An Online Methodology For Individualized Education

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Abstract - *Online courses have been debated by various sources, including Governor Jerry Brown, the UC regents, and numerous college administrators, faculty, and students. The motivation behind such discussion is varied. Since there is no standard in online education, it has produced erratic results in terms of student performance and costs to students as well as administration. Online tools, if managed and prepared for properly, have the opportunity to provide the highly regarded individualized learning experience of the small classroom with the lower costs of large lecture halls while decreasing overall overhead costs. This article presents tools and a methodology to provide the small classroom experience in a much larger setting while keeping overall costs and time commitment down as well as improve overall student performance.*

Keywords: Online Methodology, In-Class Improvement, Flipping Classroom

1 Introduction

Online courses, the latest hot topic in education, have been debated by various sources, including Governor Jerry Brown [1], the UC regents, and numerous college administrators, faculty, and students. The motivation behind such discussion is varied. Administrators see offering online courses as a way to increase the number of students despite the shortage of large lecture halls, while generating some financial savings. Faculty and students are more skeptical, fearing they will miss the face to face student-lecturer interaction in and out of the classroom. Of course, with some traditional in-class courses, having hundreds of students with varying backgrounds and motivation, the student-lecturer interaction has already been severely diminished from smaller classroom sizes, which are no longer feasible due to the shrinking educational budget. Since there is no standard in online education, it has produced erratic results in terms of student performance and costs to students as well as administration.

However, online tools, if managed and prepared for properly, have the opportunity to provide the highly regarded individualized learning experience of the small classroom with the lower costs of large lecture halls while decreasing overall overhead costs. In fact, the tools used for online courses can be utilized to improve the existing traditional classroom dynamic. Students are trained from high school to prepare for testing by memorizing as many facts and examples as possible in order to answer each question. On the other hand, college professors tend to follow a top-down approach in teaching where they cover concepts, some math or algorithms, and methods or processes of finding proper solutions. These processes, especially in Engineering, must be understood and not just memorized because they have many steps involved: specification, analysis, design and synthesis, optimization, verification, implementation, and testing. In a small college classroom of 20-30 students, lecturers can help students who fall behind individually by expending their out-of-class time. In a larger class of 150 students or more, the small classroom teaching style doesn't work as well since the time commitment for both the lecturer and students are dramatically increased for the same duration of time.

The tools and methodology presented in this article aid in providing the small classroom experience in a much larger setting while keeping overall costs and time commitment down. Such tools and methodology can be applied to any learning environment, not just online, to better prepare students for learning concepts and solving problems. It must cover

a) Lectures
b) Sample problems with solutions
c) Questions and answers
d) Homework
e) Tests

2 Improving the In-Class Environment

We will compare the typical teaching methodology for a large classroom with a modified methodology that utilizes online tools to provide a richer learning environment for students. Our initial research compares two groups of students (Group A & Group B) taking a Digital Logic Design Engineering course during two separate quarters. Online course material consisted of custom content developed specifically for this Digital Design course as well as existing UCI tools through EEE (Electronic Educational Environment). We compare the students across 3 exams:

Exam 1: Both groups are taught based on a typical teaching methodology (overviewed below). Online lecture videos are

available but no special emphasis is given to them. All material is covered in lecture and/or discussion sections. This exam is used to normalize the results for the following two exams.

Exam 2: Group A continues to be taught using the typical teaching methodology. Group B is presented with a typical Online course methodology. All lectures & samples are to be reviewed online via online videos. In-class lecture & discussion sections are now treated like online meetings; the professor and teaching assistants only cover questions asked and do not repeat any lectures.

Exam 3: Group A continues to be taught the typical teaching methodology. Group B is presented with a hybrid methodology based on in-class and online processes. A general lecture is given per topic each classroom session. Students are expected to review specific details and caveats that are covered by online videos & submit questions before the next classroom session. In the following lecture or discussion, specific questions are answered that are submitted by students, similar to an online course web meeting.

c) many students are not prepared and have no questions, exacerbating the above situations. Much of the information the students need is presented once in a lecture and/or discussion. If they miss the lecture or get lost on a concept taught, they fall further and further behind as the class progresses.

Therefore, the presentation is general and not helpful to many students with weak backgrounds or insufficient skills while leaving other students bored and non-attentive. To help alleviate some of these issues, sample problems can be covered in discussion sections with fewer students, but the above situation still applies, just on a smaller scale. Weekly homework is assigned to keep students on track; however, due to learning habits from students' past educational experiences, assignments are generally completed to gain points rather than understanding the concept from the material.

