AIM for Better Student Learning: Using Instant Messaging to Facilitate Improved Instructor-Student Communication

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Introduction

This paper describes an experiment in which the instructors in two different undergraduate engineering mechanics courses used America Online Instant Messenger (AIM) as the principal means of communication with their students outside the classroom. Following a brief summary of current trends in instant messaging, we describe the experiment and the two courses in which it was conducted. We present quantitative assessment data demonstrating the positive impact of instant messaging on student learning and on student satisfaction with both the course and the instructor. We provide the authors' qualitative findings about the positive and negative impacts of IM use, as well as recommendations for maximizing the effectiveness of this popular communication medium.

The Instant Messaging Phenomenon

Instant messaging (IM) is a communication service that enables real-time text messaging between two or more persons over the Internet. Most current IM systems include the capability for file-sharing as well. America Online Instant Messenger, MSN Messenger, and Yahoo! Messenger are the most widely used IM systems.

Instant messaging works like this:

- The user installs IM client software locally on an Internet-connected computer. This software is normally offered for free.
- Using the IM client software, the user logs into a central server.
- The IM client provides the server with connection information and the names on the user's contact list (often called a "buddy list").
- The server informs the IM client if any of the user's contacts are also logged in and provides their connection information to the client.
- The user can now send messages to any of the contacts who are on line. Because the IM client already has connection information for all of the user's contacts, messages are sent directly from user to user (i.e., between IM clients); messages are not routed through the central server. This direct electronic connection between users is the technical characteristic that causes IM to be such a responsive communication medium.
- As users communicate back and forth, their respective messages appear in a window on both computers. As each new message arrives, the previous ones remain on screen but scroll upward, leaving a complete record of the electronic conversation. This record can be saved as a log file at the end of the IM session.[1]

Aarons suggests that IM is well on its way to replacing telephone and e-mail as the primary communication mode for people with internet connections.[2] The Pew Internet and American

Life Project reports that, of approximately 13 million American teenagers who use the internet, 74% use instant messaging.[3] And although IM use is usually associated with teenagers, more than 53 million American adults also report using IM—a significant increase from 41 million in 2000.[4] PR Newswire predicts that IM will become increasingly commonplace in corporate environments, with business IM accounts projected to grow nearly fourfold over the next four years.[5]

The phenomenal growth of instant messaging among all sectors of the population is attributable to three key characteristics of the medium:

- The ability to know which of one's contacts are available on line at any time.
- The ability to communicate in real-time.
- The ability to hold multiple simultaneous conversations.

Instant messaging offers some unique communication advantages,[6] and the emergence of instant messaging as the preferred method of communication among young people is an important trend; yet, most engineering educators have yet to fully grasp its significance and its potential to enhance the educational process. On the other hand, when contemplating the use of any emerging technology, it is important to moderate enthusiasm with careful consideration of the limitations of that technology.

The Experiment

The experiment described herein had two purposes. First, it was intended to investigate the possible educational benefits of using IM as a means of communication between the instructor and students outside the classroom. The associated research questions are as follows:

- Does the use of IM increase students' satisfaction with the course and the instructor?
- Does the use of IM increase student learning?
- Does the use of IM improve the quality of instructor-student interaction, in comparison with other forms of communication?
- Does the use of IM increase the efficiency of instructor-student interaction, in comparison with other forms of communication?

Second, the experiment investigated possible adverse effects of IM use, as follows:

- Does the use of IM foster excessive dependence on the instructor?
- Does the use of IM foster excessive informality in the instructor-student relationship?
- Does the use of IM place an excessive demand on faculty time?

The experiment was conducted in two different undergraduate engineering mechanics courses at the U.S. Military Academy at West Point, during the fall semester of Academic Year 2004-2005. The first, CE300 Fundamentals of Engineering Mechanics and Design, is an introductory course in statics and mechanics of materials. During the semester in which the experiment was conducted, 87 students (in six sections) were enrolled in the course. All were non-engineering majors—students majoring primarily in the humanities and social sciences and taking CE300 as part of a three-course core engineering sequence. Most of these students take the course involuntarily. And even though all have completed four core math courses, two chemistry courses, and two physics courses prior to taking CE300, many lack confidence in their quantitative problem-solving skills.

