# Automating Grading System for Faculty and Students

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## Abstract

Use of some common Microsoft Excel functions, e.g., SUM, AVERAGE, can substantially reduce the drudgery of processing individual student grades to the final form of letter grades. This self developed Excel spreadsheet system may work better than many commercially available grade processing software because of its flexibilities to meet the needs by the department, college, and as well as by any accreditation authority. This spreadsheet system can be modified or updated any time to suit the individual courses and tastes. This paper describes the steps of developing of an Excel grading file assuming some usual weight distribution for a course. It starts with a blank spreadsheet and shows the development of the automatic grading system by using some functions, such as, AVERAGE(), SUM(), COUNTA(), COUNTIF(), LOOKUP(), STDEVA(), MEDIAN(), MODE(), and MIN(). Once these functions are in effect, the only job remains for the instructor, is to input the raw numerical scores on homework, project or test into the sheet. With each entry of scores at any time throughout a semester, the sheet shows the current letter grades of students, class statistics as well as graphical displays of various measures of the class. A partially modified electronic file, excluding the student names and any grades, can be distributed to the students at the beginning of a semester. This will make the students aware of their progress status throughout the semester thus guiding them in determining how much extra effort they might need to add in order to obtain a desired letter grade in a course.

## Introduction

Grade maintenance and analysis are simple tasks but require lots of time and attention during an academic semester. Traditional method of hand calculation and recording on paper makes the job dirty and vulnerable to errors. Commercial software makes the job handy and error free. However, these are hard-coded with factory setup often without flexibility and/or without some features one may need to use.

Microsoft Excel has many powerful tools/functions that one may program to automate the grading system according to one's own choice and requirements. Some of the important functions that can be included into a grading file are: AVERAGE(), SUM(),

COUNTA(), COUNTIF(), LOOKUP(), STDEVIA(), MEDIAN(), and MIN(). Besides, there are various graphics utilities within Excel that can be added for quick graphical presentation of grades of a class.

Once automated, this file displays the status of grades of students at any time during a semester. This is an elegant grading tool for an instructor eliminating all hassles in grading. A file without any student name and grades can also be distributed to students for their record keeping during the semester. A student's job is to record (enter) his/her numerical grades in this file as she/he receives from the instructor during the semester. As a grade is entered, all analysis fields are automatically updated. This can help budget on effort a student might need in order to achieve a particular letter grade in a semester.

This paper demonstrates the development of one sample grade file based on an arbitrary grade distribution as shown in Table 1. The Table considers three mid term tests of worth 45%, five home works of worth 10%, one project of worth 5%, five pop quizzes of worth 10% and a final test of worth 30%. Each of these items can individually be graded on a scale of 100. However, the total score for the semester can be translated into a final scale of 100. Letter grades can be assigned based on standard procedure of 'A' for 90 or more, 'B' for 80 or more but less than 90, etc. Letter grades can be assigned by scaling the standard to any level as well.

