INTEGRATION OF AVAILABLE AND NEW TECHNOLOGIES TO RAISE STUDENT UNDERSTANDING AND ENGAGEMENT

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ABSTRACT

We integrate available and new technologies to strongly enhance student engagement in upper division undergraduate courses on human evolution and history. First, we use peer-mentored discussion groups through the Blackboard system—appropriately scaled, constructed, and incentivized. These allow day-to-day monitoring of student understanding. Second, we use weekly Blackboard e-quizzes directed at important issues or areas of confusion including those revealed by discussion groups. Third, we use a novel digital textbook. This technology provides diverse, sophisticated assets ranging from animations and interactive questions to an extensive glossary hyperlinked to an electronic textbook. The ease of revision of this textbook allows us to react, year to year, to student need and experience. The real power of our approach derives from the extremely strong synergy between these three assets, as we will discuss. We describe successful applications of this model in large (ca. 500) and small (ca 25) classes.

INTRODUCTION

Large universities take advantage of the high scholarly achievement of faculty in an attempt to bring elite content to their undergraduates. However, the high skill levels of university faculty also create potential communication problems. The task of faculty is to communicate both extensive bodies of new factual information to students and, even more importantly, elite analytical, evaluative,

and problem-solving skills. This information must be transferred in a learnable fashion. However, in a very real sense, faculty and students sometimes "speak different languages" in the classroom.

We take the view that the *central process* of education is communication between *all* parties to the process. The traditionally visualized faculty-to-student communication is sterile and ineffectual unless coupled with effective, ongoing student-to-faculty and student-to-student communication. Among other important effects (below), these latter two channels of communication have the potential to allow faculty and students to bridge the enormous "language barrier" and to achieve substantially higher levels of student (and faculty) learning.

Additional potential barriers to this vital communication result from the fact that many large universities (including our own Stony Brook University) service a highly diverse, transnational student body. The complexity of this cultural mix has increased in recent years in the face of a more mobile global community. Complicating matters further, some classes (including required classes) have become both large (ca. 300-600 students) and diverse, making it especially challenging to satisfactorily transfer content to students.

Student expectations of university faculty are high. They expect faculty to be highly knowledgeable and passionate about their fields. They view part of their own ability to succeed as being closely tied to the faculty's commitment to teaching [1].

Most of these students are products of what is sometimes called the "Net Generation." They have been brought up in a time where the tools of computer technology utilized to access information globally are routinely available [1]. They are accustomed to interactive exchange of information via the internet through instant messaging, asynchronous discussions, and e-mail universally and transnationally.

In view of these experiences, students bring expectations of superior knowledge, passion for a discipline, and interactive learning of information into the classroom. For example, in a small survey of 25 University of Pittsburgh-Johnstown students, a learning environment of "50 percent lecture, 50 percent interactive" was judged most attractive [1].

Lack of effective communication between students in large, diverse classes and the faculty is a crucial concern, as mentioned above. In small classes, faculty can (sometimes) depend on direct student feedback to monitor day-to-day progress. In large classes, such feedback is sharply limited—in both quantity and quality. For example, in a large class, only a very few articulate, self-confident students ask questions. These students should not and cannot be considered a good representation of the understanding of the entire class, of course. Thus large class faculty run the risk of being robbed of crucial information needed to teach effectively.

To improve and learn from student-to-faculty and student-to-student communication, undergraduates also need to learn to clarify and express their own

thoughts by writing, speaking, and interacting with each other and faculty. It has been shown that students learn better when given the chance to "teach" each other, further enhancing cognitive restructuring necessary to make the learning permanent [2].

Our experience indicates that the combination of various readily available and emerging computer-based tools can successfully meet and perhaps exceed both student and faculty expectations of the undergraduate experience in a large, diverse class by addressing these various communications concerns and needs. Moreover, this same combination of tools can also be used to enhance and raise the level of academic, social and communication skills in a smaller class environment.

