TECHNOLOGY ASSISTED GRADE CAPTURE AND ELECTRONIC DISTRIBUTION OF PAPER TESTS

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ABSTRACT:
Feedback is critical to the learning process. However, marking and returning written work in large-enrollment courses are logistically difficult and very time consuming. Most large-enrollment classes are associated with first-year, where students require timely feedback to adjust to the expectations of university-level courses. If existing technology could be leveraged to scan hand-graded work and distribute digital copies, students could receive timely and confidential feedback in a streamlined, secure and convenient manner. This article describes a solution where Scantron® sheets were customised to provide space for students to answer open-ended questions on a test. The hand-graded work is then scanned for student identification, grades and images of the double-sided sheet. An online application was also developed to upload the data and images to the course management system.

INTRODUCTION
A learner’s need for feedback is generally not questioned. Chickering and Gamson\(^1\) include feedback as one of their seven principles for good practice in undergraduate education. They write, "Knowing what you know and don’t know focuses learning. Students need appropriate feedback on performance to benefit from courses... [A]ssessment without timely feedback contributes little to learning". According to McKeachie\(^2\) tests "are important tools for learning" and adds that students learn from their corrected tests. However, as class size increases, hand grading and returning written work on tests and exams in large-enrollment courses becomes a very unwieldy task. This challenge explains the trend towards the exclusive use of multiple-choice questions or online quizzes. But a consequence of this choice is that feedback may be lacking. Jacobs and Chase\(^3\) point out “[u]nfortunately, too little feedback characterizes university teaching, especially in large classes. Often students are given only the total score and this is not sufficient”. For those involved in large-enrollment courses, they are also familiar with the challenges of securely handing back student work. The process can be costly because of the hours involved in ensuring that the student who submitted the work is the only one who sees their grade. Also, many students do not pick up their written work once made available. This can be due to inconvenient hours, locations or the fact that by the time the graded test is released they have moved on. So how can instructors of large classes provide timely and individual feedback, especially to first-year students, who are adjusting to new requirements and expectations? If existing technology could be leveraged to scan hand-graded work and distribute digital copies, students could receive timely and confidential feedback in a streamlined, secure and convenient way. The following article describes a pilot project that attempted to achieve these goals.

METHODS
Many instructors are familiar with Scantron® sheets – the test scoring answer sheets that students use to submit their answers to multiple choice questions. Since Scantron® Test Scoring Answer Sheets (see Figure 1) were used at the institution, it was decided that this technology would be a good starting place for this pilot project. Using the Scantron® sheet as a guide, a customized version was developed to provide space for open-ended questions. The student name, ID and section areas were kept for identification purposes. (When more than one version of test is used, the section area can be utilized as an area for students to indicate the version of their test.) The columns assigned to E-mail ID and answers for multiple choice questions were removed (see Figure 2). Added to each side, were areas for graders to record the grades for individual questions – four on the front page and six on the back.

![Figure 1: Original Scantron® Test Scoring Answer Sheet – Sides 1 & 2](image1)

![Figure 2: Customized Scantron® Sheet – Sides 1 & 2](image2)

For this pilot study, the iNSIGHT 20 scanner was purchased. It is a desktop model that combines document imaging with data collection capabilities. It can detect either ink or pencil marks, with the exception of red which is invisible to the scanner. It can scan 1800 two-sided black and white, grayscale or colour images at 200 dots-per-inch per hour at 8-bit, 256-grayscale levels. It allows the capture, naming and archiving of the images in TIFF, JPEG or PDF.

![Area for grades to be recorded.](image3)
Along with creating the custom form, software was produced by Scantron® to inform the scanner as to what areas to read for data and what areas to ignore (i.e., scan profile). The customized sheet was then printed in two different colours, to facilitate different versions of a test.

With the customized sheets in hand, test questions were developed with the required spacing to answer each question and the grade break-down. This information was photocopied or printed onto the customized Scantron® sheet (see Figure 3). Headings were also added to the grading columns to help guide those grading the written work as to where to consistently enter the grades for each question or part of question.

Figure 3: Customized Scantron® Sheet with Printed Questions and Grade Headings

RESULTS AND DISCUSSION

Before the test, the customized Scantron® sheets were distributed to students who were required to fill in the identification sections. During the test, students recorded their answers for each question directly in the space provided on the sheet, using either pencil or ink. The sheets were then submitted for grading.

