Guided Slides: Flexible Lectures using a Tablet PC

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Abstract - Numerous studies tout the effectiveness of guided lecture notes in improving the quality of student in-class notes, and subsequently improving student performance on quizzes and exams. We have extended this idea, producing electronic ‘guided slides’ for use in a first semester discrete mathematics course taught for undergraduate computer science students. Using a tablet PC, the instructor augmented these slide outlines during lectures. The resulting slide images were posted on-line after each lecture for students to access. This paper reports our experiences with this method over two consecutive semesters. Survey feedback shows that students overwhelmingly support this lecture approach.

Index Terms - Guided Slides, Guided Notes, Discrete Mathematics, Tablet PC, LaTeX

INTRODUCTION

Students do not often cite discrete mathematics as the most interesting of introductory computer science courses. Part of the problem is that the future relevancy of much of the material is difficult for students to understand. In addition, many of the topics are fairly dry. Combined with lecture formats such as traditional hand-written board content or pre-finished static presentation slides, maintaining student focus and engagement during lectures can be difficult, particularly in large classes.

Guided notes is a well-studied technique for improving student focus in the classroom [1]. Guided notes are outlines of lecture topics, prepared by the instructor and distributed prior to lecture to the students. During class, the students are encouraged to complete the outline. This technique has been shown to be effective in increasing academic performance in students with learning disabilities, among other populations [2]. More recently, studies have shown that guided notes can be effectively used in ordinary classroom settings to improve students' note-taking skills. The same studies have shown that these students also perform better on evaluations over the noted material [3],[4].

The availability of tablet PCs has spurred the development of software applications designed for use in classrooms. A variety of papers have been published that introduce these applications and/or report their advantages over traditional methods of classroom learning ([5]-[7], for example).

Often, these papers report on successes won through the use of interactive software that permits students to contribute to class discussions with examples and answers sketched in real-time. Unfortunately, unless required by the school or degree program, students do not often have tablets of their own. Even when they do, the use of tablets by students in classes with more than a few dozen computers presents technical and logistical challenges that have been difficult to overcome.

For those settings, and others where funds are tight, a single instructor's tablet PC can be used to offer students interactive lectures. Our approach is to prepare in advance partially-completed guided slides and finish them during lectures. The advantages are many: Partial slide images take less time to prepare than complete slides, diagrams can be outlined to encourage more complete and more clear presentations, examples can be adjusted and even replaced on-the-fly, time spent in lectures completing slides gives students time to do the same, and the finished slides can be quickly posted for students to review.

Feedback from our students shows that they overwhelmingly support the use of guided slides on the tablet PC for lecture presentations. This support is reflected in class performance, according to recent student course grades. In the two semesters in which we have used guided slides, students have earned a higher percentage of 'B' grades and a lower percentage of 'D' grades than were earned in the last non-guided-slide semester.

MOTIVATION

Our initial interest in lecturing with a tablet PC was motivated by necessity. One semester our department's sophomore-level discrete mathematics class was assigned to a ‘horse-shoe’ auditorium that offered only a computer, a document camera, and several data projectors. Without a board, and without time to prepare traditional presentation slides, we began the semester writing lecture notes on a pad of paper beneath the document camera. This proved to be awkward, as writing on the document surface adversely affected our handwriting. In addition, we found ourselves frequently zooming in and out to make our writing visible to the students, often because the camera's focusing mechanism left much to be desired.

After two weeks, we decided that we had little to lose by experimenting with a Toshiba Portege M200 tablet PC running Microsoft Windows XP Tablet Edition. We knew of the University of Washington's Classroom Presenter project [8] from a recent SIGCSE conference presentation [6], and knew that we could use it to create ‘decks’ of blank slides easily. This is how we completed the semester: Instead of writing on a board or on paper beneath a document camera, we wrote on the tablet. Writing on top of a fairly thick computer was no more awkward than writing
on the document camera base, and over time our handwriting and artwork became at least tolerable, as the screen images in Figure 1 suggest.

**FIGURE 1**
**TWO EARLY UN-GUIDED SLIDES**

Student feedback was positive. Several students volunteered comments on the tablet approach on their end-of-term evaluations. “I really liked McCann taking notes on the tablet PC and posting them. It definitely isn’t a replacement for taking your own but it is a good reference,” wrote one student. Another student said, “He writes the notes so we can write the notes before he starts speaking.” No negative comments were received.

