

Let's Talk: Using Conferencing Software in Mathematics Courses

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ABSTRACT: Modern conferencing software can provide real benefits in mathematics courses. Instructors benefit by getting more, better feedback from the students. Students benefit by having increased ability to work together and draw on each others' knowledge. Researchers benefit by having access to a record of the group dynamics and problem (and solution) evolution. Student communication is enhanced, and the possibilities for such communication are greatly enlarged. These benefits, coupled with the relatively small time investment involved in starting to use this software, make using conferencing software a very attractive option in mathematics courses.

Modern conferencing software can provide real benefits to the mathematics teacher in feedback, in cooperative work, in distance learning, and in fostering student communication.

Conferencing software provides a ready avenue for classroom assessment and feedback, so the instructor can more closely monitor what is working and what is not. Feedback generated via conferencing software retains the immediacy and relevance of many of the quick assessment techniques, while not sacrificing classroom time. It also allows a more deliberative attitude on the part of students, which may result in more accurate evaluation.

Cooperative work is also enhanced through the use of conferencing software. Busy students can link for virtual, asynchronous "meetings," allowing far more interaction than if face-to-face meetings are required. The instructor can also see the progressive refinement of ideas, where stumbling blocks occur, and who is making contributions to the group. In addition, conferencing software maintains a record, which may then be used for grading, for research, or for refinement and revision of projects.

Finally, there are many, well-known benefits which accrue when one can get students talking about mathematics. Conferencing software allows one more avenue for this communication. It is especially useful at larger schools, in larger classes, or anywhere a significant number of students do not know each other. Many of today's students are comfortable with online relationships, and communicate more freely via a terminal than in person. For some of these students, the presence or absence of conferencing software may determine whether or not they talk about mathematics with others.

1 Classroom Assessment

It is vital for an instructor to get feedback from students. Everyone has been in a classroom where there was a chasm between what the teacher thought the students knew and what the students actually did know. And, while such a disparity will announce itself eventually, it is far better to know what the students understand, and what they don't, as soon as possible. A variety of techniques, some modern, most not, can be used to evaluate what students know (and what they do not). [1] Many of these techniques may be profitably adapted to conferencing software. We will examine two very common assessment techniques, and see some of the advantages offered by using these in conjunction with conferencing software.

One very useful assessment technique is the "minute paper." In the traditional paper-based approach, the instructor asks students to take out a sheet of paper during the last five minutes of class and write a quick response to the following questions: "What is the most important point you learned today?" and/or "What point remains least clear to you?" The instructor collects the (usually anonymous) replies and, depending on the nature of the feedback, modifies subsequent lectures and other course elements. The instructor may comment on the minute papers at the next class session. Minute papers provide a quick, regular level of feedback which can be very valuable to the instructor.

However, this paper-based approach, while useful, has some drawbacks. First, based on a standard fifty-minute class, the minute paper requires a minimum commitment of 10% of the class time. In many situations it is simply not practical to reassign this much class time. In these cases, while assessment via a minute paper might well

be beneficial, such a technique cannot be utilized. Second, experience shows that many students are in a hurry to get out of the classroom. Often students do not spend the allotted time on the paper, choosing instead to get to lunch, their next class, wherever. Some instructors have even decided that the minute paper really means just letting class out five minutes early – clearly not a strong selling point! There is also peer pressure with which to contend: a student may well have more to write, but leaves because her friend is leaving; or, a student may be unwilling to write that he does not understand something when the person sitting next to him may see his paper. (There is some evidence from end of semester evaluations to indicate that this is a real problem.) Fourth, I find that, especially in lower-level (freshman and sophomore) classes, students tend to discuss the very last topic covered, whatever that topic may be. This is more surprising in that I try to cover the most difficult topic(s) in the first half of a lecture, where I find that students' attention seems to be better. In summary, I have used the minute paper in its traditional form; and, although I have gotten a number of good, insightful responses, I have not been completely satisfied with it.