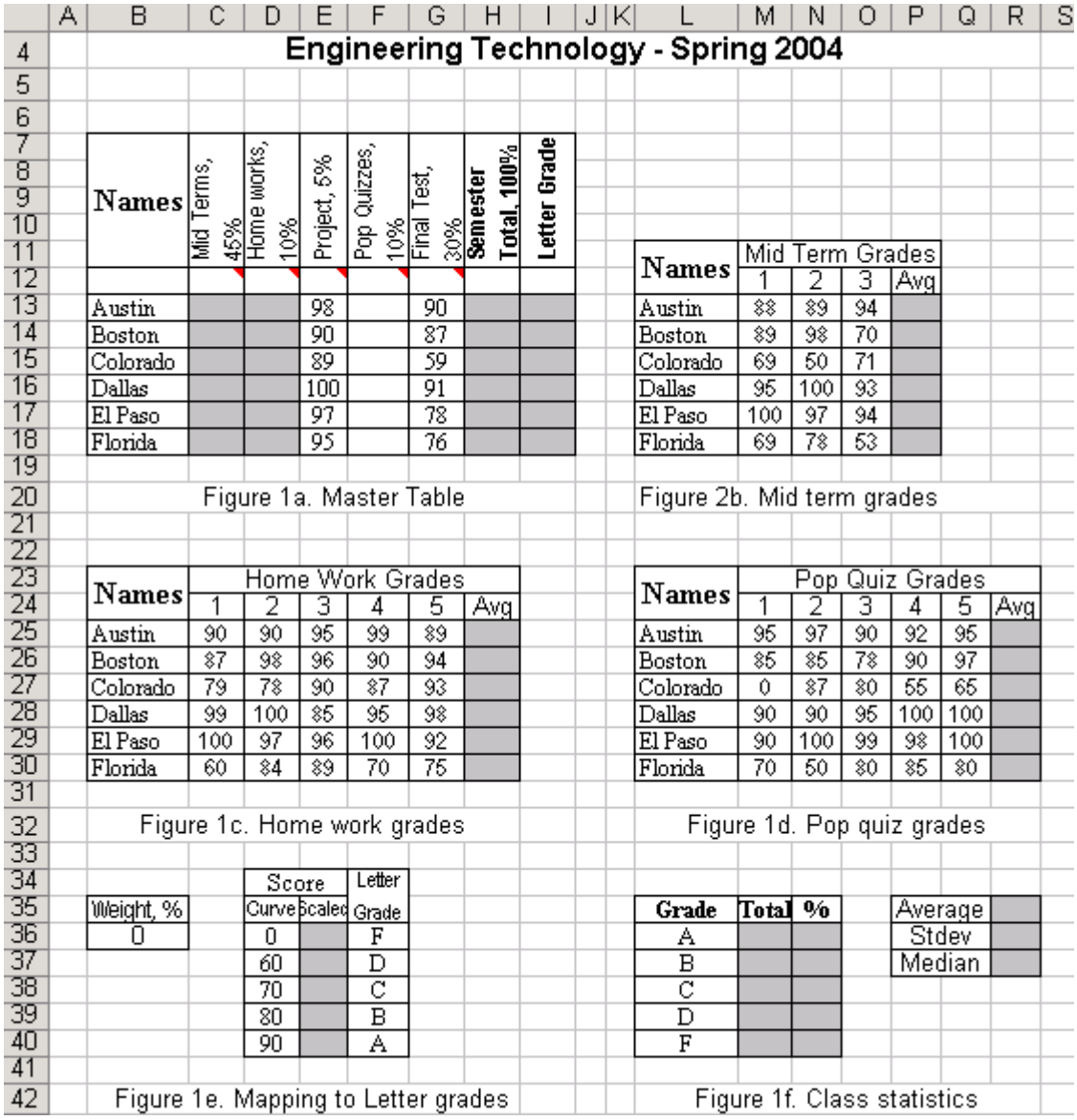
Table 1. Example grade distribution

| Grading Category | Weight, % |
|---|---|
| 3 Mid Terms | 45 |
| 5 Home works | 10 |
| 1 Project | 5 |
| 5 Pop quizzes | 10 |
| 1 Final examination | 30 |
| Semester Total | 100 |

## Design of Excel Spreadsheet

There is no specific rule of designing the spreadsheet for automating the grading system. An instructor can start on his/her existing Excel file. Figure 1 is one sample Excel spreadsheet according to the grading criteria outlined in Table 1. It is a good idea to have one master table and some small tables where there are multiple tests or assignments belonging to a single category.

Figure 1a is the master table which contains 6 arbitrary student names, one column each for mid term test average, homework average, project, pop quiz average and the final test score for each student. All are based on a scale of 100. The semester total is computed according to the weight distribution as outlined in Table 1.



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| Names | Mid Terms, 45% | Home works, 10% | Project, 5% | Pop Quizzes, 10% | Final Test, 30% | Semester Total, 100% | Letter Grade |
|---|---|---|---|---|---|---|---|
| Austin | | | 98 | | 90 | | |
| Boston | | | 90 | | 87 | | |
| Colorado | | | 89 | | 59 | | |
| Dallas | | | 100 | | 91 | | |
| El Paso | | | 97 | | 78 | | |
| Florida | | | 95 | | 76 | | |

Figure 1a. Master Table

| Names | Mid Term Grades | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | Avg |
| Austin | 88 | 89 | 94 | |
| Boston | 89 | 98 | 70 | |
| Colorado | 69 | 50 | 71 | |
| Dallas | 95 | 100 | 93 | |
| El Paso | 100 | 97 | 94 | |
| Florida | 69 | 78 | 53 | |

Figure 2b. Mid term grades

| Names | Home Work Grades | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | Avg |
| Austin | 90 | 90 | 95 | 99 | 89 | |
| Boston | 87 | 98 | 96 | 90 | 94 | |
| Colorado | 79 | 78 | 90 | 87 | 93 | |
| Dallas | 99 | 100 | 85 | 95 | 98 | |
| El Paso | 100 | 97 | 96 | 100 | 92 | |
| Florida | 60 | 84 | 89 | 70 | 75 | |

