AC 2009-1060: USING YOUR GRADE BOOK TO STORE COURSE RUBRIC INFORMATION

Walter Schilling, MSOE

Walter Schilling is an assistant professor in the Software Engineering program at the Milwaukee School of Engineering in Milwaukee, WI. He received his BSEE from Ohio Northern University and his MSES and PhD. from the University of Toledo. He worked in the automotive industry as an embedded software engineer for several years prior to returning for doctoral work. He has spent time at NASA Glenn Research Center in Cleveland, OH. In addition to one US Patent, Schilling has numerous publications in refereed international conferences and other journals. He received the Ohio Space Grant Consortium Doctoral Fellowship, as well as awards from the Toledo and Southeastern Michigan Section IEEE. He is a member of IEEE, IEEE Computer Society, and ASEE. At MSOE, he coordinates courses in Software Quality Assurance, Software Verification, Software Engineering Practices, as well as teaching Embedded Systems Software and introductory programming courses.
Using Your Grade Book to Store Course Rubric Information

Abstract

The usage of rubrics has been greatly shown to aid in consistent grading, faster grading, and improved student understanding of grades. Traditionally, the rubric is used to calculate a grade for the assignment, and then that final grade is recorded in the course grade book. This article presents a practical method for retaining within a grade book not only the final grade for an assignment, but also the individual sub-scores used to calculate that final grade. Grades are stored in Microsoft Excel, with each major assignment being stored on an individual workbook tab. Rows represent individual students, and the columns indicate the sub-scores for each line item on a grading rubric. Rubric scores are multiplied by a weighting factor to obtain an overall score for the assignment. From this data store, grade sheets, including grading comments, can automatically be generated for the students through a mail merge operation. These grade sheets can then either be printed in hard copy or e-mailed to the students as pdf attachments. Individual student performance can be tracked and graphed over time on multiple dimensions, allowing for easier observation of students who may be struggling with key concepts in the course, and the data can be used for overall assessment of course outcomes.

1. Introduction

One of the aspects that often surprises new engineering faculty members is the amount of time which must be devoted to grading. This is especially true if one is at an undergraduate teaching institution which does not have teaching assistants. In this environment, faculty members are faced with grading for 2-4 courses per term. If one factors in homework assignments, lab reports, and exams, it is possible that the professor is grading at least two to three individual assignments per class per week. Optimal efficiency is thus paramount.

One common problem which plagues new faculty members is trying to be efficient while also maintaining grading consistency between class sections and classmates. One technique that is often employed is the usage of grading rubrics. A scoring rubric represents a quantitative schema developed to guide in the assessment student work. First adopted in the K-12 educational arena, rubrics are now commonly being used in colleges, including the engineering field. Scoring rubrics can be applied to writing assignments, group activities, term projects, and oral presentations. Grading rubrics provide advantages to both the student as well as the faculty member.

From the student’s standpoint, rubrics offer many advantages. Students like the usage of rubrics as they aid in determining the expectations for an assignment. Students also like rubrics for grading as they allow them to better plan their working, gearing their development towards what is expected rather than overachieving on an assignment. Overall, students feel that rubrics result in them delivering a higher quality submission as well as receiving a fairer grade when the submission is assessed. Students like rubrics
because they allow them to focus their efforts on areas of weakness, produce a higher quality work product, earn better grades, and reduce anxiety about assignment grading\textsuperscript{2}. Grading rubrics also aid students in seeing that their grade is based upon overall course objectives rather than impulsive responses\textsuperscript{3}.

From the faculty member’s standpoint, grading rubrics also serve multiple purposes. Assignments can be graded both faster and more accurately if the grading criterion is clearly spelled out before grading commences. Furthermore, because the rubric provides detailed criteria, there is often less need for detailed comments to be written on student assignments. This improves grading efficiency. Faculty members who consistently use grading rubrics tend to have fewer challenges to their grading and are better able to defend their grading practice both to students and administrators.