Using conferencing software for minute papers yields a number of benefits. Obviously, next to no class time is used. I have also, somewhat paradoxically, experienced a higher response rate: more students wrote a minute paper on their own time than did when class time was allotted for this task. More importantly, however, I believe that I received more thoughtful responses from the minute papers delivered via conferencing software. Many of my students apparently look over their notes before writing their paper, and can thus better decide what it is they do and don't understand. Because the students can do this at their leisure, they do not feel the time pressure. In addition, they can choose to write their papers in the absence of their peers, and may well feel more free to admit what they do not understand. Lacking good protocols and controlled experiments, this analysis is speculative and anecdotal; but nonetheless I am sold on using conferencing software for minute papers.

There are some drawbacks to using conferencing software for minute papers which I should mention. One of the big advantages of the minute paper is its immediacy: in some sense one does not want

students to think too hard about it, but just blurt out whatever is confusing them. A portion (not all) of this immediacy is lost by using conferencing software. In my opinion this loss is more than compensated for by the more thoughtful and detailed responses I have gotten from students, but it is something to consider. A second drawback is reaction time for the instructor: in the traditional form one has the minute papers for examination as soon as the class is over. When using conferencing software, there is necessarily a time lag; moreover, I have found that deadlines in these matters can be difficult to enforce. If one finds a major restructuring of the next class meeting is necessary, then this reduced lead time takes on added importance. However, in my experience the need for a big change in the next class is usually obvious early on, even if all the responses are not yet in. These kinds of drawbacks, then, while they exist, are small in comparison to the benefits delivered by using minute papers via conferencing software.

A second kind of assessment technique often used is a quiz. I mean here a quiz, usually anonymous, given to check understanding; quizzes for credit (grading) purposes are another matter. For example, I have used multiple-choice quizzes where the choices are “strongly agree,” “agree,” “disagree,” and “strongly disagree,” for questions like

- I understand what a basis for a vector space is.
- I can extend a linearly independent set to a basis.
- I can find a basis in a spanning set.

(I usually use quiz questions which correspond directly to the objectives for that particular class.) I can get responses from virtually all the students in the classroom to a quiz like this, in contrast to the minute papers, where in the traditional paper form I would rarely get over 80% usable responses; and, of course, the responses are easy to quantify. (“Two-thirds of my students don’t think they can reduce a spanning set to a basis,” etc.) These quizzes share some of the disadvantages of the minute papers: they require class time (mostly administrative: getting students started on the quiz, handing them in, etc.), for example; and there is again peer and time pressure to contend with.

Administering these kinds of quizzes via conferencing software provides some of the same benefits as does the minute paper. My

experience is that response rates are still virtually 100%. (This level of response can, paradoxically, be counter-productive: using conferencing software for quizzes, I very often get responses from students who did not actually attend the class in question. While one may indeed wish to know what they know, this is not useful in evaluating the particular method used in the classroom.) Administrative overhead is less, and again there is no class time used. An additional benefit is that at least some of the software (ALTA VISTA, for example) automatically gives a real-time tabulation of the results of these quizzes. I have again found that conferencing software is a preferable way to administer this kind of feedback technique.

Of course, a number of other assessment tools are available. [1, 3] Not all can be successfully adapted to conferencing software. However, as described above, in many cases conferencing software provides an easy, high-return avenue for classroom assessment; and often the use of conferencing software yields better results in terms of participation and introspection. Conferencing software is a valuable asset in getting classroom feedback.

2 Cooperative Learning

There is ample evidence that many students learn mathematics better by working together on problems. [5, 2] In addition, many “real-life” work situations require groupwork on projects. For these and other reasons many instructors have chosen to implement some cooperative learning strategies in their courses.

Such choices can lead to difficulties, however. As increasing numbers of our students work, have families, and otherwise are nontraditional students, it becomes ever harder for groups to meet outside of class time. Evaluation of group work, although an evolving science, is nonetheless difficult. Even gauging participation levels can be tricky.

Using conferencing software can help alleviate some of these difficulties. First, groups can conduct virtual meetings in the conferencing forum. Group members need not be physically in the same place at the same time, and indeed can participate in the meeting when their schedule allows it. When I first started using group projects to a large degree in my classes, without using conferencing software, the number one complaint by my students about cooperative work

was that it was too difficult for groups to actually get together. Once I started using conferencing software (here, `FIRSTCLASS`), this complaint dropped from first to fourth. Although anecdotal, this sort of evidence coupled with student comments suggests that one of the major difficulties in using group projects can be ameliorated by using conferencing software.