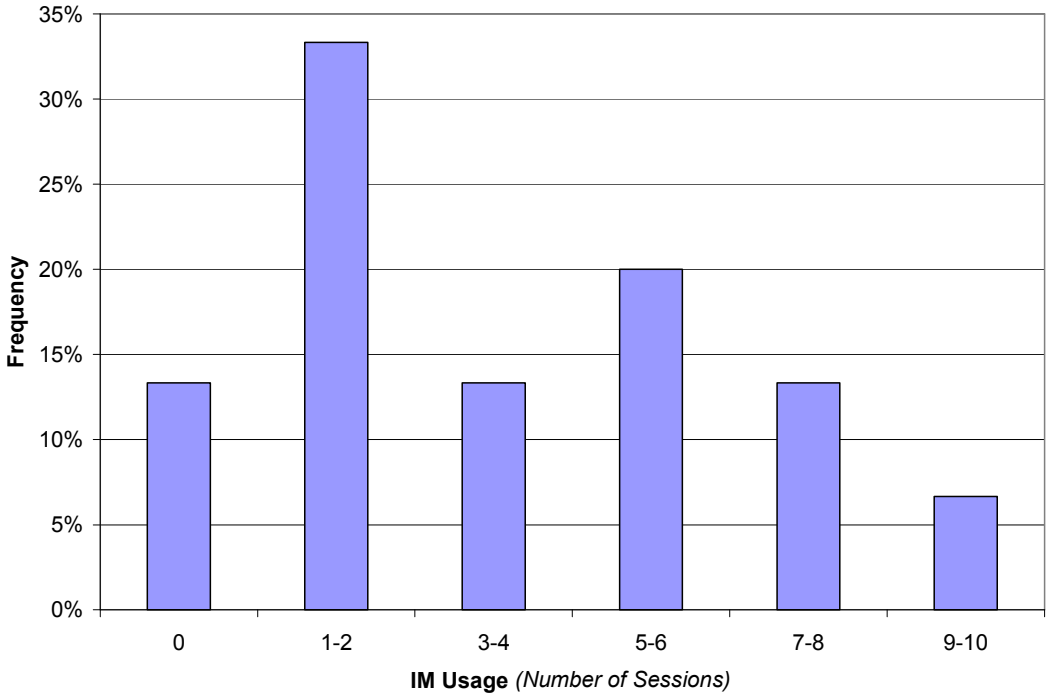
Three instructors taught CE300 during the semester in which the experiment was conducted. One instructor used AOL Instant Messenger (AIM) and strongly encouraged his students to do so. The other two instructors did not use instant messaging.

The second course is CE364 Mechanics of Materials. During the semester in which the experiment was conducted, 137 students (in nine sections) were enrolled in the course. Nearly all were 3rd-year students enrolled in an ABET-accredited civil engineering, mechanical engineering, electrical engineering, or engineering management major. Four instructors taught the course. All four used AIM, but with widely varying levels of emphasis. It should be noted that the four instructors also had widely varying amounts of teaching experience.

Quantitative Assessment Results

The CE300 instructor who used IM taught only one section of 15 students. Since he had a small number of students, he was able to carefully document their IM usage and performance on an individual basis.

The distribution of IM usage in this section of CE300 is shown in Figure 1. In this histogram, a "session" is counted as one or more IM conversations initiated by a given student on a single day; i.e., multiple conversations initiated by the same student on the same day are counted as one session.*



* This technique was used to ensure consistency in counting IM sessions. During IM interactions, some students tended to initiate a conversation and then remain connected for a period of hours, despite numerous periods of inactivity. Other students preferred to log off during periods of inactivity, thus initiating and terminating numerous IM conversations over the same period of time. Because the actual instructor-student interactions in these two cases are essentially identical, they both are counted as a single session.

Figure 1. Distribution of IM usage in the study section of CE300 during fall semester, Academic Year 2004-2005.

As the chart indicates, 13 of 15 students (87%) chose to initiate at least one IM session with the instructor over the course of a 40-lesson semester. Five students initiated only one or two sessions, while one student initiated ten sessions (on average about once every 4 lessons). All but two of the IM sessions involved requests for assistance on assigned homework problem sets. 90% of these sessions occurred outside of normal office hours—normally during the evening and within 48 hours of a homework due date.