But beyond the individual assignments, rubrics can also be applied to larger assessments as well. At an institutional level, rubrics are commonly applied to evaluate student outcomes for ABET assessment purposes. While this can be a burdensome process, if a rubric based approach to grading is used, the overhead of performing assessment can be greatly diminished, as the data required for overall assessment is often correlated with what is required for individual assignment grading\textsuperscript{4}.

Traditionally, most faculty members use their grade book to keep track of assignment grades. At the end of the term, assignment grades are averaged and weighted according predefined relationships, and final course grades are handed out. With this model of development, all that is required is for the faculty member to store final assignment grades in the grade book.

This, however, does not allow faculty members to compile student performance metrics on a sub-assignment level. For example, the net final score would not reflect if half of the students are having extreme difficulty expressing the problems they encountered while performing a laboratory experiment. Simply recording grades also does not allow one to readily factor in other aspects of grading, such as improvement with time in areas of difficulty. However, by converting the grade book into an electronic rubric book, multiple aspects of a student’s performance can be tracked, and these aspects can factor into a final student grade.

Recording all fields in a grade book also allows for another important improvement, that is, Computer-Assisted grading rubrics. Computer Assisted grading rubrics result in decreased grading times and faster return time of assignments to students\textsuperscript{5}.

2. Methodology

If one considers a traditional grade book, and its traditional implementation, it is two dimensional in nature. Each row represents a student’s performance. Each column, in general, represents a cumulative score on an assignment, be it a lab, a homework assignment, or test. Grades may be recorded as points, percentages, or letter grades. What is important is that the only aspect of the grade that is present for each assignment
is the final score. All of the other relevant history which created that score is missing. In fact, all grading typically was done manually by the grader, and after all grading was completed, the results were entered into the grade book for storage.

To convert our grade book into a rubric book, we need to shift our thinking from the flat plane of a two dimensional grade book and think of the grade book as a three dimensional collections of scores. Rows still delineate each student, and columns represent discrete assignments. However, in the third dimension we can retain the individual assessments that created the final grade. By doing so, we can then effectively monitor all aspects of a student’s performance rather than just the final score. This concept is shown in Figure 1.

![Figure 1 Three dimensional grading concept.](image)

To make this system work effectively, grading is also done directly into the grade book. As an assignment is being assessed, instead of marking up a paper copy with scores and sub-score, these items are directly recorded into the grade book while the assignment is scored. There is no need to go back through the assignments afterwards to “record” grades, for the information is directly stored in the grade book when grading occurs. The original may have random supporting comments, but the bulk of the grading is done directly in the grade book.

3. Practical Implementation

While at the highest level, the usage of a three dimensional grade recording structure may appear to be difficult and cumbersome. In reality, modern software allows this approach to be implemented rather easily.
In principle, one of the easiest ways to keep track of grades is to use a spreadsheet package, such as Microsoft Excel or Open Office. This allows the users complete control over assignment weighting, grading scale, and other aspects. Furthermore, by using this generic approach, performance metrics can readily be gathered which can be used to assess overall class performance versus previous classes or other concurrent sections.

Using a traditional approach, all student data is entered onto a single tab. Each row designates an individual student, and the columns represent attributes of the student, include name, student id, final grade, and individual grades. Hard-copies can easily be generated for archival purposes formatting printouts and sending them to a printer.

To record rubrics, a slight change to this schema is adapted in that multiple tabs are now used for recording student information. As with the previous approach, one tab still holds student information, such as name student id, final grade, and assignment grades. However, different from the simple grade book, assignments that are graded using a rubric require their own tab.