Our approach uses relatively simple (or conveniently available) assets. Its potential strength comes from the strong synergy between those tools—when properly deployed, timed, and integrated. We have integrated asynchronous discussion groups and e-quizzes through the Blackboard system, while incorporating an emerging digital textbook technology including sophisticated animations and interactive study questions to attempt to create a learning environment providing efficient, effective three-way communication (faculty-to-student, student-to-faculty, and student-to-student). (Similar discussion group and e-quiz tools are available through alternatives to Blackboard.) Moreover, digital textbook production is now possible for local faculty in partnership with private firms. Additionally, the digital textbook's use of various learning options including high quality lecture videos, standard text (on screen), enhanced text with audio, interactive questions, and sophisticated animations targets the best possible options for each student's individual learning style.

We have explored this integrated communication and learning system over the last two years at Stony Brook. We have used it in large classes (ca. 570 students) and in small classes (8 to 25 student) in the Biology/Biochemistry programs and the College of Human Development at Stony Brook University. Student and faculty satisfaction with this approach has been very high to date. We believe this system could easily be adapted to teaching many or most university and college courses. Moreover, this approach is readily applicable to the distance learning setting.

LARGE CLASS MODEL

Incentives

Our experience indicates that initial student participation in asynchronous discussion groups and e-quizzes is highly sensitive to incentives. However, these incentives need not be extravagant (or Draconian) in view of the high satisfaction with the learning these assets provide once students engage them. We have found that many students far surpass the minimum requirements for complete credit once they begin using and learning to use these assets.

The details of these incentives can easily be tailored to local audiences. An example of a successful system we have employed in the large class environment is as follows:

Students are graded (statistical curve) on a 1000-point scale. The first 250 points result from the universally required final examination (non-cumulative, covering the last 1/3 of the course). The remaining 750 points result from the best three of the following four items:

- 1 & 2: **Two exams**. These cover the first and second 1/3's of the course.
- 3: **Discussion group (below) participation**. 30 points were given for either a question that spurred strong participation or an answer of substantive quality—no partial credit was given for posts judged inadequate. Students could accumulate points up to a possible maximum of 250 for the semester. (The semester was broken into two separately evaluated halves with a possible maximum of 125 points for each half. No transfers of credit between the halves was permitted). Anonymous posts were not permitted and students were given RULES OF THE GAME instructions so as to enhance the quality of the posts and to establish appropriate decorum (no personal attacks or aggressive or disrespectful language permitted, for example). (A copy of these RULES is available on request from the authors.)
- 4. **E-quiz (below) participation.** The incentive to cheat on the e-quizzes was lowered through a point system where 4 points were given for each e-quiz question answered and 1 additional point for the correct answer. (The Blackboard system allows a somewhat indirect implementation of this scoring scheme. E-QUIZ SAMPLE available upon request from the authors. This also illustrates implementation of the scoring scheme.)

Elements of the Model

The class is structured so that the lectures are given in a large auditorium by faculty. We utilize the *Blackboard* system group discussions feature as follows: Students are divided randomly into asynchronous discussion groups (created in Control Panel, Course tools, Advanced Group Management) consisting of ca. 50 students each with one undergraduate TA designated as a monitor (a total of 12 and 14 discussion groups were used in two separate large classes).

Participation in these discussions occurs outside of class. Students were instructed to post questions in regard to either reading or lecture materials in areas that were unclear to them. Students were also directed to attempt to answer each other's questions in a thread format if they felt confident that they understood the material.

An undergraduate TA (having achieved an A in the course the previous year and having been screened by interview) monitored each group and was encouraged to have a "light touch." They were to intervene only if a question was left unanswered after 48 hours, if students were posting obviously incorrect

information that was not rapidly corrected by other students, or if the discussion became overly subjective or digressive. Mature undergraduate TAs have been shown to be effective when mentoring groups of students in a discussion format [3].

