Encouraging Student Exploration Via Spreadsheets

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The Mathematical Inquiry Project

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Introduction

Mathematical Inquiry Project

Collaboration among mathematics faculty in Oklahoma

Guiding Principles

1. Active Learning
2. Meaningful Applications
3. Academic Success Skills

Introduction

Initiation Workshop

Quantitative Reasoning - May 2021
(a.k.a. Math for General Education)

Targeted Topics

- Information presentation and consumption
- Ratios, Proportions, and Proportional reasoning
- Quantitative Reasoning
- Critical thinking
- Modeling
- Problem solving
- Spreadsheets

Background

Spreadsheets

- Engages students with real-world data
- Organizes data
- Performs difficult computations for the students
- Allows students to focus on the outcomes and their meanings
- Allows students to conduct “what-if” analysis

Materials Provided

Weighted Averages Activity

- Lesson Plan
  - Overview
  - Prerequisite Ideas and Skills
    - Identify and calculate percentages
    - Identify and calculate the mean/average
  - Instructional Plan
  - Concepts to be Learned/Applied
- Lecture Notes
  - Introduces new terminology
  - Demonstrates the connection of weighted averages to prior knowledge

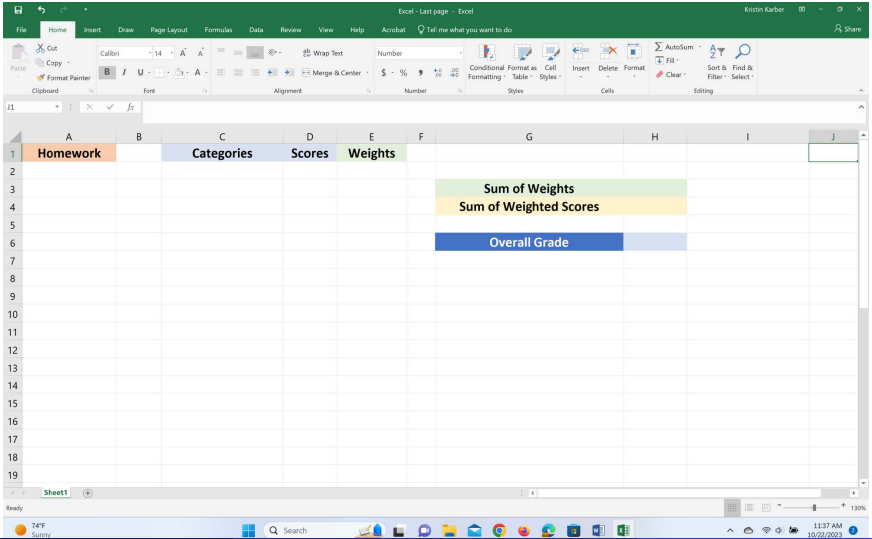
Materials Provided

Weighted Averages Activity

- In-Class Activity and Solutions
  - Compute a weighted average by creating a frequency table with given categories and weights
  - Compute a weighted average where the weights do not add to "1."
    - Students answer guided questions that use the new terminology.
    - Students reflect on their answers.
  - Generalize the idea of weighted averages to the context of financial portfolios
- Excel Instructions
- Out-of-Class Activity and Solutions

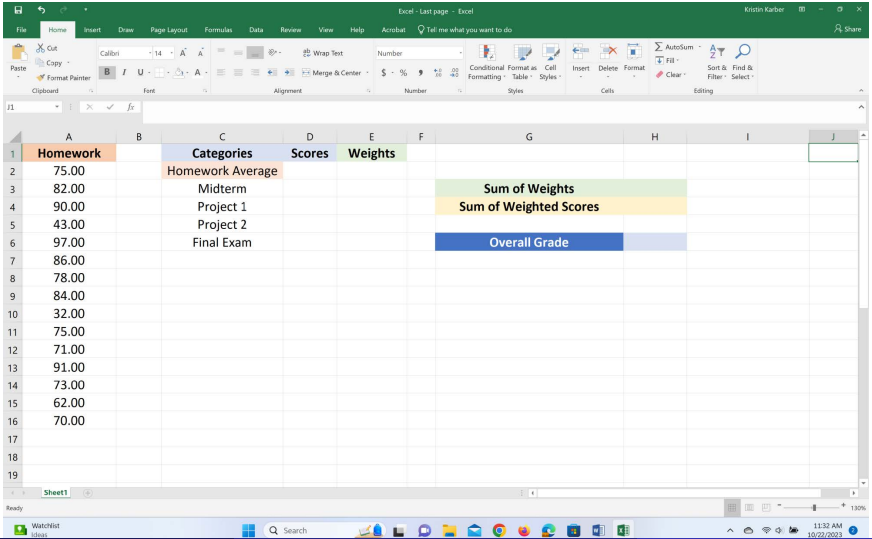
Spreadsheet

Create a new spreadsheet and include the information as indicated in the screenshot below.



