloom defines 6 levels: knowledge, comprehension, application, analysis, synthesis, evaluation, and Quellmaz defines 5 levels: recall, analysis, comparison, inference, evaluation. Unfortunately, in the traditional teaching, we tend to promote only the most basic part of learning, that of knowledge or recall. Maybe because this part is not only the easiest to teach, but also the easiest to test. Kubiszyn and Borich (2000:61)[6] make a distinction between *observable* and directly measurable learning outcome (list, recite, build, draw), and *unobservable* ones (value, appreciate, know, understand). The observable learning outcomes are certainly related with the lower levels of both Bloom and Quellmaz's taxonomies.

At the higher end of the taxonomy, the *evaluation level* (Angelo & Cross 1993)[1] is defined as : "Making judgments about the value of materials and methods for given purposes. The individual can make appraisals that satisfy criteria determined by the student or by others." This is in line with Boud's[3] definition of self-assessment as "the involvement of students in identifying standards and/or criteria to apply to their work and making judgements about the extent to which they have met these criteria and standards" (p. 5). The whole concept of self-assessment, making the student engaged and critically thinking is very much part of the larger concept of active learning.

2. A concrete example

In Winter 2001, the course "Fundamentals of Software Design", was given by the same professor to three different sections (2 in English and 1 in French) with a total of 350 computer engineering and software engineering students[1]. This course has a very important lab component, but the professor cannot be present during the lab sessions (because that would make up for an extra 24 hours a week). The management of 350 students is therefore complemented

[1] In Winter 2002, the same course will be given to 3 English sections and 1 French section for a total of 500 students. This course is now required as well for Electrical Engineering students. Two professors will be sharing the load, the author will be giving the 3 English sections (360 students).

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with the management of 14 TAs. We will look first at how a FAQ page was used to establish a virtual presence, and second we will present our self-assessment approach.

2.1 The FAQ page

The underlying hypothesis for a virtual presence to be useful is that individual concerns are often group concerns. This must be true for replacing multiple one-to-one communications by a single broadcasting one-to-many communication. Anyone who has taught knows that a question asked by one student is likely to be asked (silently or not) by many others. The Web definitely surpasses physical presence for this as it allows to broadcast to all students the answer to one student's question. A simple FAQ (Frequently Asked Question) page maintained by the professor saved line ups at her office. Any question sent by email from a student was taken, complemented by an answer and put "as is" on the FAQ page. Any student was well advised to go to the FAQ page before sending email, as any duplicated questions would remain unanswered.

As the FAQ page and other web pages for lecture content, lab descriptions, etc, were maintained and updated, the students felt a presence, a virtual presence outside of class time. They felt like someone was still there thinking of them, still guiding them via these frequent updates. It helped their learning and reassured them to have most of their questions already answered on the FAQ page, as someone else had asked the same question before. They did not feel lost or abandoned or blocked, having to wait to the next consultation time or next lecture to be able to ask a question.

Most students questions are related to their lab work. They need clarifications on the lab description, or a few hints on how to do certain things, or they are not quite sure how the lab questions relate to some material seen during lectures. All the answers to these questions represent extra information valuable for everyone. During the first few weeks, many questions are also related to the self-assessment process (see next section), and therefore the Web presence is a very important tool for the implementation of that strategy.

2.2 Implementation details of the self-assessment strategy

A typical lab work (assignment) mostly involves doing an Object-Oriented Design and writing Java code. In a traditional setting, students would go to the lab session to start their work and ask questions to the TAs present, then complete their assignment outside of lab time, and finally hand in a report. Then, one or two weeks later they would receive their report back with often only a grade on it or with a few comments, at most. Because of limited resources and large number of students, our TAs have about 10-15 minutes per report and do not have time for elaborating the justification for their marks. This quick marking often leads to inconsistency, as some TAs tend to be much more generous than others. Even when a single judge (or scorer) goes through all students work, there is an intra-judge variability (Ward and Murray-Ward 1999[8]) as the judge is more or less tired, happy or irritated. When multiple judges perform the same task, there is now an inter-judge variability which is much harder to control. That variability is certainly perceived by the student as unfairness, and should be avoided. Intra or inter-judge

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variability is certainly more a problem when evaluating performance tasks such as assignments than it would be for multiple-choice questions on an exam.