Figure 2 shows an actual rubric used for grading an assignment. In this example, students worked on a two week lab assignment in groups. The grading rubric is divided into two segments, a portion which reflects group performance as well as a portion which reflects individual performance. In this particular assignment, students worked as a team to complete a lab assignment. At the completion of lab, each student was assessed by their peers using a rubric. These scores were tabulated and entered into the individual performance area of the assignment. The group assignment grade was derived from traditional grading of the group lab report excepting that grading was done entirely electronically by markup up the pdf submission using pdf annotator.
### SE-4831 Software Quality Assurance Lab 4/5 Grading Rubric

**Student Name:**  

**Grade:** / 100

<table>
<thead>
<tr>
<th>Points Possible</th>
<th>Points Awarded</th>
<th>Weight Factor</th>
<th>Base Points</th>
</tr>
</thead>
</table>
| Lab Report Submission | 2 | Abstract / Introduction  
- Goals of the lab clearly stated  
- Clear understanding of what the lab will demonstrate as well as how it will be demonstrated | 10 |
| | 3 | Questions  
- Assignment Questions answered clearly and succinctly  
- Appropriate supporting data provided for answers to questions | 13 |
| | 2 | Graphs  
- Plots drawn properly with appropriate axis labels and titles  
- Discussion of plots provided indicating what they represent | 10 |
| | 2 | Things gone right  
- Appropriate discussion on the aspects of this lab which went well | 10 |
| | 2 | Things Gone Wrong  
- Appropriate discussion on the aspects of this lab which posed problems | 10 |
| | 2 | Conclusions  
- Succinct discussion of what has been learned from the lab-experience | 10 |
| | 2 | Appendices  
- Peer review defect log submitted, indicating which reviewers discovered defects as well as which defects were part of the selected set  
- Raw data submission showing reviewer yield, preparation rate, etc. | 10 |
| | 1 | Team member review sheet completed and submitted | 5 |
| Individual Participation | 2 | Reviewer / Team Leader Individual Preparation  
Reviewer:  
- Adequate advanced preparation occurred prior to lab.  
- Review list completed and brought to lab  
- Substantial defects uncovered during review preparation  
Team Leader:  
- Reviewer roles and responsibilities clearly identified.  
- Artifact appropriate size for review  
- Artifact delivered to reviewers at appropriate time.  
- Complete Review Package Delivered  
- Review kept on task and efficient | 10 |
| | 2 | Appropriate Group Participation1  
- Actively participated in review  
- Maintained neutral, non-aggressive demeanor during review | 5 |

**Base points:**  

5 – Fully Compliant. No major or minor errors noted.  
4 – Mostly complete. Minor error found in some area.  
3 – Partially complete. Multiple minor errors found or significant major errors discovered.  
2 – Absent. Assessment item significantly missing or Incomplete.  
1 – Intermediate Values may also be possible.

**Comments:**

---

1 Rubric is based off of typical participation receiving a score of 2.5, with 5.0 representing exceptional work, and 0 representing no individual participation.

---

Figure 2 Sample grading rubric for assignment
Figure 3 shows how grades are entered into the grade book. Major assignments have each been given their own tab, and rubric values have been recorded for each entry. Metrics for each rubric assessment are calculated. In this case, Lab 4/5 represents that lab assignment that used to rubric of Figure 1. The grade book allows specific comments to be recorded for each student, and automatically determines a total grade based on the individual assessment scores.

4. Returning Student Work - Automatically generating Students rubric sheets

When it comes time to return assignments to students, this mechanism offers yet another advantage, in that it is possible to return assignments to students electronically.

Using traditional grading techniques, once an assignment is graded, the faculty member has two sets of paperwork. In one hand is a rubric sheet which denotes the scores for each assessment. In the other hand is the original assignment, which may or may not contain comments and other markups. To return assignments to students, and maintain FERPA confidentiality, the professor must return each assignment to each student by hand, guaranteeing that only the submitting student handles their assignment. For large classes, this is a practical problem, as it may take a significant amount of time to return assignments. And, if the assignment had group work but had individual grades assigned, there is the difficulty of determining who in the group receives the original marked up copy.

