Effective Online Office Hours in the Mathematical Sciences

Jeff Hooper
Department of Mathematics and Statistics
Acadia University
Wolfville, NS, Canada
jeff.hooper@acadiau.ca

Marco Pollanen
Department of Mathematics
Trent University
Peterborough, ON, Canada
marcopollanen@trentu.ca

Holger Teismann
Department of Mathematics and Statistics
Acadia University
Wolfville, NS, Canada
holger.teismann@acadiau.ca

Abstract

In this paper, we describe our introduction of anonymous online office hour sessions for mathematics courses and outline a number of ways in which these sessions are more effective than traditional office hours. Our study is based on our experience with conducting the sessions as well as on data from student surveys. Our sessions make use of the enVision communication software (freeware), which permits easy, real-time communication of complex mathematical ideas.

Introduction

The importance of office hours as a teaching resource has been well studied. Nadler & Nadler (2000) provide a review of the literature that suggests that increased contact with faculty outside the classroom correlates positively with student retention, academic performance, higher educational aspirations and more satisfaction with the college experience.

On the other hand, Nadler & Nadler (2000) also summarize the literature concerning traditional office hour attendance. While there is a great deal of variability in reported frequencies across studies, the pattern suggests that office hour use is very infrequent and superficial with the majority of the visits brief at less than 10 minutes. While there is no study specific to the mathematical sciences, anecdotal evidence suggests that the use of office hours in mathematics is no better, if not worse.

In an effort to improve attendance of office hours, we have introduced online help and discussion sessions into our courses, using the Web-based communication platform "enVision," developed by Pollanen (2006). In this paper, we describe our experience with these sessions, the use of the system, and the students' responses.

The enVision system resembles a cross between a whiteboard and a chat-room, with a great deal of additional functionality that allows users to easily create complicated formulas and diagrams in real time. EnVision is small, easy-to-use, and requires no special skill or software on the part of the user.

Participation in the online sessions has far exceeded our expectations: far more students have participated in these sessions than would normally attend office hours, or could even be accommodated. From our experiences conducting the sessions and the student feedback, we have also been able to identify some of the aspects of the sessions that may significantly influence the learning outcomes. Those include:

Anonymity: An important ingredient of the system is the ability for students to remain anonymous throughout the session. Our results show that a significant number of students consider this an important feature. They can ask questions, or offer opinions, without the fear that either their instructor or their peers will be able to connect the question or opinion back to them.

Engagement and multi-way dialog: Using the enVison system, students soon started having discussions amongst themselves.

Passive participation: Students not only have access to their own personalized discussions with the instructor, but they can watch other conversations taking place and thereby see the questions that other students are asking.

At the end of the paper, we consider some minor drawbacks to these sessions, when contrasted with traditional office hours, and describe directions for further study.

Mathematics communication with enVision

According to a recent study (Jones and Johnson-Yale, 2005) the Internet has had a phenomenal impact on college and university teaching. Over 98 percent of faculty use e-mail to communicate with their students with 73 percent of those reporting that their communication with students has increased as a result. Furthermore, 37 percent of faculty use chat-rooms to communicate with their students.

There has been recent interest in the use of chat software such as the various instant-messaging tools. These generally allow text messages to be sent back-and-forth between students and instructor, and permit virtual chat-rooms, so that students may sign on and participate in the discussion.

Although there has been some success in using such solutions (Roper and Kindred, 2005), anecdotal evidence suggests that these have almost completely been in the context of more "text-based" subjects. There is little evidence to suggest that the use of chat-rooms is pervasive in the mathematical sciences.

The major problem appears to be that a number of subjects, like mathematics, engineering, or chemistry, rely heavily on symbols, visual aids, and other non-textual communication, with the result that communication over the Internet can be a slow and frustrating process. As an

example, undergraduate mathematics students are often imprecise in their use of parentheses in communicating mathematical concepts. In text chat format, where expressions must be inline, even the simplest statements students write are often ambiguous and easily misinterpreted. For example, if a student writes 1/2x, does she mean *one half of x* or *one over two x*? Similarly, does the statement *x2* represent x^2, x_2, or *two times x*? Of course, this problem becomes amplified when dealing with Greek letters, graphs, matrices, and complicated formulas,such as:

$$\int_2^5 \frac{x^3+3x-2}{\sqrt{x^6-1}}dt = \sum_{||P||\to 0} \frac{(x_i^*)^3+3(x_i^*)-2}{\sqrt{(x_i^*)^6-1}}\Delta x_i$$

This communication problem is particularly serious for live interactive communication, where all participants must be able to produce unambiguous equations and diagrams quickly.