In addition, TAs had their separate discussion group. Each TA could go to the TA group for help or advice about questions they may have within their monitored group. TAs were permitted to see the contents of each other's monitored groups for informational purposes, though they were asked to post only in their own monitored group.

Finally, the TAs would send on any questions that could not be addressed by the students or the TAs as a group to the faculty instructors. Faculty instructors would answer these questions either through the TAs or using the weekly digests (below). In particular, faculty never directly posted on the discussion boards to avoid intimidating or interfering with student correspondents.

Once per week, each TA would forward on to the faculty instructors any threads that were especially active, evocative, or misunderstood. The instructors used this information as a rich source of insight into student comprehension and progress. For example, areas of misunderstanding were identified. Conversely, areas of high student comprehension (requiring no further attention) were identified. Key areas of misunderstanding could then be addressed in three ways.

1. In the next lecture, the faculty lecturer could address misunderstandings specifically.
2. Weekly e-quizzes were created specifically targeting the main areas in need of clarification as identified by the discussion groups. These quizzes were given, again, asynchronously through the Blackboard System outside of class time. Comprehensive feedback was given for both correct and incorrect e-quiz answers to further enhance student understanding. Completed e-quizzes with detailed feedback remain on the Blackboard system for studying for examinations.
3. Weekly digests of discussion group materials were prepared and made available to all students as PDF downloads through the Blackboard site. (An example of a DISCUSSION GROUP DIGEST is available on request from the authors.) These digests included faculty responses and additions to especially useful materials from the diverse individual student discussion groups (provided by the TAs as above). We always took care to be respectful and to protect student identity in these very public documents. Especially useful threads, frequently recurring questions and areas of particular confusion were among the materials chosen for the digests. These weekly digests were also especially useful study aids for exams.

Three major exams were given focusing on key concepts and essential technical information from lectures, the discussion boards, the e-quizzes, and the weekly digests.

We supplemented these tools with a digital textbook designed for the course with digital versions of lectures, interactive questions and answers, a glossary, and 2- and 3-dimensional images and animations. This textbook was prepared in collaboration with a Stony Brook alumnus-owned and operated private digital publishing company [4]. This staff of programmers, digital artists, and educators made it possible for us (as relatively computer-illiterate faculty) to nonetheless produce the kinds of digital learning aids that fulfill the now routine expectations of the Net Generation [1].

SMALL CLASS MODEL

We adapted the above model to enhance the teaching and learning experience in a small class (8-25 students). One particular example is described here.

The system was as described for the large classes above and, in addition, we included the following:

Students were incentivized to use the asynchronous discussion board to not only discuss the lecture material, but to also discuss various outside readings such as conflicting and supporting primary literature articles and book chapters pertaining to course material. The students, through their asynchronous posts, were encouraged to debate the material in writing.

During class time, we then used this written debate material to foster verbal debate and discussion between students and with faculty. This strategy allows students to clarify and expand on their thought before beginning face-to-face discussion and debate. This has the effect of substantially improving the coherence and quality of face-to-face discussion. This, in turn, appears to significantly enhance student assimilation of course material. Equally important, this approach apparently fosters development of student analytical and self-expression skills. (An example of a SMALL CLASS DISCUSSION thread is available from the authors upon request.)

OBSERVATIONS OF PARTICIPATION

Large Class Model

Discussion Board Participation

Sampling at various points indicates consistently high participation in discussion groups throughout the duration of the semester. For example, discussion board participation in the middle of the semester, with no imminent exam, was approximately 70% of the class. Moreover, post quality remained consistently high. For example, more than 80% of posts in a typical sample were of high quality and would receive credit. Many posts were focused on the topic of the lecture, gave supporting ideas and other references, and, by the end of the thread, many rational conclusions based on the evidence were often reached.

Discussion group posts are sufficiently detailed for use in accessing cognitive structures using a published rubric [2]. A large portion of students show evidence of such cognitive growth over the semester.