A second benefit of using conferencing software in group work is that the instructor can, if she wishes, “sit in” on all the group meetings. When my classes do group work in class, I find it very useful to listen to the discussions. It helps identify what students know, who knows it, and how deep their understanding is. I also can, if I choose, head off a “wild goose chase” by intervening when some inappropriate choices are made. (It is not always beneficial to intervene in this way, of course [4], but it is nice to have the option to do so.) One problem is that an instructor can only listen in on one group at a time in this way. If, however, the discussions are taking place via the software, the teacher can observe all the groups. She can see who is participating (and who is not); she can see where (if) groups are going off the rails; she can intervene, either gently or forcefully, as necessary. I find this to be a powerful benefit to using conferencing software in group work.

A third advantage to doing cooperative work via conferencing software is that more students can more fully participate. When groups meet in person, they can easily be dominated by a physically larger, socially more aggressive, or intellectually quicker member. Conferencing software provides an avenue for a more shy group member to participate. Indeed, many students are more comfortable expressing their opinions at a keyboard than in person. A more introspective student, who may have very good ideas but may respond more slowly than some of the others, can also have her voice heard. For example, the awkward silence when everyone is thinking about a problem is not nearly so awkward in a virtual meeting. Moreover, the very act of writing ideas down may help clarify and refine them, whether the thinker is shy or outgoing. By changing the group dynamic, conferencing software can provide these kinds of extra benefits to cooperative work.

To sum up, in the event an instructor chooses to use group projects, conferencing software can provide a number of benefits by allowing asynchronous, virtual meetings. Student complaints are

reduced, monitoring is improved, and participation increased. Using conferencing software helps make group projects more successful.

3 Automatic Record Keeping

One of the problems with group work outside of class is that the instructor can typically only see the final result, not the way in which that final result was cobbled together. When used in a cooperative learning setting, conferencing software provides, as an added bonus, a record of work done on group projects. This record is invaluable as a basis for assigning grades, for refining projects and problems, and as an aid in research.

A major problem when using group work in a class is evaluation: how does one assign individual grades fairly? While in fact group self-evaluation has proven quite successful, the automatic record of meetings that conferencing software provides is useful as another check on participation levels, and also on the quality of the participation. If most or all of the group's meetings are virtual, through the conferencing software forum (and especially if the instructor insists that a summary of physical meetings be posted to the forum), then a very good record of the group exists for the instructor to evaluate. It has been my experience that potential problems (negligible or desultory participation by a group member) can be identified and corrected early, via monitoring the posts to the forum. In contrast to a number of complaints when I did not closely monitor the groups' participation levels (or when I did not use conferencing software), I had remarkably few complaints when I monitored and intervened via the conferencing software. Indeed, close attention paid early in the semester seemed to stave off problems later on: as the semester went on, fewer and fewer interventions were required. This is the opposite of my experience when not using conferencing software, where student complaints about their group partners generally increased as the final exam got closer. I also have received fewer complaints about the portion of the grade which came from group work in those classes where I used the record of the conferencing software to help assign scores. Again, this is anecdotal, and definitely not a controlled experiment, but I am happy to feel more confident assigning grades while reducing student complaints.

Another important use of the record kept by the conferencing

software is to refine and enhance the projects. It is very useful to be able to see where students are spending their time, what about a project is confusing them, and how hard they think various parts of the projects are. I have redesigned some of my projects, having found that students were spending too much time on issues that I considered to be beside the point. Confusing language, inappropriate jumping from particular to generic, presumed knowledge which was not in the students' backgrounds – I have found all of these and more by looking at the record of student meetings. And, while some of this information can be gleaned from the groups' final reports or presentations, often it can be hidden there as well. Given clear objectives, an instructor can much more easily see if those objectives are what the students are working on in a setting where he can monitor the group discussions; if they are not, assignments can be refined so that the objectives are the focal points of the students' work.

A third use of the record kept by the conferencing software is in research. One can see group dynamics, and the evolution of a group's structure, in these notes. One can see what problem solving skills have been brought to bear, and which are notably lacking. (This is one example of information which is very difficult, if not impossible, to glean from the final report or "polished" version of an assignment.) A researcher can see the evolution of ideas, how students attack problems, when they decide to try different methods, and what they consider to be important. All of this information provides fodder for research, both into the problems themselves and into the method(s) that students are bringing to bear to solve them.