In an effort to combat these communication difficulties, enVision was developed by Pollanen (2006). enVision is a synchronous, real-time communication tool that resembles a whiteboard or chat-room but has added functionality to easily create mathematical equations. It is Web-based, loads as an applet into a Web-browser without installation, and allows multiple participants to share a workspace in which they can create equations, graphs and other mathematical content. enVision is free and can be downloaded from www.xiom.org. A screenshot of enVision is shown in Figure 1 below.

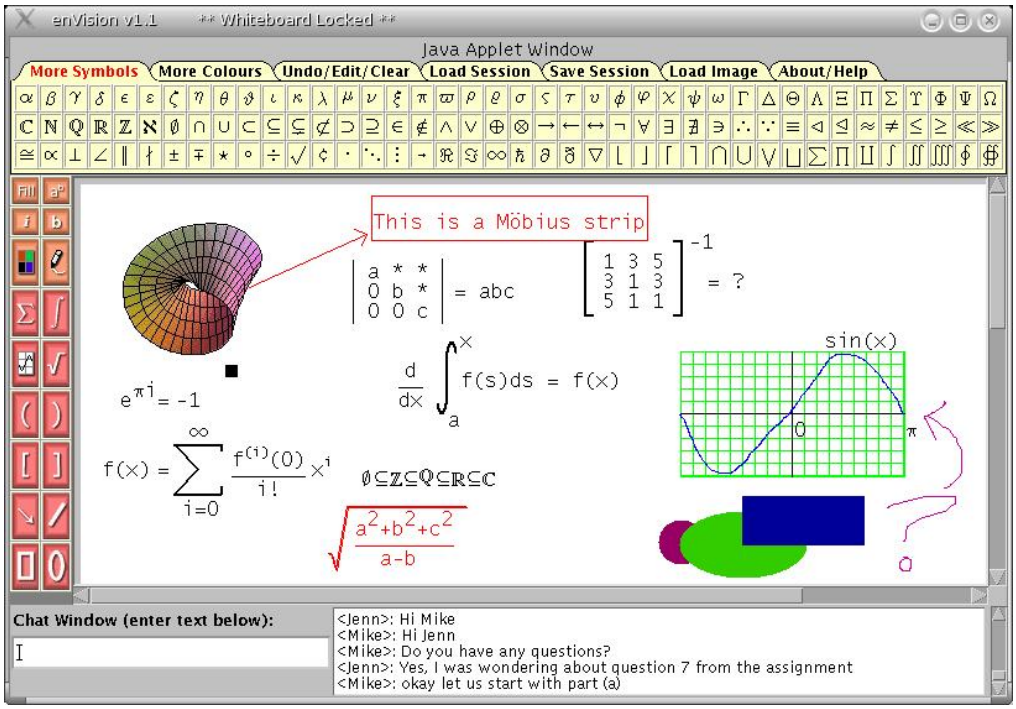

Figure 1: A screenshot of an enVision session.

Online Office Hours Using enVision

Recently, in an attempt to increase the effectiveness of out-of-classroom help for our students, we have introduced a series of regular online help hours for first- and second-year students at our universities, using the new enVision system. The response has been overwhelmingly positive, which is reflected in both student turnout and feedback during the sessions themselves and in later surveys. Using these surveys, we have identified several important aspects of the delivery of online office hours using enVision, including student turnout, anonymity, and student involvement through passive participation. We will now examine each of these in further detail and discuss how online office hours compare with traditional office hours.

Student Turnout

Our attendance at regular office hours varies considerably from no turnout at all during some hours, up to a dozen or so on the days before assignments are due or tests are scheduled. (Our first-year calculus course is multi-sectioned with a total enrollment of about 190 students.) In comparison, in our online office hours, even during off-peak times, when the general student focus has not been on our course, we have had 10-12 students using the session. During peak times, when one would expect roughly a dozen students, we have had sessions where as many as 40 students attended simultaneously. Just to emphasize, 40 students attending represents more than 20% of the entire enrollment in the course, more than could physically fit in an office. It is clear that our use of this system has had a major impact in student use of office hours. This dramatically increases both the efficiency and effectiveness of our use of the time. Because all students can watch and participate in the discussion, similar questions and points can be addressed once, and so we are able to discuss more topics in the allotted time than we could normally.