In the typical in-class environment with ever increasing classroom size and varying student skill levels, most of the lecture and discussion time available is used to cover examples, go over homework solutions, and prepare for testing. There is simply not enough time available to

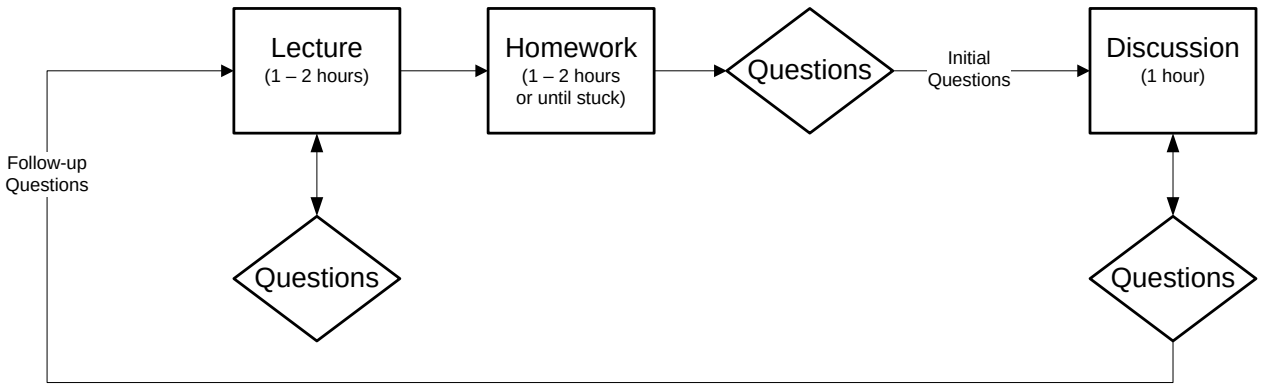

Figure 1: A Typical In-Class Methodology Work Flow.

2.1 A Typical In-Class Learning Environment

The in-class teaching environment was originally developed for small classes (20-40 students). However, enrollment in many college courses has grown to over 100 students per class. Lectures for a couple hundred students in a large lecture hall for 1-2 hours are very difficult because

a) schedulers have problems with room sizes and cannot schedule too many short lectures or discussions.

b) a single presentation needs to cater to the varying skill levels and knowledge of all 100-200 students.

individualize the learning experience for many students with the current teaching methodology.

In Figure 1, a typical in-class methodology is presented. Students are given a 1-2 hour lecture, which may cover several concepts. During this time, general questions are covered. Follow-up questions are not typically asked since students need to think about the material, read more references, or do some homework before they have additional questions. When they attempt the homework, they may have initial questions. These are answered during the discussion section, along with some follow-up questions from the lecture. This method is not efficient since it moves at the rate of the slowest students and much of the time is spent answering

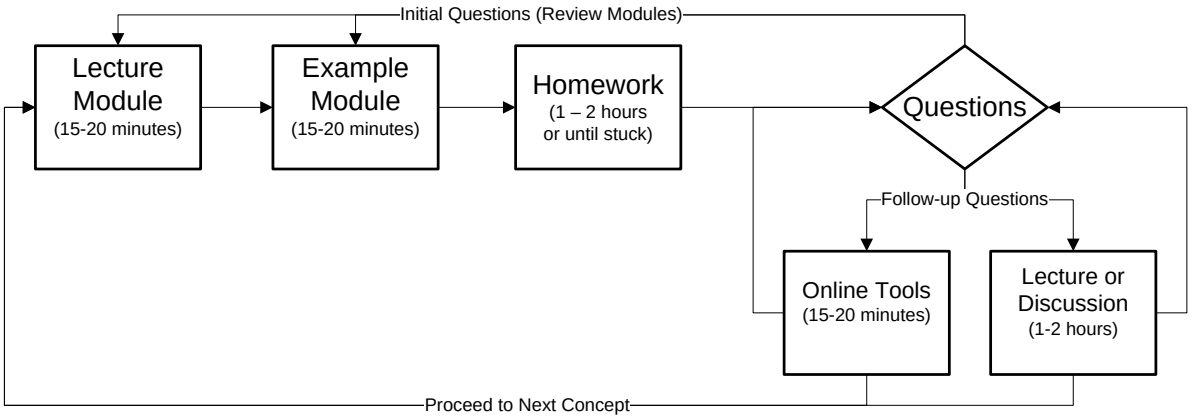

Figure 2: A Typical Online Methodology Work Flow.

general questions since follow-up questions require additional review of the material.