Figure 1c. Home work grades

| Names | Pop Quiz Grades | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | Avg |
| Austin | 95 | 97 | 90 | 92 | 95 | |
| Boston | 85 | 85 | 78 | 90 | 97 | |
| Colorado | 0 | 87 | 80 | 55 | 65 | |
| Dallas | 90 | 90 | 95 | 100 | 100 | |
| El Paso | 90 | 100 | 99 | 98 | 100 | |
| Florida | 70 | 50 | 80 | 85 | 80 | |

Figure 1d. Pop quiz grades

| Weight, % | Score Curve | Score Scaled | Letter Grade |
|---|---|---|---|
| 0 | 0 | | F |
| | 60 | | D |
| | 70 | | C |
| | 80 | | B |
| | 90 | | A |

Figure 1e. Mapping to Letter grades

| Grade | Total | % |
|---|---|---|
| A | | |
| B | | |
| C | | |
| D | | |
| F | | |

| | |
|---|---|
| Average | |
| Stdev | |
| Median | |

Figure 1f. Class statistics

Figure 1 Arbitrary grades entered in Excel spreadsheet

Figure 1b, Figure 1c, and Figure 1d contain the raw scores for mid term tests, home works, and pop quizzes respectively entered by an instructor. A student will do the same for his/her scores only. Excel spreadsheet based on the functions used for the cells will compute all blank cells automatically. In each case, the last column computes the average for each student. The average values are automatically updated into master table in Figure 1a.

## Filling in the Blank Cells

Figure 1 contains the Excel cell references (alphabets at the top of the spreadsheet and numbers at the leftmost column). A function is written for a blank cell and copied to rest of the cells for similar operations.

### Mid Term Average

Raw scores for the three mid term tests are entered in cells under columns 1, 2, and 3 for respective students as shown in Figure 1b. The following are the steps to compute the mid term average:

- Place the cursor in cell P10 in Figure 1b and enter the following AVERAGE function with arguments inside the parentheses
  = AVERAGE(M10:O10)
  This gives the mid term average for student named Austin in row 9
- Copy the content of cell P10 for the other students (Click on cell, P10. Place the cursor at the bottom-right corner of the cell. A plus sign appears. Drag the plus sign onto the cells for the other students down).

### Homework Average

Raw scores for five home works are entered in cells under columns 1 through 5 for respective students as shown in Figure 1c. The following are the steps to compute the homework average:

- Place the cursor in cell H22 in Figure 1c and enter the following function
  = AVERAGE(C22:G22)
  This gives the homework average for student named Austin in row 21
- Copy the content of cell H22 for the other students

### Pop Quiz Average

Raw scores for five pop quizzes are entered in cells under columns 1 through as shown in Figure 1d. The following are the steps to compute the pop quiz average:

- Place the cursor in cell R22 in Figure 1d and enter the following function
  = AVERAGE(M22:Q22)
  This gives the pop quiz average for student named Austin in row 21
- Copy the content of cell R22 for the other students

### Copying the Averages to the Main Table

The following are the steps to copy the Mid Term averages from Figure 1b to the main table in Figure 1a:

- Place the cursor in cell C10 for Austin's Mid Term average
- Type the following
  = P10

This copies the value in P10 to C10.

- Place the cursor back to cell C10. Copy this value to the Mid Term cells for rest of the students

The homework and the pop quiz averages are copied to the main table in the same way.

**Semester Total**

The function arguments for the semester total depend on the weight distribution in a semester decided by the instructor as shown in Table 1. Following steps generate the semester total:

- Place the cursor in cell H10 in Figure 1a for Austin's semester total.
- Enter the function, SUM with arguments as per Table 1
  = SUM(C13*C$12 + D13*D$12 + E13*E$12 + F13*F$12 + G13*G$12)/100
- Use of '$' copies a fixed cell value for other cells. Copy the contents of cell H10 for rest of the students

**Letter Grade**

The next step is to find the corresponding letter grades. Figure 1e shows the standard format for converting numerical scores to corresponding letter grades. The numbers under column, "Curve" and the letters under column, "Grade" are according to the standard format.