E-quizzes

Between 80 and 82% of the students participated in each weekly e-quiz obtaining a mean score of approximately 23 out of 25 points.

Small Class Model

Discussion Board Participation

Approximately 65% of the students participated in the written group discussions in an acceptable manner as described above. (Notice that this class included elite Honors College students. A slightly larger fraction of these confident students elected to be graded solely on exams and e-quizzes rather than asynchronous discussion group participation.)

Round Table Participation

The quality of student contributions was generally higher than we have seen in absence of the advance preparation allowed by asynchronous discussion group participation. Especially striking was the ongoing improvement in student confidence and skill at public debate and at thinking on their feet as the semester progressed—even in this elite student population.

E-quizzes

Approximately 92% of the students participated in each weekly e-quiz.

DISCUSSION

Synopsis of Our Experience to Date

Our experiences with this approach to date have a single, central point. It is possible to exploit readily available, easily implemented technical assets to very substantially improve all three of the communication channels vital to effective education—student-to-faculty, student-to-student, and faculty-to-student. Indeed, this approach can turn what are traditionally thought of as **liabilities** to easy communication (large class size, diverse cultural backgrounds) into **assets**. The following is a partial list of our current understanding of how this is achieved.

First, from the faculty viewpoint, we receive crucial feedback regarding the quality of the lectures and the understanding achieved by students. We can react and adapt to their needs and concerns from one lecture to the next. This rapid feedback time allows us to address student needs before exams and tighten and

clarify lectures for maximum effectiveness not only for the current year's students, but also for future years' students. (Discussion board posts are extremely valuable planning aids for future years.)

Second, several technical details of discussion groups are important. The large, diverse classes give faculty access to an especially robust sample of feedback. Moreover, the use of undergraduate TAs to monitor the discussion groups (faculty never enter them directly) provides an environment in which the students feel freer to express both confusion and even active disagreement with course material. This allows clear definition of the areas requiring faculty attention and response (through other channels).

We emphasize this particular feature of this approach especially: faculty often fail (sometimes miserably) to grasp what it is that students are not understanding (or misunderstanding). In the absence of robust feedback, faculty determine student confusion by projection or from random, socially influenced in-class questions—both quite inadequate approaches.

Third, the mixing of culturally diverse students in these discussion groups has proven highly effective in exposing students (and faculty) to sometimes surprising new ways of looking at content and inference. Beyond the strong educational benefit, this diverse exposure enhances our student's perspective as global citizens. It is noteworthy that this approach would be fruitful with truly international discussion groups in a global distance-learning environment.

Fourth, course evaluations indicate that many students liked the opportunity to express themselves, ask questions, and clarify their thoughts. The participation rate, if compared to traditional in-class participation, was well above the norm in our experience. Notice one thing especially here. The small class environment has the *potential* for allowing strong face-to-face communication; *however*, it also includes complex social barriers to that communication—ranging from shyness to naïve biases by students based on appearance. In appropriate applications, the asynchronous discussion format apparently has the potential to provide the "best of both worlds"—fostering a quality of communication superior to the traditional "gold standard" of the small class. Moreover, in those instances where it is determined that a small-class face-to-face environment is necessary for the teaching of advanced verbal skills, these assets can be employed as we describe above to increase verbal debate and thought-clarification skills.

Fifth, it is important to emphasize another element of our experience with the asynchronous discussion groups. It might be imagined that student-controlled discussion groups (with only undergraduate TA daily monitoring) would be highly prone to misinformation or erroneous conclusions, arguments, and directions. *To the contrary*, we find that groups of this size are highly and rapidly self-correcting. (Appropriate group size is certainly essential to this effect.) Indeed, the opportunity to respond productively to occasional misstatements or incorrect arguments, logic, or conclusions is richly illuminating for students. Understanding what isn't correct or true can often be as enlightening as understanding what is.