At the end of the semester, the CE300 students' responses on the USMA standard course-end feedback survey were used as the basis for assessing their satisfaction with the course and their perceptions about their learning. Relevant course-end feedback results are shown in Figure 2. For each survey question, average responses are provided for the students in the IM section, for all students in CE300, for all students taking civil engineering courses, and for all students at USMA.

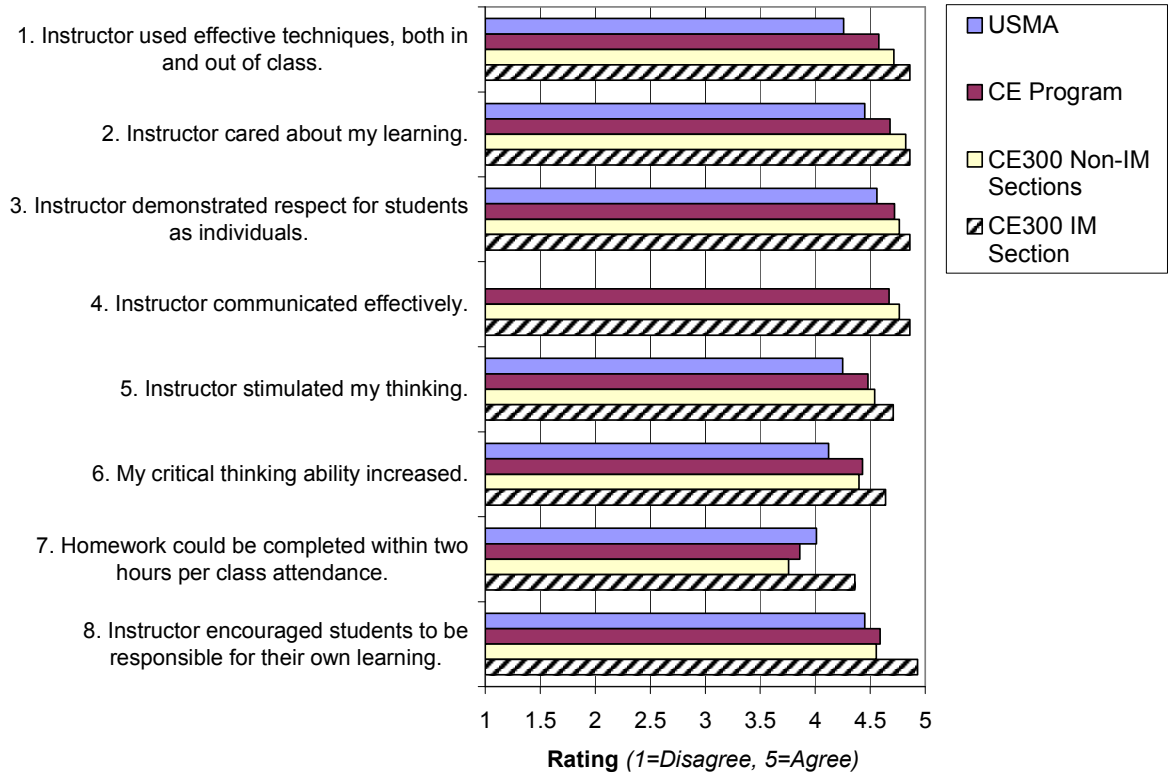


Figure 2. Selected course-end feedback results for CE300 during fall semester, Academic Year 2004-2005.

The course-end feedback results suggest the following:

- Survey items 1-5 indicate that students in the IM section were very satisfied with both the course and the instructor. Their level of satisfaction was greater than that of students in the CE300 non-IM sections, other CE courses, and all other courses at USMA. This comparison is by no means conclusive, in part, because correlation does not necessarily imply causation. The instructor of the IM section had considerably more experience than the instructors of the non-IM sections; thus, the differences in ratings might be entirely

attributable to differences in teaching skill. Although the instructor of the IM section had never taught this particular course before, the ratings shown in Figure 2 are generally consistent with his student evaluations from other courses (with the exception of items 6, 7, and 8, discussed below). Thus, from these data, we can only reasonably claim that the use of IM did no harm.

- Survey item 6 indicates that students in the IM section perceived that their critical thinking abilities increased, to a greater extent than students in the other categories. The average student rating for item 6 was atypically high for the instructor of the IM section.