With this method, everything is handled electronically and it is possible to return private scores to individual students as well as return the original submission to all group
members. To do this, the Word mail merge functionality is used to merge the data in the gradebook with the rubric sheet. This results in rubric sheets being created, each being customized to the performance of the individual student.

To perform this operation, the grading rubric is transformed into a mail merge template. This involves linking the rubric sheet to the grade book and assigning the table entries to locations in the template document. By running a mail merge operation, individual grading sheets are generated for each student that can be returned. Figure 4 shows an example of a completed student rubric that the student would receive.

![Figure 4 Automatically generated student rubric.](image-url)

The true advantage of this system, however, comes from being able to return assignments completely electronically. When performing the mail merge, the default output is a
single file which contains all of the grading rubrics. The intent is that this file will be printed out and stuffed into envelopes. However, it is also possible to configure the mail merge to print into portable document format. By doing this, each student’s work is stored in a separate PDF file, and this file can be e-mailed directly back to the student. In fact, the mail merge operation even has an option which automatically creates e-mails and attaches the merged document to the e-mail. By combining this with scripts to automatically attach student work to e-mails, assignments can be easily returned to students at any time, including Sunday’s and holidays, and without using lecture time.

5. Tracking student improvement

This article has thus far focused on the advantages of automatic rubric generation and automatic student grade distribution. However, the greatest advantage to this process is the ability to track student progress across lab assignments.

Effective teaching requires continuous improvement, and continuous improvement must be based upon continuous student feedback. Some of this feedback can be obtained from direct student surveys through the use of minute papers and other techniques. But, equally important is the ability to monitor student performance at a detailed level.

Figure 5 shows an example of two plots which have been generated from grade book data. The top chart shows student progress in assessing the things that went wrong in the lab experiment (i.e. students must express to the faculty members the problems they encountered with their technique, procedures, or assumptions, in a meaningful manner; the rubric assess how successful the students were at communicating this aspect). On the first lab, the students had significant issue with this task, as is denoted by the average rubric score of 2.1. Performance improved on the second lab to an average of 3.1, but dropped on the third lab to 2.6 before rebounding on lab 4/5 to 4.6. This chart also indicates a decrease in standard deviation, indicating that students are performing both better and with less variance across assignments, an indication that they have became more consistent in their application of skills in this area. This type of data can then be used to aid in demonstrating that a course is meeting its objectives.
The second example represents student performance in writing an abstract or introduction for the lab report. In this case, students on average performed better than on the things gone wrong write-up. However, their performance has oscillated greatly, indicating that the students are, as a whole, not yet being consistent in their performance on this criterion. To rectify this, it may be necessary to add additional comments to the student in this area or perform some activity to reinforce this concept.
This mechanism also allows for easy spotting of students whose performance is not keeping pace with the class. Figure 6 shows a plot of student performance on the Things Gone Wrong assessment normalized against the average score and standard deviation. Most students either improve relative to the average or oscillate around the same score relative to the average. However, in this plot, student Andrew Jackson has suffered significantly poorer performance on each assignment. This chart does not tell us why this is the case, but it certainly presents a warning that intervention may be required.

6. Challenges

While at the outset this method may seem daunting, from a technical standpoint there have been very few issues with this model of implementation. Problems have occurred with inadvertently entering the wrong rubric score in the wrong row when performing the mail merge or attempting to send to an incorrect e-mail. Other problems have occurred with outboxes overflowing when large documents were returned. But, aside from these relatively minor technical problems, this mechanism has generally worked quite effectively for all courses in which it has been applied.

The largest obstacle to this mechanism by far, however, has been the development of valid and meaningful rubrics. While with practice this has gotten better, the largest effort is in creating the measures that will be used for assessment. This is compounded by the fact that, due to the nature of the courses being taught, the rubrics tend to be assignment specific and re-use is not necessarily possible. Being that these courses were all being taught for the first time, there is hope that the rubrics will be reusable in future course offerings, though it is anticipated that there will be some improvements required due to the knowledge gained from writing other rubrics.
The other obstacle to this problem has been students checking their e-mail. As part of the student registration at Milwaukee School of Engineering, each student is provided an official e-mail account. However, because most students already have other e-mail accounts, they may not routinely check their “official” e-mail account. At best, this results in the students delaying their review of the assignment, and at worst, it results in a bounced e-mail if their account is full and can no longer receive e-mail.