For grading purposes, it was determined that either pencil or pen could be used, with the exception of red. Markers which may bleed through the paper could not be used, since this creates errors when the two sides are scanned for either student identification or grades. A grading rubric was given to each Teaching Assistant (TA) and they were asked to provide written comments directly on the individual sheets. They were also asked to “bubble-in” the score for each question or question part (See Figure 4). During this process, grades were not totalled and the sheets were not alphabetized, as this is unnecessary.
The ScanTools Plus software allowed the user to name the data file and select the scanning parameters (e.g., scan profile, etc.). The hopper was loaded with sheets and then the “Scan” button was clicked. The scanner read each sheet for identification and grades data. At the same time, it captured an image of side 1 and 2. The images were stored based on the student ID number entered on the sheet (e.g., 0123456_Top.jpg and 0123456_Bottom.jpg). Figure 5 provides a screen shot of this window while scanning was in progress. Each scanned sheet is listed, along with its status. The system allowed for the hopper to empty and additional sheets to be added through clicking “Resume Scanning”. The new student information was appended to the current file. If a page was oriented incorrectly, or a reading error occurred, the window provided an alert next to the sheet with the error. The problem sheet could then be easily found, corrected and scanning continued until the job was finished (e.g., 800 sheets in 35 minutes).
An online application was written in PHP to facilitate the upload of the data file (student name, ID, section and grades) and the images to the course management system. After logging into the web tool, using the instructor’s central username and password, the instructor selects the particular course located on the course management system. The program then directs the user to name the assignment and provide the maximum score (Figure 6). This information is needed by the Grades tool. Next, the system creates a column in the grade book, as well as a folder for each student in the Locker area, where the two images will be uploaded (see Figure 7). In step 3 and 4, the user identifies where the data file is located (Figure 8) and what images to upload (Figure 9).

Figure 6: Online Interface – Step 1

Figure 7: Online Interface – Step 2

Figure 8: Online Interface – Step 3

Figure 9: Online Interface – Step 4
Once the system collected the needed information, the last step provides an opportunity to review the data (Figure 10), before uploading the information to the course management system. The student information is compared against the class. All entries that match are highlighted with a green check mark. Any entry that does not match the class list is highlighted by a red “x”. The instructor can correct any incorrect data entered by the student (missing or incorrect ID number digits). The grades for each question, or question part, are listed next to each student’s name. A weighting is applied to each column, such as a zero to exclude a column from the assignment’s total, e.g., a grade area not used on the current test. The system also allows for the re-weighting of any question. Once the data is correct, the “Submit” button is clicked and the information is uploaded to the course management system. Figure 11 provides a view of the Group Locker area where the two images were placed for the student to view.
CONCLUSIONS:
The developed system provides solutions to many issues faced by instructors of large-enrollment courses; namely,

1. No need to spend time totalling grades and possibly making mistakes – the system precisely adds up individual grades, with any applied weights, to produce a final score.
2. No need to spend time alphabetizing exam papers – all the data is stored electronically and can be easily sorted and searched.
3. No need for manual data entry of grades – the system efficiently reads individual grades from the sheets and saves the information in a comma delimited file.
4. Statistics on individual questions or even parts of questions can be easily obtained from the data collected.
5. Marked work is returned effectively and securely – the entire class has the same access but only to their own individual work.
6. Student access is convenient – students have 24/7 access through the course management system.
7. Instructors have a copy of student’s original work so modifications are evident and trackable to ensure academic integrity.

In the end, this system is more efficient, accurate and secure than regular written pages. Instructors have the ability to spend more time on grading and providing feedback than processing and returning marked papers. The one-time cost to initiate this project (see Table 1) is low relative to the ongoing, per semester cost of using TA’s or Instructor’s hours for adding up grades, alphabetizing papers, manually entering grades into computers and handing back the marked work to individuals. The ongoing costs for this project beyond the initial phase are low. By using a distribution method that requires login and password unique to the individual (i.e., a course management system) the risk of an exposed physical copy is removed. Also this method of distribution provides students with easy access to their work.

Table 1: Budget for Project

<table>
<thead>
<tr>
<th>Items</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>iNSIGHT 20 OMR &amp; Imaging scanner - Model IN20/E</td>
<td>$4200</td>
</tr>
<tr>
<td>Composition of Custom Form (one-time fee)</td>
<td>$790</td>
</tr>
<tr>
<td>Custom Form Application (to read custom form - one-time fee)</td>
<td>$765</td>
</tr>
<tr>
<td>Printing of forms (5000 sheets)</td>
<td>$890</td>
</tr>
<tr>
<td>Custom Software Development</td>
<td>$15,000</td>
</tr>
</tbody>
</table>

The current design of the customized Scantron® sheet offers instructors lots of flexibility in the design of their test. More space can be created on the customized Scantron® sheets by having a list of questions printed on an additional sheet and simply printing question labels (e.g., Question 1:) on the customized Scantron® sheet. Of course, additional custom sheets could also be developed to address other needs, such as a custom 8.5" × 14" sheet. Next steps include expanding the use of the custom sheets to other courses and eventually scaling the project for campus-wide implementation.
REFERENCES