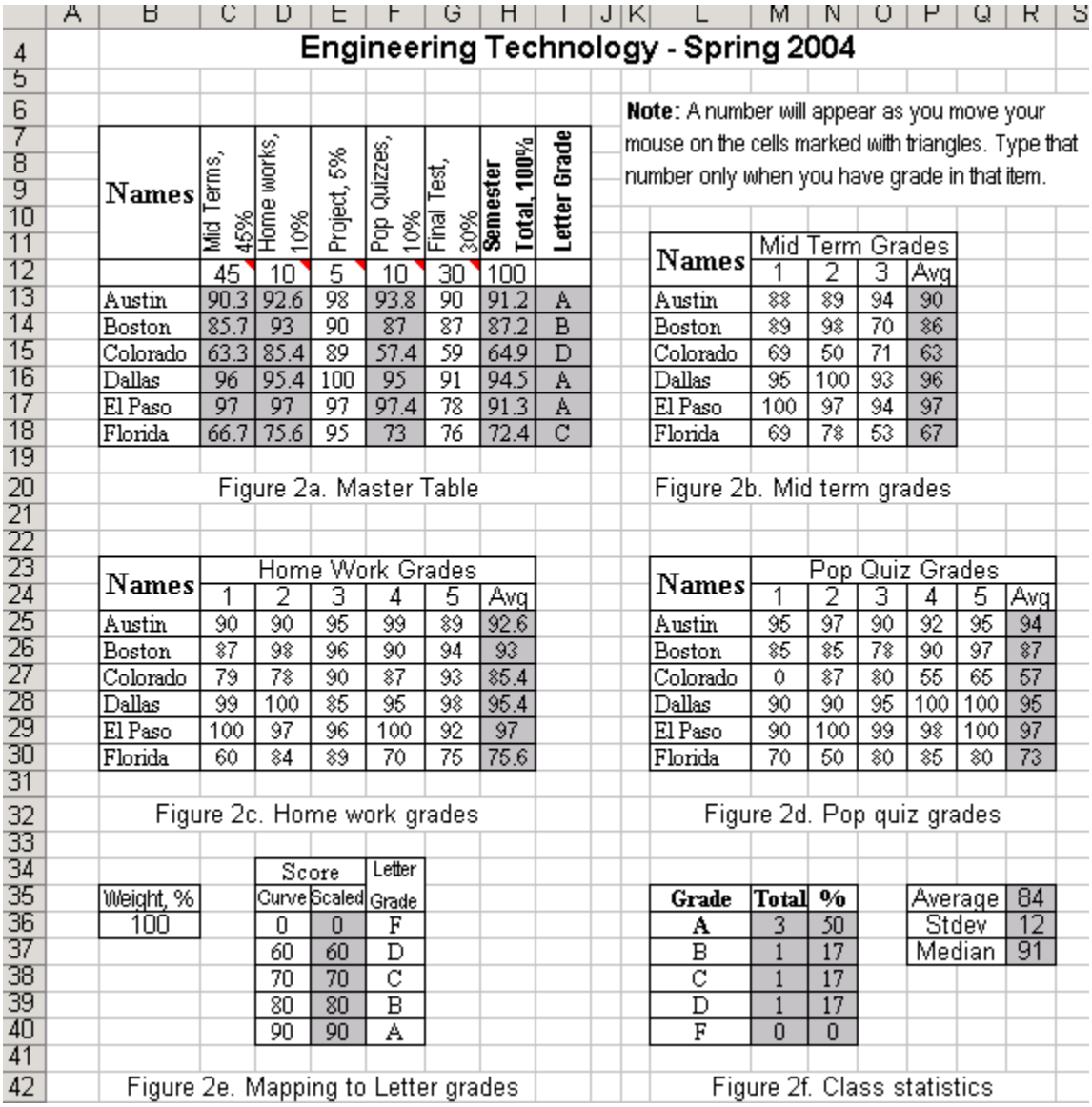
- The number under column, "Weight" is automatically calculated by adding the values in cells from C12 through G12. For example, when only the mid term grades are available, it becomes 45. With homework grades available, it becomes 55. Likewise, at the end of the semester, it becomes 100. The values under column, "Scaled", are automatically calculated by multiplying the "Weight" and the numbers under column, "Curve". This generates intermediate letter grades for the students in the Master Table and the final grade at the end of a semester as well.

Computing the Final Letter Grades

Now finally to convert Austin's numerical grade to corresponding letter grade use the following steps:

- Place the cursor in cell I13 in Figure1a.
- Type the following function with arguments
  =LOOKUP(H13, E$36:E$40, F$36:E$40)
- Now copy the contents of cell I13 for rest of the students.