As the term wore on, to save time in class, we started to write out in advance material such as complex diagrams and refreshers on past lecture topics. The success of this approach motivated the creation of guided slides.

**CREATING GUIDED SLIDES**

Our discrete mathematics lecture materials have evolved from handwritten notes to computer typeset lecture topic documents. As with nearly all of our class materials, we used the LaTeX 2e extension to Knuth’s TeX program [9] to create these documents. We have tried many word processing and document formatting applications, and have returned to LaTeX for several reasons: It is commonly used in the sciences for document preparation, it is freely available on a variety of platforms, documents we created with it a decade ago format as well today as they did then, and it does a fine job with the formatting of mathematical expressions, a notable advantage when working with topics in discrete mathematics. And, although some time was required, we have learned to enjoy being compared to the dinosaurs by aficionados of more recent document formatting applications.

Our procedure for converting LaTeX’s .dvi files into Classroom Presenter 2.1’s .csd format is indirect but effective. Using the Prosper [10] presentation slide package for LaTeX, we create incomplete slides in much the same manner as we would create conference presentation slides. The experience gained from the use of the tablet during the previous class helped us decide how to partition the lecture material between slides. The utilities dvips and ps2pdf are used to format the LaTeX source into a Portable Document Format (PDF) file. The convert utility of the ImageMagick software collection [11] is then used to convert the PDF file into a sequence of Graphics Interchange Format (GIF) files. Finally, Classroom Presenter’s DeckBuilder application makes assembling an image sequence into .csd format an easy task. Although this may seem to be a time-consuming sequence of steps, thanks to scripting the time and effort required are minimal. Note that Microsoft PowerPoint slides may be imported directly into Classroom Presenter; the intermediate step of converting its slides to images is not necessary. Figure 1’s corresponding completed guided slides are shown in Figure 2.

Creating the PDF version of the slides has other benefits. Our slides can be formatted as half-completed (for completion during lectures) or fully-completed (useful for lecture notes and for ‘collegial coverage’ of lectures). A printout of the completed slides makes a fine set of lecture notes, with plenty of room for additional handwritten reminders. We have discovered that a printout format of four incomplete slides per page works well to help us determine how much content we can reasonably write on each slide during lecture. And, because the guided slides are already generated in PDF, producing guided notes for students would require minimal additional effort.

Having produced a collection of slides as individual GIF files, we can assemble a set of slide images tailored for each lecture. Our typical daily slide deck begins with an announcements slide (on which we write, just before lecture, the day’s news and reminders), perhaps a slide for a review of the last lecture’s highlights, the slides for that day’s topics, and a few blank slides for unplanned examples and tangents. We do not force ourselves to complete a particular set of slides during each lecture. To be safe, we make certain to include more slides in a day’s deck than we expect to cover.

Classroom Presenter can save annotated slide decks as sets of images, with or without a basic HTML page design. This makes producing a web version of each day’s slides...
easy. We are routinely able to link each lecture's slide set to the class web page within minutes of returning to the office.

During the final week of class meetings of each of the two semesters in which guided slides have been used, we asked the students to complete an eight question anonymous survey of their opinions of our use of this system for lecturing. The surveys were nearly identical for each class; the single difference is discussed below. Forty-five students returned the survey from the first class, as did 70 from the subsequent semester's class. Due to some students repeating the class, at most a dozen students completed the survey both times. Because the survey was conducted anonymously, we do not know how many of the dozen submitted surveys in both semesters. Because the surveys were administered in class on days when healthy percentages of the students were present, we feel that the following results are representative of overall student opinion.

Slide Availability and Impact

All 115 of the respondents reported knowing that the completed slides were available from the class web page. 52.2% of them had accessed the slide collection 10 or more times by the time of the survey; only five students reported not accessing the slides at all. Based on this feedback, we feel that posting the slides is worth the daily effort.

78.9% of the students reported that having the completed slides available was very helpful to their studies. The rest considered them to be either somewhat (15.8%) or not at all (5.3%) helpful.