- Survey item 7 shows that students in the IM section perceived—to a *significantly* greater degree than students in the non-IM sections—that they were able to complete course requirements within the allotted two hours per lesson. (This rating was also atypically high for the instructor of the IM section.) This result is particularly interesting (and quite unexpected) because surveys of *actual* student out-of-class time expenditure reveal *exactly the opposite result.* In this course, all three instructors administer a daily anonymous survey of the number of minutes each student spent studying CE300 since the last lesson. These data are intended primarily for course administration and assessment. For the semester in which this experiment was conducted, students in the CE300 IM section spent an average of 69.3 minutes on outside work between class meetings, while students in the CE300 non-IM sections spent an average of 60.4 minutes. Thus students in the IM section *spent more time working outside of class but perceived that they spent less time.* The reasons for this difference between perception and reality are uncertain (and will be investigated in a future research project); however, we speculate that students who used IM to get assistance on homework were less likely to experience frustration and were more likely to work on problems until they achieved a successful result. Thus they actually spent more time while perceiving that they spent less.

- As survey item 8 indicates, students in the IM section perceived that they were being held responsible for their own learning—again an atypically high rating for this instructor. This result is important because it suggests that IM did not cause students to become excessively dependent on their instructor. Indeed, it is possible that students perceive the enhanced engagement with their instructor via IM usage as an assumption of greater responsibility for their own learning.

- In response to an open-ended question about IM usage, 13 of the 13 students who used IM responded that it had been very helpful, even if used infrequently.

To determine if IM usage had any effect on student learning, we began by obtaining the following data on the performance of each student enrolled in the CE300 IM section:

- Overall grade point average (GPA) at the start of the course.
- GPA in the six courses that were expected to be the best predictors of performance in CE300—four core mathematics courses (Discrete Dynamical Systems, Calculus I, Calculus II, Probability and Statistics) and two core physics courses.
- Final grade in CE300.

We calculated the correlation coefficient relating the CE300 Grade to *both* the Overall GPA and the Math and Physics GPA. The results are summarized in Table 1 below. These results suggest that, as expected, the Math and Physics GPA is a better predictor of CE300 performance than the Overall GPA.

Performance Measure	Correlation with CE300 Grade
Overall GPA	+0.633
Math and Physics GPA	+0.752

Table 1. Correlation of CE300 grade to Overall GPA and GPA in Math and Physics courses.

Working from the assumption that a given student's prior performance in six math and physics courses represented a reasonable measure of his or her *expected performance in CE300*, we then devised one additional performance measure—the difference between a student's *actual performance* in CE300 and his or her *expected performance* in CE300. This performance measure is calculated by subtracting the Math and Physics GPA from the earned CE300 Grade for each student.

We then calculated the correlation coefficient relating IM Usage (measured as the number of IM sessions during the semester) and each of four different student performance measures, as shown in Table 2.

Performance Measure	Correlation with IM Usage *(Number of Sessions)*
Overall GPA	-0.033
Math and Physics GPA	-0.051
CE300 Grade	+0.336
Difference between Actual and Expected CE300 Performance *(CE300 Grade)-(Math and Physics GPA)*	+0.546

Table 2. Correlation of CE300 grade to overall GPA and the GPA in math and physics courses.

These results indicate the following:

- There was no significant correlation between Overall GPA and IM Usage or between Math and Physics GPA and IM Usage. That is, strong students were no more or less likely than weak students to use IM.

- The CE300 Grade was weakly correlated with IM Usage. Students who used IM more frequently tended to perform somewhat better in the course.

- The Difference between Actual and Expected CE300 Performance was significantly more strongly correlated with IM Usage. Students who used IM more frequently performed significantly better than their prior performance in math and physics would have predicted. The R-squared corresponding to this relationship is 0.299, indicating that 30% of the variation in student performance can be predicted as a linear function of IM usage. The scatter plot (with trend line) is shown in Figure 3.