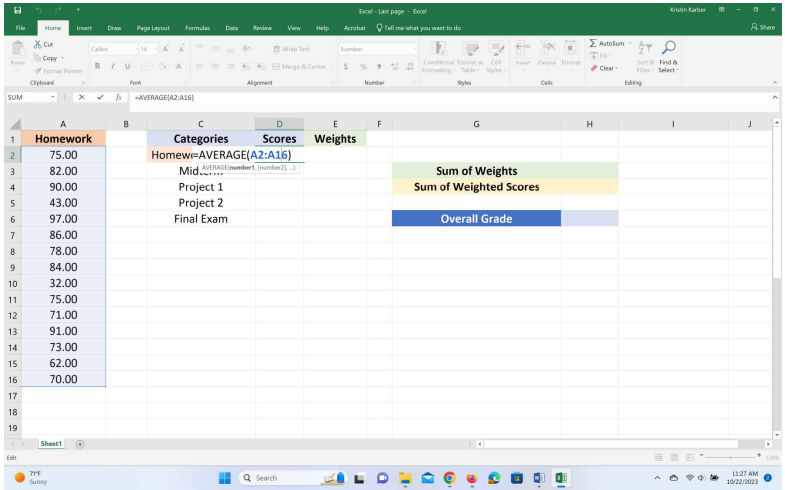
Spreadsheet

Input the Homework Scores in Column A as shown below.



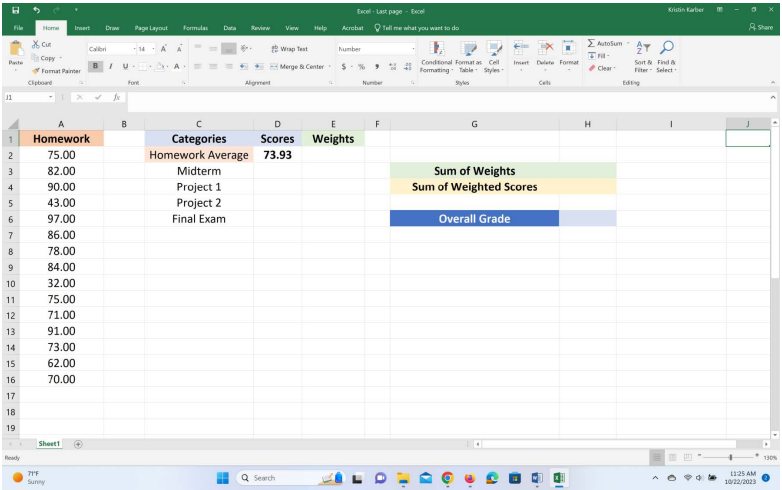
Spreadsheet

Use the Excel function, AVERAGE, to compute the Homework Average in Cell D2.
In Cell D2, type: "=AVERAGE(A2:A16)".



Spreadsheet

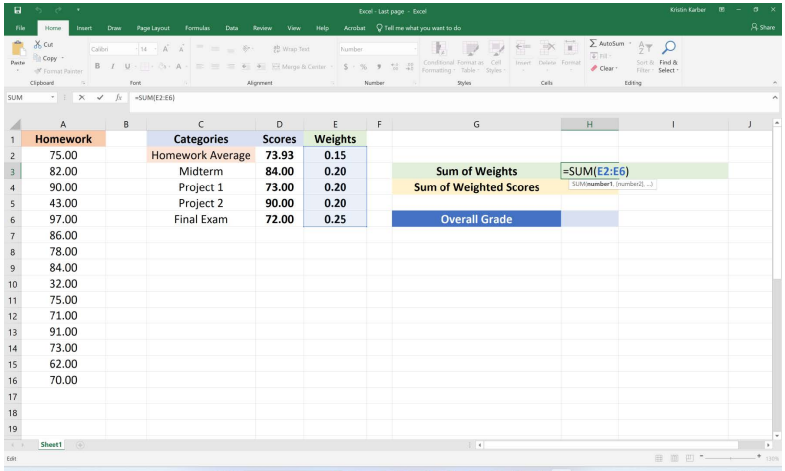
After the Homework Average formula is input, the following quantity should appear in Cell D2.