We propose that the Web can help implementing a partial solution to these problems of lack of feedback and inter judge variability. It was used very efficiently here to post guided walk-through solutions to assignments so the students could mark themselves. In fact, involving the students in marking their assignments obliges the professor to complete transparency about the marking scheme and to a thorough justification of the proposed solution. The students became involved in a way that made them understand what is important and why. By providing detailed solutions, consistency was assured for students who follow the guidelines. But most importantly, this exercise encouraged the students to think about what they did, compare it by walking through a solution, find the similarities and differences, examine, judge what is acceptable or not, and by doing so, it forced them to develop their critical thinking.

A few implementation details: During the Winter 2001 session of "Fundamentals of Software Design", there were 8 lab works, and each lab was due by email on Monday midnight. The lab description was posted on the Web page the previous Friday (10 days earlier). The purpose of the email was to obtain a time-stamp of the lab submissions and to retain a record of them. Students couldn't give themselves marks for assignments they didn't submit, and the proof of submission is the email being received. A detailed marking scheme and walk through solution for each lab was posted on the Web on the following day, Tuesday around 6pm. The particularity of this approach and what made it work is that the marking scheme included a very detailed solution, showing some alternatives, giving reasons for arriving at that solution, and assigning marks to specific parts of the solution. Feedback was quick, so students who wanted could mark themselves right away. Each lab counted for 2 points in the final grade, and each self-evaluation itself counted for an extra 0.5, for a total of 20 points (16 points for 8 labs + 4 points for 8 auto-evaluation), representing 20% of the overall grade.

In addition to the marking itself via guidelines such as: "Give yourself 5 points if you did this.", "Take 2 points out if you didn't think of this.", "Give yourself 1 point if you thought of this instead.", the walk through solution included lots of questions for encouraging thinking and questioning to be answered during the marking process, such as: Did you do it this way? Why? Why do you think this is a good approach? As mentioned in Hobson (1996)[5], tag questions (of the type "why?") keep prompts open-ended, encouraging students to dig deeper into their analysis to produce an adequate justification of their position. The overall process lead students to *evaluate, appraise, judge, justify, defend*, the 5 verbs related to the evaluation level of Bloom and given in Stiggins[8].

The self-marking strategy just described is not a complete self-assessment in which students would also define the criteria themselves, set their own goal, etc. Self-assessment requires some maturity not yet present in a freshman student, but self-marking is a good first step. With specific guidelines to follow, the students are nevertheless active in their own evaluation. It was important as well to lead the students from an analytical view to a holistic view of scoring (Ward and Murray-Ward[8]). At the beginning, the students must be well guided, as this whole procedure is new to them, and they're not quite sure what to do. A checklist (analytical) approach was used if the first few labs. The students had to make sure they included all items

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on the checklist in their solution. As the students became accustomed to this self-marking process, as the labs became more complex and lead to larger software designs, it became not only impossible to give all the alternative solutions but also inappropriate. Even if the assignment can be divided in different parts to be achieved, the students are lead to give themselves a more holistic evaluation for each part (component-based holistic evaluation). For example, "Give yourself 8/8 if your solution of PartA meets the same criteria X,Y,Z as the solution given", or "Give yourself 6/8 if your solution takes care of X, Y but you forgot to perform that extra Z step". This type of evaluation shows more maturity from the students, as they are not looking for specific items, done exactly like the solution, but look more for a general understanding, a general meeting of the objectives defined, and this is where we want to lead them.