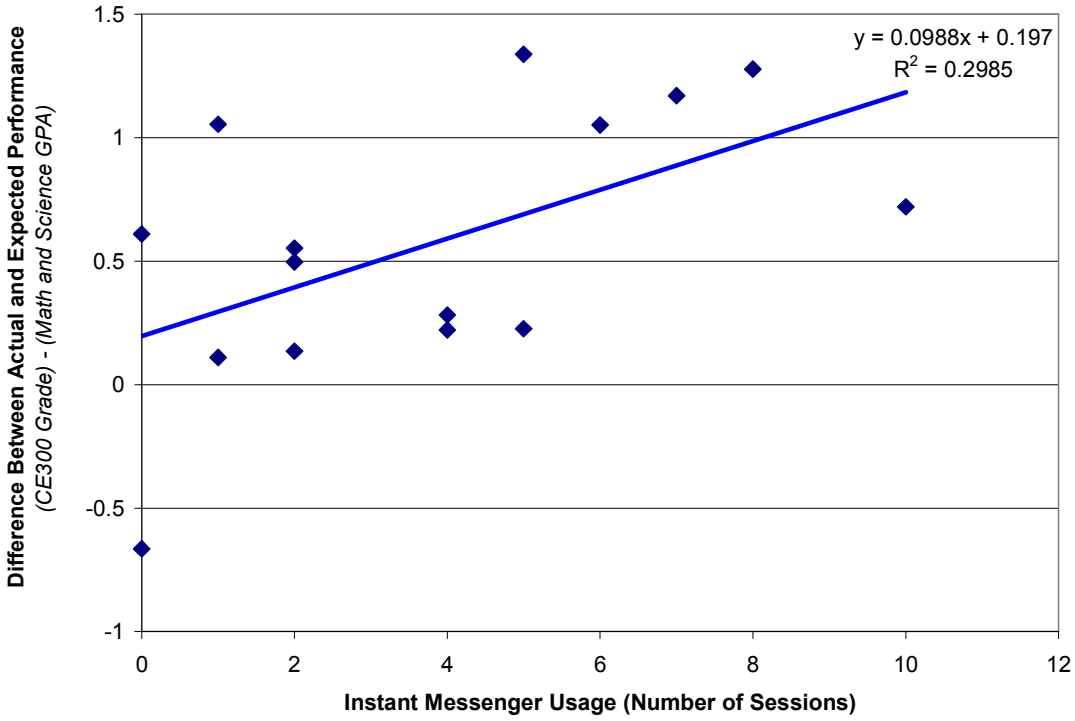


Figure 3. Difference between Actual and Expected CE300 Performance vs. IM Usage for CE300 students.

In one sense, these results seem obvious. One would reasonably expect that students who apply themselves and seek out help, regardless of the communication medium, would perform better than expectations. However, this perspective overlooks the most common accusation leveled by IM's detractors—that IM renders student-instructor interaction "too easy," resulting in students seeking help before they ever really engage with their homework. If this accusation were true, then students' IM usage *would not* improve their performance. The data indicate otherwise.

CE364, the second course involved in this experiment, relied primarily on qualitative assessment of the positive and negative aspects of instant messaging. One item of quantitative data is worth noting, however. As part of the course-end feedback survey, the course director included three specific items on IM usage. Figure 4 shows the average student responses for each of these items. Averages are presented for the course as a whole and for each of the four instructors. These data suggest three significant findings:

- Students appear to be more likely to interact *with each other* via IM on course-related matters than they are to interact with their instructors. This follows the assertions in the earlier part of this paper related to the prevalence of IM usage among college students.

- Students' willingness to interact with their instructors via IM is strongly influenced by the extent to which the instructor encourages IM use. In CE364, Instructor A emphasized to his students that he could be contacted via IM and then reminded them about this resource frequently throughout the semester. The other instructors placed little emphasis on IM use beyond providing students with their IM screen names at the start of the semester. As a result, Instructor A's students reported significantly higher levels of IM

usage and significantly more positive influence on their learning. It is perhaps significant that instructor enthusiasm had little or no effect on student-to-student usage; the students did not need to be reminded that peer-to-peer IM was there, only that student-professor availability existed.

- Approximately 50% of Instructor A's students communicated with him via IM during the semester. This level of IM usage is lower than that of the CE300 students (87%), as reported above. There are two possible reasons for the difference. First, the CE300 instructor routinely logged into Instant Messenger in the evenings, while the CE364 instructors generally did not. Second, the CE364 students were all engineering majors taking their second engineering course; the CE300 students were non-engineering majors taking their first engineering course. The CE300 students had considerably less confidence in their problem-solving abilities and thus were more likely to seek help.