The updated information is shown in Figure 2



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**Note:** A number will appear as you move your mouse on the cells marked with triangles. Type that number only when you have grade in that item.

| Names | Mid Terms, 45% | Home works, 10% | Project, 5% | Pop Quizzes, 10% | Final Test, 30% | Semester Total, 100% | Letter Grade |
|---|---|---|---|---|---|---|---|
| | 45 | 10 | 5 | 10 | 30 | 100 | |
| Austin | 90.3 | 92.6 | 98 | 93.8 | 90 | 91.2 | A |
| Boston | 85.7 | 93 | 90 | 87 | 87 | 87.2 | B |
| Colorado | 63.3 | 85.4 | 89 | 57.4 | 59 | 64.9 | D |
| Dallas | 96 | 95.4 | 100 | 95 | 91 | 94.5 | A |
| El Paso | 97 | 97 | 97 | 97.4 | 78 | 91.3 | A |
| Florida | 66.7 | 75.6 | 95 | 73 | 76 | 72.4 | C |

Figure 2a. Master Table

| Names | Mid Term Grades | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | Avg |
| Austin | 88 | 89 | 94 | 90 |
| Boston | 89 | 98 | 70 | 86 |
| Colorado | 69 | 50 | 71 | 63 |
| Dallas | 95 | 100 | 93 | 96 |
| El Paso | 100 | 97 | 94 | 97 |
| Florida | 69 | 78 | 53 | 67 |

Figure 2b. Mid term grades

| Names | Home Work Grades | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | Avg |
| Austin | 90 | 90 | 95 | 99 | 89 | 92.6 |
| Boston | 87 | 98 | 96 | 90 | 94 | 93 |
| Colorado | 79 | 78 | 90 | 87 | 93 | 85.4 |
| Dallas | 99 | 100 | 85 | 95 | 98 | 95.4 |
| El Paso | 100 | 97 | 96 | 100 | 92 | 97 |
| Florida | 60 | 84 | 89 | 70 | 75 | 75.6 |

Figure 2c. Home work grades

| Names | Pop Quiz Grades | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | Avg |
| Austin | 95 | 97 | 90 | 92 | 95 | 94 |
| Boston | 85 | 85 | 78 | 90 | 97 | 87 |
| Colorado | 0 | 87 | 80 | 55 | 65 | 57 |
| Dallas | 90 | 90 | 95 | 100 | 100 | 95 |
| El Paso | 90 | 100 | 99 | 98 | 100 | 97 |
| Florida | 70 | 50 | 80 | 85 | 80 | 73 |

Figure 2d. Pop quiz grades

| Weight, % |
|---|
| 100 |

| Score | | Letter |
|---|---|---|
| Curve | Scaled | Grade |
| 0 | 0 | F |
| 60 | 60 | D |
| 70 | 70 | C |
| 80 | 80 | B |
| 90 | 90 | A |

Figure 2e. Mapping to Letter grades

| Grade | Total | % |
|---|---|---|
| A | 3 | 50 |
| B | 1 | 17 |
| C | 1 | 17 |
| D | 1 | 17 |
| F | 0 | 0 |

| | |
|---|---|
| Average | 84 |
| Stdev | 12 |
| Median | 91 |

Figure 2f. Class statistics

Figure 2. Finalized grade sheet for a semester

**Class Statistics**

Figure 2f generates the total number and the percentage of students in each category of letter grades including average, mean and median values of the class.

The following steps show how to generate the total number of students in each letter grade.

- Place the cursor in cell M36

- Enter the following function for the total number of students with grade "A"
  =COUNTIF(I$13:I$18, "A")
- Copy the contents of M36 for rest of the letter grades, such as "B", "C" etc.

To find the percentage of students belonging to each letter grade use the following steps

- Place the cursor in cell N36
- Enter the following function for the percentage students with grade "A"
  =COUNTIF(I$13:I$18, "A")/COUNTA(I$13:I$18) * 100
- Copy the contents of N36 for rest of the letter grades, such as "B", "C", etc.

Place the cursor in cells R35, R36, and R37 and use the following functions to find average, standard deviation and median respectively for the class:

= AVERAGE(H13:H18)
= STDEVA(H13:H18)
= MEDIAN(H13:H18)

## Results

The final result for the semester appears as in Figure 2. Insertion of functions and copying them to respective cells in Figure 1 creates automated grade sheet. Any change made in the sheet will cause a domino effect making appropriate changes in all relevant cells and graphs if any. This sheet is the final official record of grades in a semester for submission.