Attendance

We posted the completed slides with trepidation. Even though we employ unannounced quizzes, we feared that once the students learned that the slides would be posted promptly, they would be less likely to attend lectures. Even after having been explicitly instructed to ignore any influence that the quizzes had on their attendance, over three-quarters of the students (77.2%) indicated that the presence of the completed slides made them no more and no less likely to attend lectures. A substantially larger percentage of students (14.0%) reported that having the completed slides available made it more likely that they would attend class than reported being less likely to attend (8.8%). We wonder if those who reported being more likely to attend so indicated only to encourage us to continue posting slides. Another possibility is that the ‘completed’ slides are still enough like outlines so as to encourage students to attend to hear our accompanying explanations. We do not take attendance in lectures; however, based on the return rate observed on our un-announced quizzes, roughly 90% of our students regularly attend the lectures. Certainly, we have not noticed a drop in rates of student attendance since we started lecturing with guided slides.

Impact on Note-taking

Two additional fears concerned student attention spans and note-taking habits during lectures. We dislike lecturing from pre-finished slides because we feel that students are more likely to skim the displayed text and figures, and lose focus until the next slide appears. By using guided slides, we hoped that students would be more likely to pay attention to our presentations. Some students feel compelled to write down everything presented to them. When completed slides are shown, such students may fail to get the broader meaning in their rush to copy the content verbatim. We hoped that by taking class time to do much of the writing ourselves, students interested in taking detailed notes would be able to do so, while still having time to think about the content as well as its context.

As shown in Table I, just over half (50.4%) of our students reported taking detailed lecture notes. The rest were nearly evenly split between taking occasional notes (26.1%) and taking no notes at all (23.5%). Unlike the previously reported results, for this question there was a large difference in the responses between the two classes. The second, larger class reported more than double the

FIGURE 2

FIGURE 1’S CORRESPONDING COMPLETED GUIDED SLIDES

STUDENT FEEDBACK
percentage of occasional note-takers (32.9% vs. 15.6%), with the growth coming mainly at the expense of detailed note-taking. Other than the inclusion of surveys from students retaking the course, we have no explanation for this difference.

| TABLE I |
|------------------|------------------|------------------|------------------|
| “NORMALLY, I TOOK ___ NOTES DURING LECTURES.” |
| Class #1 | Class #2 | Totals |
| Σ | % | Σ | % | Σ | % |
| Detailed | 26 | 57.8 | 32 | 45.7 | 58 | 50.4 |
| Occasional | 7 | 15.6 | 23 | 32.9 | 30 | 26.1 |
| No | 12 | 26.7 | 15 | 21.4 | 27 | 23.5 |
| Totals | 45 | 100.1 | 70 | 100.0 | 115 | 100.0 |

(Note that percentages do not always total to 100.0, due to rounding.)

Effects of Other Lecturing Mechanisms

Prior to the creation of the guided slides, our preferred lecture format for the discrete mathematics class employed chalkboards or whiteboards for displaying information and examples. We augmented with projected computer images for software demonstrations and the like.

As mentioned in the Motivation section, our classes are not always assigned to rooms with usable boards. The second of our surveyed classes, for example, was held in a wide room with boards placed on the front-left and front-right of the room. Writing on one board is unreadable by the half of the class sitting on the opposite side of the room. The first surveyed class, however, was held in a room with vertically-stacked whiteboards that could have been used for lectures easily and effectively.

Due to the equipment differences, we asked the two classes variants of the same question about their note-taking expectations, had a different presentation mechanism been employed. The first class was asked if they would have taken more, fewer, or about the same amount of notes had the whiteboards been used. Over half (55.6%) of the students said that their note-taking would not have changed. The rest, by a wide margin (37.8% to 6.7%), said that they would have taken more notes had the whiteboards been used. We do not know if these students are using this ‘found’ time to pay more attention to our explanations. Regardless, the time is available.

The second class was asked to choose from the same three answers had we used Microsoft PowerPoint slides or had used the classroom’s document camera to display notes written in real-time on a pad of paper. We asked this as a single question to parallel the survey given to the earlier class. With these options, well more than half (61.4%) of the students said that they would have taken the same amount of notes. However, only 11.4% said they would take more notes; more than twice that number of students (27.1%) said they would take fewer. In hindsight, we should have asked two separate questions, one for each of the two alternative mechanisms. We wonder if students were assuming that PowerPoint would be used (it was listed first in the question), and further, assuming that the slides would be available after lectures, even though this was neither stated nor implied in the question.

Guided Notes

Although our guided slides could serve as guided notes, we have not yet made guided notes available. To see if doing so would be of interest to our students, we asked two questions about guided note availability.