Students themselves benefit from the record kept. They have a chance to review information that they have previously discussed, and can decide how much of it they want to pursue. There are fewer of the "lost calculations" or "the dog ate my homework" sorts of difficulties, since no one student is solely responsible for all of the group's work. Students may also be more likely to make connections, since they have all of their previous discussion available to them. I have received favorable comments on this capability of the conferencing software, so at least some of my students have found it to be useful.

In short, the record kept by the conferencing software provides valuable data for grading, for problem and project refinement, for

research, and for students in their work. It is a very useful byproduct of the virtual meeting.

4 Communication

It is very important for students' mathematical development that they talk about mathematics [6]. Whether this occurs in the context of cooperative learning strategies or simply as an outgrowth of classroom activities, it may not be too strong to say that the more students talk mathematics, the more they learn mathematics. However, large classes, large schools, isolated students, all contribute to students talking less, when they need to be talking more. Conferencing software provides one avenue to help overcome this obstacle.

It is often the case that, for a given class, most of the students do not know a single other student in the class on the first day. It is a challenge to find ways to get such students talking about mathematics. Group work and cooperative learning strategies help, but I also want to encourage student communication outside of these "official" requirements. Conferencing software has worked well by providing another pathway for students to communicate.

Many of the benefits of conferencing software in this context have already been illustrated in the discussion of cooperative learning, section 2. It is worth noting that many of today's students feel at least as comfortable "talking" via keyboard as they do talking face to face. (The obsession of the popular press with "internet romances" is an illustration of this tendency.) Despite this kind of hype, there remains the fact that some of our students, for whatever reasons, do not talk about mathematics to their peers. The fact that some of them then do talk about mathematics via a conferencing software forum makes such a forum a valuable addition to a mathematics class.

There is one more reason to consider using conferencing software for communication's sake. It is very possible that more informed, higher-level mathematical conversations take place via the forum than do in face-to-face encounters. I have a few student comments to indicate that this may be true. Of course, it makes sense. The conferencing software provides a context for student conversations. It provides opportunities for followup (indeed, to recall that followup is appropriate) by retaining a record of what has been said. It

allows for review of previous remarks, and thus at least potentially allows for better synthesis of concepts discussed. Finally, there is the notion that the very act of writing something down (or typing it into a forum) clarifies thinking. To the extent that one believes such a notion is valid (I do), the use of conferencing software makes communication just that much clearer.

Conferencing software provides an additional outlet for students to discuss mathematics. There is reason to believe that it not only encourages some students to talk math who otherwise would not, but that it helps make mathematics discussions more useful, focused, and clear. Using conferencing software benefits communication, which in turn is of great benefit in learning mathematics.

5 Conclusion

I have found using conferencing software to a powerful tool in the mathematics classroom. The students like it. It allows me to get better feedback at a smaller cost in class time. Group work is made easier and more profitable. Grading is easier, and I have more information on which to base grades. It provides me with more data for research questions. It helps stimulate student conversations about mathematics, encourages those unlikely to participate in such conversations absent the software, and may enhance those conversations. It is easy to get started using conferencing software from an instructor's point of view, and even easier from the students' (especially given the newer, web-based software).

Conferencing software provides many benefits in mathematics classrooms. It could profitably be used in many more classes.

References

- [1] Angelo, Thomas A., and Cross, K. Patricia. *Classroom Assessment Techniques: A Handbook for College Teachers*, second edition. Jossey-Bass Publishers, San Francisco, 1993.
- [2] Grouws, Douglas A., ed. *NCTM Handbook of Research on Mathematics Teaching and Learning*. Macmillan, New York, 1992.
- [3] Ratcliff, James L., ed. *Assessment and Curriculum Reform*. Jossey-Bass Publishers, San Francisco, 1992.

- [4] Schoenfeld, Alan H. *Mathematical Problem Solving*. Academic Press, Orlando, Florida, 1985.
- [5] Sutherland, Tracey E. and Bonwell, Charles C., eds. *Using Active Learning in College Classes: A Range of Options for Faculty*. Jossey-Bass Publishers, San Francisco, 1996.
- [6] Triesman, Uri. "Studying students studying calculus: A look at the lives of minority students," *The College Mathematics Journal*, **23** (1992), 362 - 372.

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