Major elements from Figure 2 can be emphasized graphically. For example, Figure 3 displays a pie diagram of the percentage of students in each letter grade category in the class. This requires highlighting the '%' column in Figure 2f and selecting the Pie from the ChartWizard list.

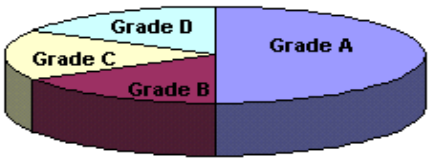


Figure 3. Final letter grade distribution in the class

Figure 4 shows the semester grades of students graphically. Figure 5 shows the mid term standings of students.

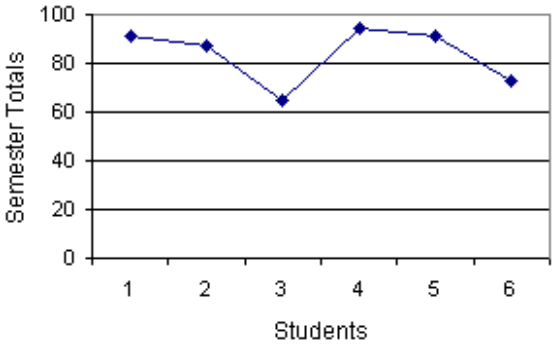


Figure 4. Semester totals for students

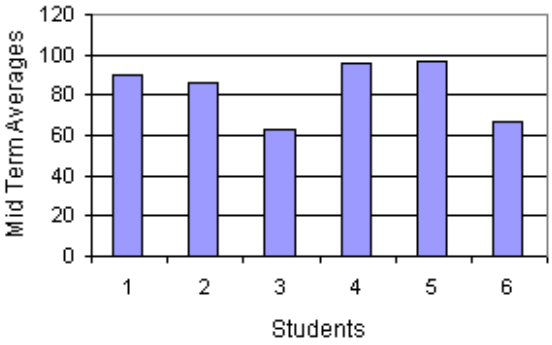


Figure 5. Mid term averages for students

**Maintaining the Grading File**

New electronic grading file can be developed using the method described in this paper. To begin with a semester, a new file can be developed from scratch every time. However, it is always better to modify an existing file to fit new parameters and ideas. To modify the existing file, the cells for student names and raw grades may be cleared and new names of students entered. Additional columns, like class participation, extra credit, may be added in the main table (Figure 1a) as necessary. New grades may be entered as semester progresses.

**Flexibility**

This grade sheet has two important flexibilities. One is to find letter grades corresponding to whatever materials are covered at any time during a semester. The second is shifting the scale for letter grades (popularly known as curving for grades.

An instructor will find this useful in posting the mid term grade. Students will like it by seeing their status in terms of corresponding letter grades at any time during the semester.

The second flexibility is useful for the instructors while posting the final letter grades. Often an instructor decides to scale down the standard grading format. For example, replace the numbers under column, “Curve”, with new a set of numbers, for example, 0, 50, 60, 70, 80. In this case, a student with a numerical score of 80 or better will get an “A”, 70 or better he/she will get a “B” and so on.

**Student Copy**

An electronic copy excluding any student name and numerical scores can be distributed among students at the beginning of a semester. They can enter their scores on mid term, homework, pop quiz, etc. into this electronic file as they are available from their instructor. This will help students remain updated about their grade status throughout the

semester. If a student can obtain the score on the final examination, he may find his final letter grade immediately.

### Upgrading the Grade Sheet

The grade sheet can be upgraded any time with new features visualized by instructors or as required by the department, college or any accreditation agency. As an example, an instructor may decide to ignore the lowest grade of two or more pop quiz grades. The following expression combines three functions together to ignore the lowest pop quiz grade. This replaces the simple function called AVERAGE().

=((SUM(M25:Q25)-MIN(M25:Q25))/(COUNTA(M25:Q25)-1))

The function MIN() finds the lowest grade in the list. This is subtracted from the sum of the list. The function COUNTA() counts the number of entries. The number of entries is then subtracted by one to adjust the total number of entries used in computing the average.

## Conclusion

The electronic grading system as described in this paper is a very useful and an elegant way of managing the grades by an instructor. Instructor can distribute a copy to the students to keep them aware of their status during a semester. This may be a guiding tool for students to decide on how much additional study effort they need to put to achieve their expected grades. Thus, this acts as a teaching aid too.

The instructor has his/her own control to upgrade the file to suit many different ideas and requirements.

### Biographical Information

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