7. Conclusions
This article has discussed an automated method for the creation and distribution of grading rubrics to students. Student assignments are graded electronically using an electronic rubric, and assignments are returned automatically via e-mail. By using this mechanism, individual performance can be tracked across multiple assignments and multiple dimensions.

References


Mail merging with Microsoft Office makes the generation of individualized grade sheets and rubric sheets quite trivial. The amount of detail shown can be easily customized, and the results can be distributed either via hard copy or e-mail attachment. This Appendix provides an introductory tutorial for mail merging using Microsoft Office 97.

Office 97 merging begins with the creation of a data source. This can be in many different forms, however, for our purposes, we will be using an Excel spreadsheet. Figure A-1 shows an example Excel spreadsheet which will be used to provide the merge data to Word. Rows represent the data that will be merged into a word document, and columns represent the individual mail merge fields.

To perform a merge operation, the first step is to create a template document in Word. The template document defines what information will be common across all merged documents as well as defining where the individual fields will be placed within the document. The easiest way to do this is to create a blank document in Word. For this example, the merged document will be a basic word file which displays the name of the student, the student’s e-mail, and a table of four rubric scores. This form of a document is shown in Figure A-2. At this point, the word document is no different from any other Word document.
Once the basic layout for the document has been created, the next step is to link the template with the data source, in our case, the Excel spreadsheet. This is done by selecting the “Mailings” menu item, “Select Recipients”, and “use Existing List”. This opens a dialog box which will allow one to browse to the Excel file. After choosing the Excel file, a dialog box will open asking which table contains the data that is to be merged. This is the name of the workbook tab with the given data. In the case of the
document shown in Figure A-1, this would be the “Introduction” tab. This is shown graphically in Figure A-3.

Once the source data is linked with the templates, adding the merge fields is simply a matter of clicking on the “Insert Merge Field” button wherever the user desires to place the merged data. Figure A-4, for example, shows the placement of the E-mail merge item on the template document. Merge fields are denoted in the form <<merge field>> where the brackets denote a merged field and the name inside of the brackets matches the name of the merge field.

Once all of the fields have been added to the document, clicking on the “Merge preview” icon will preview the resulting output. Each page can be viewed and checked if desired. A sample of this is shown in Figure A-5.
While it is possible that the data imported from the Excel spreadsheet will match exactly with the desired recipients, it may be possible that certain rows may need to be excluded from the merge operation. This might be a case of a student who has expressly requested that grades not be returned via e-mail, or it may be a statistical field (such as the average or median) which does not need to be merged. To deselect these items, select the “Edit Recipients” button and un-checks those rows which are not to be included in the mail merge operation. This is shown in Figure A-6.
The final step is either printing the hard copies or creating the e-mails containing the merged grade sheet. To create hard copies of the document, select the “Finish and Merge” button to print the documents. This will open up a dialog box to select the printer and perform routine printer configuration.

If one wishes to distribute the contents via e-mail as pdf attachments, one clicks on the “Merge to Adobe PDF” button. This brings up the dialog box shown in Figure A-7. This dialog box allows the user to specify which records are to be merged and the prefix for the acrobat files which are created. By clicking on the e-mail options, one can select the merge field which contains the e-mail address, enter the subject line for the e-mail that will be sent, and type a short e-mail message. By clicking on OK, pdf files will be created on the local computer from the mail merge. These files will then be automatically attached to an e-mail and sent out via the e-mail client.

![Figure A-7 Merging to Adobe PDF e-mail attachments.](image-url)