2.2 Adding an Online Methodology

In order to have more advanced discussion and cover concepts that help struggling students as well as advanced students in a large class, the "what, where, when, and how" of information to be presented and consumed must be improved upon. First, we will address general lectures and sample problems. Traditionally, they are presented in class, leading to the problems described previously. By using online tools to "flip the classroom," [2] a popular concept that has been around for years but is much better realized with the easy accessibility of the Internet, we can cater to a much wider audience and more efficiently use our time in the classroom. Flipping the classroom involves moving most of the general lecture material from in-class to at-home. Students now review the general lectures and examples at home in between lectures while lectures are used to answer student questions and provide a more interactive and dynamic learning environment.

Lectures can be succinct and split into individual modules or concepts instead of a weekly 1-2 hour lecture session which usually covers several topics. Students can review the material multiple times, refer to references at their own pace, and discuss with classmates, teaching assistants, and the professor regarding the material presented. Classroom time can now be utilized for more advanced discussion and better targeted toward student skill levels based on the content they discuss through available online tools, such as the course mailing lists and message boards.

In the Online methodology work flow, shown in Figure 2, students begin by reviewing 15-20 minute lecture and/or example modules. Any initial questions regarding the lecture, example, or homework can typically be answered by reviewing the module again in more detail, which is not typically possible with a traditional in-class environment. If there are follow-up questions, they can be answered using online tools, such as message boards or mailing lists.

The turn-around time per concept is much quicker than a typical in-class work flow and can happen multiple times throughout any given week. An in-class or streaming lecture and discussion can still take place; however, note that the majority of questions asked now are follow-up questions, which allows for more efficient use of interaction time and discussion of more advanced topics. The overall amount of time spent in this work flow is similar to the in-class work flow since lectures and discussions can be decreased in favor of using online tools and modules to cover the general concepts. Students can also work at their own pace, allowing for a more individualized experience.

2.3 Preliminary Results

The initial results are encouraging. We compared Group A & Group B as a whole, as well as in 3 separate groups based on performance (top third, middle third, and bottom third) in Table 1.

As stated earlier, we will be using Exam 1 as the normalization factor. Students in Group A & Group B received the same typical in-class teaching methodology for material leading up to Exam 1. On average, students from Group B score between 4-8% lower than students in Group A. All other factors being equal, we expect this performance to stay in that range. Since we change the teaching and learning methodology for Exam 2 & 3, we expect some changes in performance as well.

For the material covered in Exam 2, a typical online methodology was used, which just moved lectures from in-class to online videos. This can help address in-class problems like scheduling of large lecture halls, being able to present to students of varying skill levels by allowing them to choose the appropriate videos, and keep overhead costs down in a general sense. There is a minor improvement in allowing the lecturer to reach out to students of different skill levels

Table 1: Group A vs. Group B Performance.

Exam 1:	Group A	Group B	Difference	Improvement
All Students:	81.31%	75.07%	-6.24%	n/a
Top 1/3:	90.24%	85.76%	-4.47%	n/a
Middle 1/3:	80.63%	74.58%	-6.05%	n/a
Bottom 1/3:	72.85%	64.86%	-7.98%	n/a
All Students:	65.28%	60.42%	-4.86%	**1.37%**
Top 1/3:	79.37%	79.44%	0.08%	**4.55%**
Middle 1/3:	64.92%	60.14%	-4.78%	**1.27%**
Bottom 1/3:	51.22%	41.67%	-9.55%	**-1.57%**
All Students:	53.52%	54.72%	1.20%	**7.44%**
Top 1/3:	70.77%	72.53%	1.76%	**6.24%**
Middle 1/3:	54.23%	55.31%	1.09%	**7.14%**
Bottom 1/3:	35.12%	36.32%	1.20%	**9.18%**

through the videos and online message boards; much of this effectiveness depends on the students' willingness to and frequency of which they use the technology. Since some material is offloaded outside the classroom, there is more time to spend on individual student questions during the classroom session. Similar to the video and online message board issue, this also depends on the students' motivation to take advantage of these opportunities.

As a whole, students in Group B showed a marginal improvement over students in Group A (1.37%). When split into three separate groups based on performance, the top third of students in Group B outperformed the top third of students in Group A by approximately 4.55% after normalization is considered, the middle third of Group B did 1.27% better, and the bottom third did 1.57% worse than Group A.

In an attempt to bring learning to a more individual level using online tools, Group B students were taught using an online hybrid methodology that goes beyond the typical in-class or online methodologies for Exam 3. Students in Group A continued to receive a traditional in-class teaching educational environment.

In the hybrid methodology, we combine the advantages of in-class and online environments. The classroom is still "flipped," where much of the learning is done outside of the classroom through online videos, mailing lists, and discussion on message boards in between scheduled class sessions. However, we help guide students with introductory lectures and answer general questions during an early classroom session. Since a significant portion of the material is covered outside of the classroom, there is more time for individualized help and advanced discussion in the classroom itself. From there, students are required to go through online lecture and sample videos. Finally, they must take notes and submit questions on concepts they wish to be discussed in following lectures.