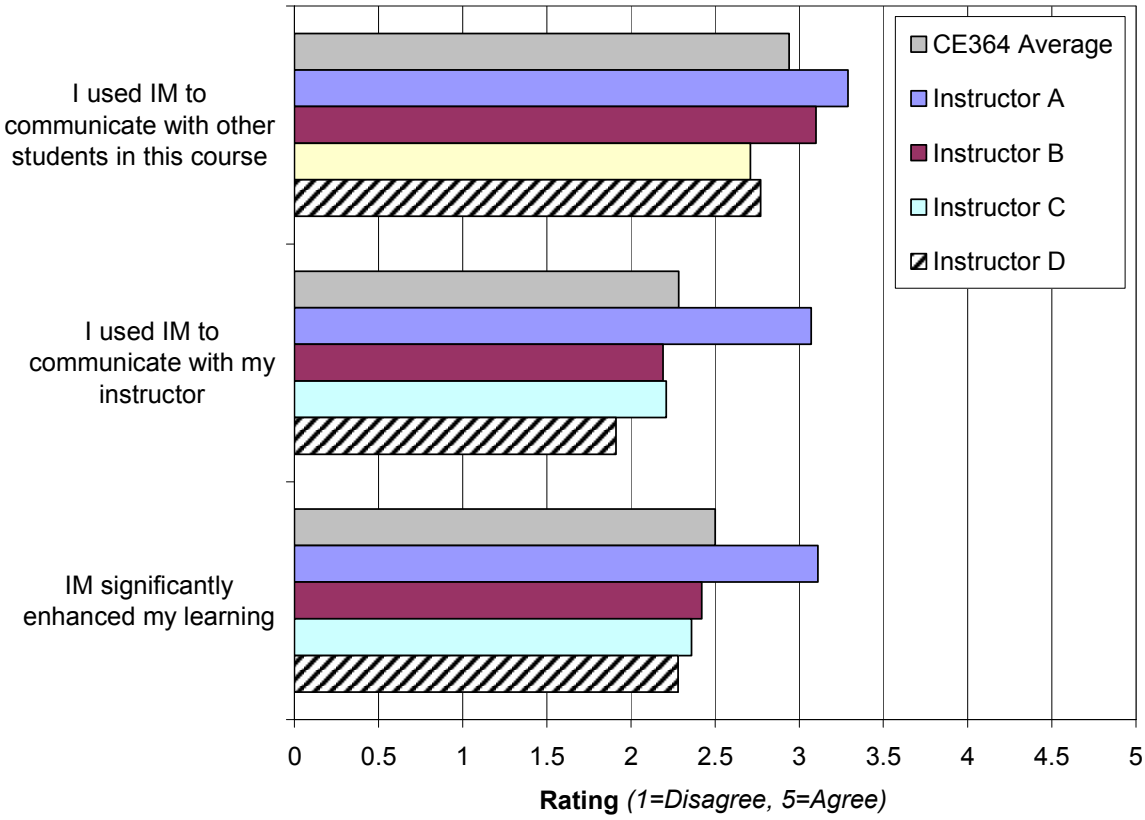


Figure 4. Selected course-end feedback results for CE364 during fall semester, Academic Year 2004-2005.

Qualitative Findings

Figure 5 shows a representative log file of an IM conversation between the CE300 instructor (WPBridgeGuy) and one of his students (hecoxinator). This actual IM session, which took place on August 29, 2004, illustrates a number of important qualitative findings of this study:

- In both CE300 and CE364, students used IM primarily to request assistance on homework problems.