Two factors seem to play a prominent role in the improved turn-out: convenience and comfort. A few quotes from our surveys may illustrate this.

> "[the instructor] can explain the questions to multiple people at once, which is convenient because people usually have the same questions."
>
> "I'm much more comfortable with the online sessions."
>
> "Online is less personal which can be good for a lot of students."
>
> "... you can stay in your room with all your resources."
>
> “Online Office Hours are more convenient...”

Anonymity

It is interesting to note that while some of our students use their given names, surnames, or some other obvious form of "clear" name, a large number make use of the anonymous feature of the system, preferring to instead remain faceless during the session. And although some names may be obviously "clear" names or obviously anonymous, for many of the student aliases the exact status may not be apparent to the instructor, even if she knows all of the names of her students.

In particular, the exact nature of the knowledge of a student's identity among his or her peers will often not be clear at all to the instructor.

In our experience with the system, and in student survey responses, there are two important types of anonymity, being anonymous from the professor and being anonymous from peers.

The anonymity feature of enVision was conceived as a means of tackling the issue of "math anxiety", which is of fundamental importance in post-secondary mathematics education (Tobias, 1990). Survey data suggests that 85% of first-year students in introductory mathematics classes suffer from at least mild math anxiety (Perry, 2004). Our experiences are similar. However, even in the survey responses of our own students it is interesting to note that of the students who feel that anonymity is an important feature of the system, the majority of these speak in the third-person. They make statements such as "some students may feel uncomfortable asking questions", or "sometimes students are uncomfortable approaching a prof. about problems", or even "some people don't feel comfortable with everyone knowing it's them". In fact, the number who refer to anonymous use in the first person is far below the number who actually use aliases during the sessions. This appears to suggest that their anxiety or fear may be more deeply-rooted than one might expect. The fact that even on an anonymous survey a number of students can still not admit to their personal wish for anonymity seems to us a fascinating problem, one worthy of further study, and certainly one of interest to us in examining our further use of enVision.

A related issue is also of interest. As students can choose to be anonymous, it is easier for the instructor to engage the students in active participation by prompting individual students to answer questions online without the instructor feeling she is putting the student on the spot. In this environment, students are free to “take risks", which is an important part of learning, without having to fear looking foolish in front of peers or professors.

Here are a few more few more quotes from our surveys pertaining to the anonymity aspect:

> "...the student will be more confident in asking questions without embarrassment of asking a ‘stupid’ question."
>
> "...It's easier to risk asking something dumb when your prof and your friends don't know it's you."
>
> "...if someone is embarrassed to ask questions they don't have to worry about it."

Passive Participation

Another factor which interested us, and which was borne out by the opinions expressed in our student surveys, relates to the passive use by a number of students. Since we have had as many as forty students logged on to the system at a time, it is clear that we cannot be meeting the precise needs of each student at any given moment. This was a concern of ours since the session logs clearly indicated that roughly one-third of our student users were "lurking" throughout the session and were not actively participating in the discussions, nor asking about any problems of their own. We were led to ask ourselves a number of hard questions. Did we need to address this concern and look for ways to alter our use of the system to get these students more engaged? Were they feeling marginalized? Was the heavy use of the system making them too shy or anxious to participate?

From the student surveys, however, it is clear that much of this "lurking" has a distinct type of educational value. Many students, both during the sessions and in their survey responses, noted that they often didn't need to contribute since their own problems were reflected in those which were being discussed. There were also a number of students who logged on "just in case" there might be something they had missed, and quite a number of students have expressed the opinion that just by watching the unfolding discussion they were being exposed to questions and subtle points that had not even occurred to them. As one student put it:

"I myself have logged on and just sat and watched. I actually picked up a lot just sitting there!"

They are also being exposed to the mistakes of other students, and in their use have begun to jump in and help each other with corrections and clarifications.

Finally, and perhaps most importantly, we are also seeing evidence of the impact on students when they realize that they are not the only ones with problems or questions. In a non-anonymous environment, the fear of being looked down upon arises. One student expressed the situation this way: "It's hard to ask questions in class because [you're] surrounded by very smart people. You don't want to be the only one who doesn't know something".