The first question asked students to assume that guided notes (that is, the not-yet-completed guided slides) were available from the class web page. 42.1% of the respondents said that they would never print the slides to complete them in class. Exactly the same percentage said that they would do so some of the time. Only 15.8% said that they would do so for every lecture.

The second question asked if students would be willing to purchase copies of the guided notes at a reasonable price from the campus bookstore and use them for in-class note-taking. As Table II shows, the two classes had very different views. The first class was not very receptive to the idea, with only 13.3% indicating that they would definitely be willing to buy and use guided notes. The second class was much more willing to do so (31.4%). Overall, nearly half (47.0%) of the students would not buy copies of the incomplete slides.

Together, these questions indicate that a significant number of students have no interest in having the incomplete slides available for note-taking. Of those with a strong interest, purchasing seems a bit more popular than printing.

| TABLE II |
|------------------|------------------|------------------|------------------|
| “IF THE ‘BLANK’ SLIDE OUTLINES HAD BEEN AVAILABLE FOR PURCHASE (FOR A REASONABLE PRICE) IN THE BOOKSTORE, I WOULD HAVE BOUGHT THEM IN ORDER TO TAKE NOTES ON THEM DURING CLASS.” |
| Class #1 | Class #2 | Totals |
| Σ | % | Σ | % | Σ | % |
| Yes | 6 | 13.3 | 22 | 31.4 | 28 | 24.3 |
| Maybe | 16 | 35.6 | 17 | 24.3 | 33 | 28.7 |
| No | 23 | 51.1 | 31 | 44.3 | 54 | 47.0 |
| Totals | 45 | 100.0 | 70 | 100.0 | 115 | 100.0 |

Completed Slides in Advance?

Our concerns about student attendance have also kept us from posting completed slides before lectures. We added a question to the survey to find out if our fear is justified.

More than four of five respondents (80.9%) claimed that they would have attended class just as often had completed slides been available in advance. 12.2% would have attended less often, with the remainder (7.0%) saying that they would have attended more often (the percentages do not total to 100.0 due to rounding). We can not explain why
having completed slides in advance would encourage students to attend more often. As with the attendance question, we wonder if these students merely hope to encourage us to do this. Based on this question, it seems that offering the slides in advance would not reduce attendance greatly. Even so, we would not feel comfortable taking an action that would encourage an eighth of the students to attend less often.

**Student Performance**

The two semesters in which we used guided slides (Classes #1 and #2) were immediately preceded by the semester in which we used whiteboards for the last time (Class #0). Comparing the class grades from the guided slide semesters with those of the whiteboard semester shows an encouraging improvement in student performance. Table III shows the letter grades and percentages for the students who took the final exams. Note that the ‘E’ is not an error; our institution uses ‘E’ as the failing grade.

We determine course grades using the traditional 90-80-70-60 scale; 90% and better is an A, 80% to 90% is a B, etc. We do not ‘curve’ any scores.

The grade distributions of the two guided slide semesters are quite consistent, and show a notable overall improvement over the preceding term. By comparison with Class #0, the percentage of students earning grades of ‘D’ has dropped by more than 13%, while the percentage of students earning grades of ‘B’ increased by more than 15%. Grades of ‘C’ are steady at about 30%, and very few students who attempt the final exam earn failing grades. The decline in the percentage of grades of ‘A’ is a concern. We wonder if the additional structure of the guided slides, while apparently helping the weaker students, is not sufficiently stimulating to hold the attention of all of the more capable students. The class grade point averages (GPAs) show the overall performance gains.

**TABLE III**

<table>
<thead>
<tr>
<th></th>
<th>Class #0</th>
<th>Class #1</th>
<th>Class #2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Σ %</td>
<td>Σ %</td>
<td>Σ %</td>
</tr>
<tr>
<td>A</td>
<td>11 22.0</td>
<td>10 17.9</td>
<td>12 15.0</td>
</tr>
<tr>
<td>B</td>
<td>11 22.0</td>
<td>21 37.5</td>
<td>32 40.0</td>
</tr>
<tr>
<td>C</td>
<td>15 30.0</td>
<td>18 32.1</td>
<td>24 30.0</td>
</tr>
<tr>
<td>D</td>
<td>12 24.0</td>
<td>6 10.7</td>
<td>8 10.0</td>
</tr>
<tr>
<td>E</td>
<td>1 2.0</td>
<td>1 1.8</td>
<td>4 5.0</td>
</tr>
<tr>
<td>Totals</td>
<td>50 100.0</td>
<td>56 100.0</td>
<td>80 100.0</td>
</tr>
<tr>
<td>GPAs</td>
<td>2.38</td>
<td>2.59</td>
<td>2.50</td>
</tr>
</tbody>
</table>

We realize that a single non-guided-slide semester is not a solid basis for comparison, and admit that the measured increase in GPA is not statistically significant at an approximate $\alpha = 0.05$ level. While we would have liked to include data from prior terms, in those offerings of the class the course material was structured differently, making comparisons less meaningful.