INSTANT MESSENGER LOG – AUGUST 29, 2004

hecoxinator: Sir, this is Cadet Cox
WPBridgeGuy: hi, jeff
hecoxinator: I was wondering about part F on the problem set
hecoxinator: the summing of moments
hecoxinator: Do you have to break it apart into 2 different FBD's?
WPBridgeGuy: what's the total number of unknown reactions you need to solve for?
hecoxinator: 2, A a roller and B, a pin
WPBridgeGuy: good, but that's the number of supports. how many *reactions?*
hecoxinator: 3, on A one in the y dir and both x and y at B
WPBridgeGuy: good. now, if you draw a FBD of the entire structure, is the force system concurrent or non-concurrent?
hecoxinator: non-concurrent
WPBridgeGuy: good again. so how many equations of equilibrium can I write for the entire structure?
hecoxinator: 3 right?
WPBridgeGuy: right! so we've got 3 equations, 3 unknowns. Bob the Builder says, "can we solve it?"
hecoxinator: yes we can!!!
WPBridgeGuy: so you don't need to break the structure up into pieces. you never need to break a structure up unless (1) you don't have enough equations to solve based on an FBD of the entire structure or (2) we ask you to solve for an internal force (more on this in a few lessons).
hecoxinator: okay, sir. One other thing though
WPBridgeGuy: go ahead
hecoxinator: I tried to sum moments around pt B (subtracting the 5 and 7 kip forces and adding all the others)
hecoxinator: I added in the 100 ft kips separately and came up with a negative number
hecoxinator: if I don't put in the 100 ft kips I come out with a positive number, which makes more sense
WPBridgeGuy: a negative number for what? the reaction at A?
hecoxinator: yes sir
hecoxinator: it should be positive to press upwards
WPBridgeGuy: it's theoretically possible for a roller reaction to go downwards, but probably not in this case. I suspect you've made a math error. Let's take it step by step...
hecoxinator: roger sir
WPBridgeGuy: you said the 5 k and 7 k forces were subtracted. this sounds like you are assuming clockwise positive, right?
hecoxinator: roger sir
WPBridgeGuy: go ahead and write out your moment equation for me, like this...MB=(2k)(6') + ...
hecoxinator: MB=-(5*14')-(7*6')-(10*0')+(2*6')+100ftkips+(0.5*6')+(Fa*14')
WPBridgeGuy: which direction does the 0.5 kip force tend to rotate the body about Point B?
hecoxinator: clockwise
WPBridgeGuy: look again
hecoxinator: about B it is counter clockwise
WPBridgeGuy: right. remember that you are summing moments about B, so think of B as the pivot point. the 0.5 kip force tries to rotate the body CCW about B. see it?
hecoxinator: yes sir
WPBridgeGuy: go ahead and re-work your numbers.
hecoxinator: then I can just sum forces for the other 2 reactions, right sir?
WPBridgeGuy: right.
hecoxinator: thank you very much, sir

Figure 5. Representative AOL Instant Messenger log from CE300

- The character of student-instructor IM interactions was generally productive and appropriately respectful. In a few cases, instruction on proper forms of address and polite usage were necessary, but no more so than with verbal communications. We

acknowledge, however, that the nature of instructor-student interactions at a military academy are not representative of instructor-student interactions at civilian institutions.

- As indicated in Figure 5, the nature of the medium demands that students formulate specific questions about specific difficulties they are experiencing on an assignment; thus, IM generally did not serve as a *substitute* for student work. Arguably, the IM medium forces students to formulate coherent questions and to rationally evaluate their problem-solving methods prior to asking for help. The message "I'm completely lost" never turned up.

- Our experience suggests that IM is most effective when the instructor does not directly answer students' questions. Rather, whenever possible, the instructor should respond to a question with a question. Note in Figure 5 that WPBridgeGuy responded to hecoxinator's question with five consecutive questions, each intended to help hecoxinator arrive at the solution on his own.

- A major limitation of IM for assisting students is the inability to use sketches, symbols, and other visual means of communication that would be available in a face-to-face discussion. In Figure 5, note how much more efficient the conversation would have been if WPBridgeGuy could have seen hecoxinator's free body diagram. In the absence of a diagram, WPBridgeGuy had to infer the assumed positive direction and then ask hecoxinator to confirm it.

- Similarly, the instructor's inability to see the student's written solution during the IM session can inhibit timely detection of conceptual or procedural errors. Thus, in Figure 5, WPBridgeGuy needed to ask hecoxinator to text-message an entire equilibrium equation in order to diagnose a simple sign error.

Some broader qualitative observations contributed by the instructors who participated in the experiment are as follows:

- Responding to IM requests for assistance can be more efficient for both the instructor and the student than a telephonic request or an unscheduled office visit. An IM message is less disruptive than a ringing telephone or a knock at the door, and a slight delay to check a reference or perform a quick calculation, if necessary, before drafting a concise IM response does not preclude the student from performing another task in the meantime. Indeed, very long lags during an IM conversation (sometimes on the order of hours) do not place a constraint on the instructor's or student's time, and a written log remains for the student to consult without disturbing the instructor.