The use of enVision as we have described it has the potential to help students by allowing them to see what they describe as "dumb questions" being asked by other students, and could go a considerable way towards boosting their own self-confidence. As one of our survey respondents expressed it:

"I don't feel nearly as inferior as I used to. Lots of others have the same questions I do!"

Comparison with Traditional Office Hours

There are a number of fundamental differences between traditional office hours and online hours using enVision. In an online office hour, it can be difficult to maintain a balance among the different students, and some of the more assertive students can at times monopolize the discussion to meet their own needs. And students may still need to wait for extended lengths of time in order to have their particular topics discussed, though they will be able to watch and participate in other discussions in between. In particular, it can be difficult for both instructor and students to maintain perspective on the waiting times, and students can misinterpret the situation and feel that the instructor is not being fair to them.

From an educational perspective, probably the biggest concern is that we don't actually see the students, and so we lose access to one of the major human forms of communication, the visual. In a traditional, face-to-face situation, the instructor has a number of visual cues at her disposal. She can use eye contact to assess understanding, can use facial expressions and other physical means, such as hand movement, to try to add emphasis to her explanations. In the sort of anonymous office hours we are offering, we must relinquish these in order to gain access to the alternative benefits.

Discussion and Future Directions

In the above sections we have described several important aspects of the delivery of online office hours using enVision. In this format, we can help more students than we can in a traditional office hour. Since the online sessions are being used to supplement regular office hours, we are catering to students with different learning styles.

Although our use of this has been at relatively small universities, this approach has a strong potential for use at large universities, especially those with satellite campuses where many students commute and may not have any friends in the class. A student who wants to attend an online office hour can connect in from anywhere, using any standard browser, and can set herself up in comfort with all her resources available. The "live" nature of the session means that students can get engaged and even discuss material with one another. In fact, the system is left running all the time, even when outside the online office hour and without the instructor, and students are free to log on and discuss the material with one another.

Our ability to archive the sessions for future playback means that learning can go on even outside the actual office hour, for busy students who are unavailable at the appointed time. The sessions themselves are stored in a simple text format and are easily edited, and so we can create databases of our sessions for later consultation by students. Those students with special needs can also benefit from the ability to replay the sessions at their own pace and from the ability to access help without needing to travel in.

We are also able to integrate different resources into the discussion. For instance, by using mathematical software such as Maple, we can quickly create a complicated plot, export it as an image, and then load the image into the enVision window. This ability to integrate such technology, and in a way in which large numbers of students can view it and follow the ensuing discussion, is an additional key facet of the system. This would be far more difficult in a regular office hour setting. An instructor can also surround herself with a number of traditional resources (texts, solution manuals, notes, and so forth) to refer to during the session without really breaking the chain of discussion or any potential embarrassment of needing to look something up. Palmer (1998) discusses the fear that instructors often have of their students and the communication barriers that this creates between student and teacher. Thus, creating a relaxed atmosphere for the instructor to access resources may improve communication. This may particularly be true for junior faculty and for graduate students employed as teaching assistants.

Our use of online office hours has also left us with many interesting questions about their use in enhancing student learning. The anonymity issue has led us to ask a number of questions which we feel require further investigation. Are the two types of anonymity that students mention (anonymity from peers, anonymity from professor) related? Do different students feel more strongly about one type than the other? Are students just using their online persona or are they trying to be anonymous? We also seem to be seeing an increase in the amount of risk-taking going on. Is this actually the case? The anxiety or fear we are seeing expressed in the surveys—is it purely mathematics-related, or is it something different? If this fear is actually affecting student performance, is that reflected in our students' results after using enVision?

Conclusion

In this paper we have described our experiments with using enVision to deliver anonymous online office hours as a supplement to the standard help hours offered for our first-year calculus students. As compared with traditional office hours, we have seen a much larger turnout for these sessions and have greatly increased our communication with students. At the same time, surveys of student opinions show that students were overwhelmingly positive in their response to the online office hours, and frequently cited the anonymity of the sessions as a key factor in helping to relieve their anxiety, allowing some students to more actively participate in the discussion while others could choose a more passive role and still gain from the session. Our work so far with introducing these online sessions has also left us with many interesting questions about their use in enhancing student learning as well as a number of exciting further directions to explore.

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