We are encouraged by this overall GPA improvement, and are particularly pleased by the increase in the fraction of the students earning grades of ‘B’. Another indication of the success of this approach was found in a survey we conducted of students who were just completing the intermediate data structures course that has our discrete math course as a prerequisite. Over three-quarters of the 62 surveyed students (75.8%) said that we should adopt guided slides in that course as well. Just 8.1% said we should not; the rest had no opinion.

**ADVICE FOR ADOPTERS**

We have lectured using a tablet in three offerings of a discrete mathematics course (twice with guided slides) held in three different classrooms. We hope the following observations can ease the adoption of guided slides for others.

Writing legibly on a tablet screen takes some practice. If the classroom work surface offers sufficient space, using a textbook of comparable thickness as an armrest can reduce strain on the writing arm. We carry a VGA extension cable to class to increase our chances of finding a suitable writing position.

Even with guided slides in place, we sometimes pre-write additional content prior to lecture. In one instance, doing so has helped us ensure completion of a topic before the start of a school holiday without skipping or unduly rushing through content. We have also used pre-writing to recast examples that we had designed for completion during lecture into ‘try this with your neighbor’ in-class activities. Having semi-completed slides need not reduce flexibility.

Early on, we selected ‘burlywood,’ a sandy brown, as our slide background color. This choice seemed appropriate because it is not as harsh as white, and all of Classroom Presenter's standard pen colors (black, red, green, blue, and yellow) are easily visible against it. A small number of students have told us, either on the surveys or on class evaluations, that they do not like the choice. The only reason we have been given is that printing the slides on an ink jet printer exhausts color ink cartridges at an unimpressive rate. In the future, we plan to try post-processing the completed slide images to replace the background color with white and then to place the slide images, perhaps three or four per page, into a PDF file. We believe doing so will make printing more convenient for students, and perhaps make the process of posting slides more convenient for us.

Most people have had the experience of watching a presentation in which the text was nearly lost in the background, as the presenter assured the audience that “it looks fine on my laptop!” No matter the overall color scheme you choose for your guided slides, we suggest inspecting a variety of samples displayed by the projector whose output your students will be viewing. Doing so will ensure that information displayed in all color combinations...

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can be easily read. Additional adjustments may be necessary to accommodate students with certain types of color vision deficiency.

**CONCLUSION**

Guided slides offer instructors with a tablet PC and appropriate software a presentation option that combines the flexibility of whiteboards with the professional touches of pre-finished electronic slides. Guided slides are not difficult or time-consuming to create, can be adjusted with the stroke of a stylus, allow students time to write and reflect, and can serve as guided notes to improve students' note-taking. Our surveys of two classes of discrete mathematics students show that our completed guided slides were accessed by nearly all students, that the presence of completed slides did not modify the reported attendance habits of most students, that over 40% of students claim to have little interest in procuring guided notes, and that maintaining an embargo on completed slides until after lectures encourages lecture attendance. We note that the student attrition rate in the class has dropped by roughly two-thirds in two years, from an overall rate of 7.5% to approximately 2.5% for the two classes discussed here. Apart from the adoption of guided slides, very little about the course had changed.

In the near future, we plan to test students' reported disinterest in guided notes by making copies of the incomplete slide images available for downloading and/or purchase. We are also interested in soliciting more detailed student feedback in hopes of resolving the ambiguities of these results and further refining the content, design, and use of guided slides in our discrete mathematics course.

The final question on our student survey asked students if we should continue using the guided slides. Of the 115 responses, 114 said ‘yes.’ The lone ‘no’ came from a student who wrote that we should use “anything else,” demonstrating that Publilius Syrus was correct: “It is a very hard undertaking to seek to please everybody” [12].

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**REFERENCES**