3. Discussion

We presented our view that the Web can be a valuable resource outside of class time to promote learning. It allows a virtual presence to provide feedback and to establish a system of active participation through self-marking of assignments. The new Engineering education reality of teaching large classes certainly demands new solutions to manage many students while providing quality education. When teaching large classes, professors realize how much more organized they need to be, how a preparation which is theoretically the same for teaching 20 or 150, is in practice not the same at all.

Our view is that in large class setting, because of the limited interaction during class time, an important part of learning is transferred outside of class time, and we believe that without the Web, a good management of large classes outside of lecture time would be almost impossible. With the Web, we can provide a virtual presence, and even more, easily introduce active learning strategies such as self-assessment to promote learning.

Making use of self-evaluation is not in itself related to the Internet, but we certainly believe that without the Web, such a process, involving much effort in class management, would be almost impossible in a large class setting. Just the burden of collecting assignments to time-stamp them, to give them back, to print marking schemes, to distribute them, to collect them a week later, would be immense with over 300 students. The Web allows the implementation of the self-assessment process paper free which reduces quite a lot the management time, as well as avoids impinging on the lecture time for distribution and collection.

As money and resources are usually considered important factors in University management, a very positive side-effect of self-marking is the reduction of the number of TAs required to mark assignments. But for education per se, without resource consideration, it also has a second positive effect of eliminating inconsistency among TAs. Two students will not compare their marked exercises and find discrepancies in marking for similar solutions. This inconsistency was mentioned in our introduction as a destabilizing factor for the students.

The professor's time is also an important university resource, and the virtual presence approach via the FAQ page is certainly saving time. Naturally, the professor should monitor every other

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day or so the emails received from the students, which takes some time, but that would have to be done anyway and the extra time required to post the answer on the web is minimal (a few minutes) saving many more similar emails to answer to as well as line ups at consultation time.

The self-assessment process on the contrary is very time-consuming for the professor. Especially in the first few labs when an analytical scoring approach is used. The marking scheme must be very detailed, and if different solutions exists, they should be presented, so the students are not lost. As we move toward a more holistic grading, less work is involved as the solutions are posted (and they would have to be worked out anyway) along with some more general guidelines about the marking.

Self-marking of lab assignments within a specific course "Fundamentals of Software Design" has been described, to give a concrete example of using the Web to efficiently encourage critical thinking. For the same course, we have shown how moving from a one-to-one physical presence to a one-to-many virtual presence can provide efficient feedback and tracking with the use of a simple FAQ page. Of course this is not equivalent to face-to-face contact, but we would argue that there is a way to make this virtual presence feel like a personalized contact by choosing the right type of language and style of writing. Using a non-formal language (both in the FAQ and walk-through self-marking guide) gives the student reading the instructions and questions the impression that they were written just for him or her.

The effectiveness of the proposed approach would be hard to evaluate quantitatively. Informally, when asking the students why so few come to my consultation time, they tell me that there is no need to, that everything is always on the FAQ. The effectiveness of the self-evaluation is also hard to evaluate quantitatively. The students were surveyed at the end of the semester on their appreciation of such a method. Overall the comments were positive, but when asked the specific question: Have you learned more or less than if a TA had marked your lab? they don't really know. The problem is that the comparison point is unstable. Would they learn more than if there was 1 TA for 10 students or 1 TA for 60 students? Would they learn more than being provided with good comments on their work from a TA being very verbose or receiving their lab with just a mark on it? The comparison metric is not stable, and then answers are unclear. Although, as a professor, seeing the progress of the students over the years, I have no doubt that they learn more, if only by the fact that they are forced into a comparative thinking, they are forced to be critical, they are forced to be their own judge, which becomes also an ethical questioning for some of them.

We want students to learn, but we cannot force them to learn. All we can do is give them tools to be able to learn if they wish to. The Web, by giving us the facilities to provide the students with a virtual presence is an important contributor to students learning. Also by making it much easier to introduce important active learning activities such as self-marking, the Web contributes even further to students learning. Especially in the context of teaching large classes, the Web is a very good complement to lectures, helping to take care of the students outside of class time.

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