- IM provides a particularly effective means of *coaching* students through the solution of conceptually challenging or open-ended homework problems. On such problems, students frequently used IM to seek interim feedback on their problem-solving process; e.g., "Here's what I'm doing. Am I on track?" Used in this manner, IM proved to be a powerful tool for performing *formative assessments* that make the students' thinking visible to both themselves and their instructors.

- Even during office hours, many students prefer instant messaging over face-to-face meetings, because of IM's convenience and students' perceptions that IM provides a low-threat environment. This is the case, even though a face-to-face help session is generally more productive.

- If given the opportunity to communicate with an instructor via IM after office hours, especially during evenings and weekends, students will respond enthusiastically. In the experiment, students used IM far more readily than they would call an instructor on the telephone. This is the case, in part, because IM users automatically communicate their availability to potential contacts simply by being logged in. When an instructor communicates his or her availability by being logged in, students can safely assume that the instructor will not be inconvenienced by a request for assistance.

- Responding to IM requests for assistance does indeed place a significant demand on faculty time—particularly if the instructor chooses to be available during evenings or weekends. Yet because IM requests for homework assistance are largely concentrated in the 48-hour period prior to homework due dates, these time demands are reasonably manageable.

- Some instructors may choose to limit the hours during which they are available for instant-messaging with students. This is easily done by creating a special screen name for instructional use, and is roughly equivalent to providing students with a phone number through which the instructor can be reached. A frequent concern about IM is the demand on instructor time, but this can be controlled by simply shutting down the system or logging off the special screen name.

- Some students may seek to use IM as the *exclusive* means of communicating with their instructors outside of class. By foregoing face-to-face instructor-student interaction, these students may be missing important opportunities to develop verbal communication skills. Instructors should be sensitive to this tendency and should encourage their students to achieve an appropriate balance between electronic and face-to-face communications.

Conclusions

As a communication medium, IM offers a number of unique and powerful capabilities—responsiveness, real-time feedback about availability, a low-threat environment, and the capacity for multi-tasking. Most IM client software is available at no cost. Moreover, the vast majority of college students are already using IM to communicate with each other. They are entirely comfortable with this medium of communication—more comfortable than with the telephone and, in many cases, more comfortable than with face-to-face communication. For all these reasons, IM has enormous potential to enhance student learning and student engagement in the learning process.

This study has attempted to determine if that potential can be realized. Based on both quantitative and qualitative findings, we draw the following major conclusions about the use of IM as a means of communication between faculty and students outside of the classroom:

- The use of IM does not detract from students' satisfaction with the course and the instructor.
- The level of IM usage is positively correlated with student learning. In the experiment, students who interacted more frequently with their instructor via IM were more likely to perform above expectations.
- Responding to IM requests for assistance can be more efficient for both the instructor and the student than a telephonic request or an unscheduled office visit. An IM message is less disruptive than a ringing telephone or a knock at the door; and IM's capacity for multi-tasking ensures that inevitable delays—to check a reference or perform a quick calculation, for example—need not result in wasted time.
- Used effectively, IM can improve certain aspects of instructor-student interaction. In the experiment, IM was particularly useful as a means of coaching students through the solution of conceptually challenging homework problems. IM also proved to be a powerful tool for performing formative assessments that made the students' thinking visible to both themselves and their instructors.
- On the other hand, the inability to easily communicate drawings and symbols significantly reduced the efficiency of many IM sessions. Similarly, the instructor's inability to review a student's written work also reduced efficiency.
- Contrary to our expectations, there was no evidence that IM use fostered excessive dependence on the instructor. No student used IM more than once per four lessons of the course. Furthermore, IM use appeared to improve students' perception that they were responsible for their own learning.
- There was no evidence that IM fostered excessive informality in the instructor-student relationship.
- IM use can, in fact, place high demands on faculty time, particularly if the instructor chooses to be available on line during evenings and weekends. These demands are mitigated, to some extent, by the fact that periods of intense student IM usage are highly predictable and therefore manageable. More importantly, instructors can control the amount of time they spend instant-messaging with their students by simply limiting the periods of time when they are available on line.

The validity of these conclusions is necessarily limited by the small number of students in the experiment and by the lack of a control group in the experimental design. During the next year, the authors will attempt a broader and more rigorous study, with the intent of further increasing our understanding of instant messaging in engineering education.

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