Sixth, as mentioned above, we believe the synergy between the various elements of our approach is vital to achieving a truly large improvement in student (and faculty) learning and satisfaction. Each of the tools deployed (well-planned lectures, discussion groups, e-quizzes, digital assets) is useful, but each provides only a very limited impact alone. However, synergizing these assets vastly enhances their collective impact.

For example, when the lecturer responds in class explicitly to confusion expressed in discussion groups, real (rather than imagined) student confusion is addressed and students are empowered. When done aggressively from the beginning of the course, this greatly encourages ongoing student use of the discussion groups.

Further, for example, when e-quiz questions are designed to directly attack areas of expressed student confusion, the students receive new, real-time insight into problems they are specifically struggling with. The value of this, in turn, is further greatly enhanced by referring the students to the digital textbook and discussion group assets in the feedback portion of the e-quiz. Notice, in particular, that this point of synergy allows students with diverse cognitive and learning strategies to access information relevant to their areas of difficulty or confusion in very different forms (written, animated, spoken).

Seventh, the use of the digital textbook has the advantages alluded to above. However, it also provides an important capability that faculty unfamiliar with these assets might not anticipate. Digital textbooks can be easily added to and revised on an ongoing basis. Thus, they represent a tool that accretes power and value year after year. The digital textbook becomes shaped increasingly to address real areas of student difficulty—ultimately enhancing student learning and satisfaction to an extent probably not achievable with any other currently available approach.

Eighth, the technical details of our use of e-quizzes are relevant. Specifically, the Blackboard e-quiz feature is quite robust. For example, large numbers of answers are permitted in the multiple-choice format. As well, images, charts, and graphs can readily be incorporated into questions (and feedback). Finally, assigning most of the credit for attempting the question (and only a small residue for a *correct* answer as above) licenses complex, subtle, or even strategically devious questions.

Combining these attributes permits the design of e-quiz questions that are far more difficult and challenging than a typical in-class examination question— with the objective of enriching and solidifying student comprehension. In our experience this is an especially powerful approach to leading students to mastery.

Outcomes and Measures of Satisfaction to Date

First, quantifiable student satisfaction (from course evaluations) is high (well above University norms). Enrollment in our large elective course has continued to increase based on word-of-mouth student support—reaching ca. 570 students.

Second, diverse anecdotal sources support these measures. For example, students frequently express to us as instructors that this course is the best of their undergraduate careers. These include mature students with experience at other elite teaching universities. Further, for example, disinterested University exit interviewers in the Division of Biology routinely ask each graduating senior about which of their courses most changed or effected their lives. Our large course, since the implementation of the approach described here, has been the most frequently mentioned in this category for the last several years. Finally, both authors are highly experienced (each with more than 20 years experience in university education or elite communication in the business/education world). We have each found our understanding of how elite education works (and doesn't work) enormously enlarged by the insights provided by the routine functioning of this relatively simple approach. Our own levels of professional satisfaction and continued growth and development have been enhanced greatly.

Concluding Remarks

We emphasize to faculty that this approach is now sufficiently well developed and "road tested" that it can be implemented with relatively little effort. The substantial rewards in both student and faculty learning and satisfaction appear to amply justify the modest investment.

We expect to continue to refine and grow the model in coming years. we look forward to learning from the experiences of others employing similar approaches.

REFERENCES

1. D. Oblinger and J. Oblinger, Educating the Net Generation, *Educause*, available online at http://educause.edu/books/educatingthenetgen/, 3.4-3.6, 2005
2. S. L. Chang, Effects of Facilitation on Cognitive Restructuring in Online Discussion, *Journal of Interactive Online Learning*, *3*:3, Winter 2005.
3. C. B. Wortman and J. W. Hillis, Undergraduate-Taught "Minicourses" in Conjunction with an Introductory Lecture Course, *Teaching of Psychology*, *3*:2, pp. 69-71, April 1976.
4. Rothman Media, Inc. available at http://www.rothmanmedia.com, 2005.

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