Using this method, students in Group B performed significantly better than students in Group A as a whole and as smaller groups. After the normalization factor, Group B averaged 7.44% higher on the exam, with the top third performing 6.24% better in Group B, middle third 7.14% better, and bottom third 9.18% better than Group A.

2.4 Student Feedback

Student feedback regarding the traditional, online, and hybrid methodologies have shown that online videos and tools

Table 2: Helpfulness of Different Formats of Instruction for Students in Group B.

Helpfulness:	1 (least)	2	3	4	5	6 (most)
Reading Textbooks:	24.09%	21.90%	20.44%	13.87%	10.95%	8.76%
Watching Online Lecture Videos:	3.65%	6.57%	11.68%	30.66%	32.12%	15.33%
In-Class Lectures:	12.50%	16.18%	19.12%	19.85%	19.85%	12.50%
Watching Online TA Example Videos:	0.73%	2.19%	3.65%	13.87%	28.47%	51.09%
In-Class TA Examples:	2.92%	5.84%	15.33%	22.63%	30.66%	22.63%

Table 3: Study Habits of Students in Group B after Class.

Study Habits:	1 (never)	2	3	4	5 (very often)
Reading Textbooks:	18.71%	27.34%	27.34%	17.27%	9.35%
Watching Online Lecture Videos:	2.90%	5.07%	20.29%	32.61%	39.13%
Watching Online TA Example Videos:	2.90%	4.35%	18.12%	26.81%	47.83%

are aiding in improving their overall performance.

First, we review how students ranked each format of instruction in terms of helpfulness in understanding the course content in Table 2.

In general, online lecture and TA example videos are preferred to in-class lectures and examples. Reading the textbook is the least preferred of the 5 learning formats. As mentioned earlier, lectures were not formatted as traditional lectures, but were handled similar to Q&A type sessions; therefore, the basic knowledge required for the class is presented in the videos. More time is spent discussing deeper concepts in-class, which was more useful to students who were studying more often or participating more often in-class. TA examples were more popular than concept lectures since they are given similar homework problems and solutions to review.

Next, we look at how students are spending their time studying outside of the classroom in Table 3.

Again, students in our Digital Design Logic course preferred watching online lecture and TA example videos over reading textbooks. The videos were able to better target varying skill levels of students and could be updated throughout or between the quarters. Since students receive a general overview and more detailed example in short concise videos, they can more efficiently prepare for the next lecture or homework as well as discuss problems rather than reading long chapters in a textbook.

Lastly, we review how much time is actually spent studying for this course compared to other courses in Table 4.

Considering 3-4 classes is a typical full-time course load, students are studying more for this course than any other single course in their curriculum. This is due to the more rigorous studying methodology required for the Digital Design course including studying online videos, completing homework based on the videos, and submitting questions for lectures based on each set of online lecture and example videos. However, they are still studying well under the 40 hours total that is typical of a full-time course load. A typical course requires about 10 hours per week of total studying; with more students studying in the 6-10 hour range, we would expect the performance of the students to be even higher.

3 Conclusions

This modest sampling of using online teaching methods to improve an existing large in-class environment has been shown to be effective. Overall, students have varying amounts of motivation to ensure they do well and get the most out of their learning experience. Initial feedback suggests that the online videos are well received once they are presented with our hybrid teaching methodology. By using online tools, making small changes to how in-class sessions are utilized, and adjusting how students learn inside and outside the classroom, student performance can be increased without impacting factors such as cost and quality of education. In fact, by utilizing new technology and spending time to find effective means of conveying concepts and materials like that of the hybrid online methodology we can provide a more individualized experience for larger student classes in this time of increased enrollment, with a small increase in the number of TAs, and some initial online investment.

4 References

[1] David Siders. “Jerry Brown carries the day on online classes at UC, CSU”; *The Sacramento Bee* 17 January 2013. http://www.sacbee.com/2013/01/17/5120340/jerry-brown-carries-the-day-on.html

[2] J.W. Baker, “The ‘Classroom Flip’: Using Web Course Management Tools to Become the Guide on the Side.” 11th Conference on College Teaching and Learning, Jacksonville, FL, 12-15 April 2000.

Table 4: Study Frequency of Students in Group B Outside of Class.

Studying Frequency:	0 - 2h	2 - 4h	4 - 6h	6 - 8h	8 - 10h	> 10h
Preparing and Studying for This Class:	24.09%	21.90%	20.44%	13.87%	10.95%	8.76%
Preparing and Studying for Other Classes:	3.65%	6.57%	11.68%	30.66%	32.12%	15.33%