	A	B	C	D	E	F	G	H	I	J
1	**Homework**		**Categories**	**Scores**	**Weights**					
2	75.00		Homework Average	**73.93**						
3	82.00		Midterm				**Sum of Weights**			
4	90.00		Project 1				**Sum of Weighted Scores**			
5	43.00		Project 2							
6	97.00		Final Exam				**Overall Grade**			
7	86.00									
8	78.00									
9	84.00									
10	32.00									
11	75.00									
12	71.00									
13	91.00									
14	73.00									
15	62.00									
16	70.00									
17										
18										
19										

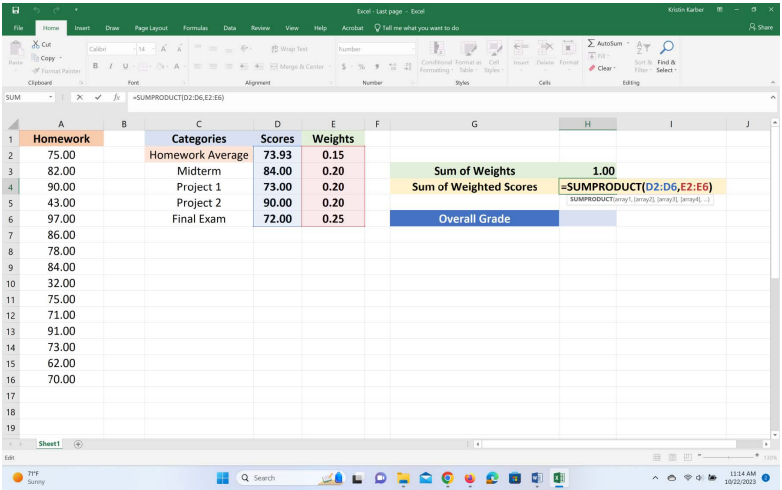
Spreadsheet

To calculate the Sum of the Weights (H3), we will use the SUM function and indicate that the function should sum the weights from (E2:E6).
In Cell H3, type "=SUM(E2:E6)".



Spreadsheet

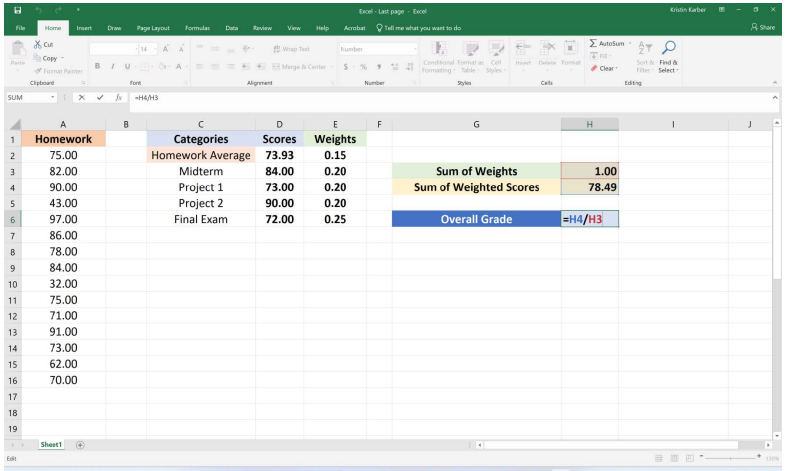
To calculate the Sum of the Weighted Scores (H4), we will use the SUMPRODUCT function where it uses the scores from (D2:D6) and the corresponding weights from (E2:E6).



	A	C	D	E	G	H
1	**Homework**	**Categories**	**Scores**	**Weights**		
2	75.00	Homework Average	**73.93**	**0.15**		
3	82.00	Midterm	**84.00**	**0.20**	**Sum of Weights**	**1.00**
4	90.00	Project 1	**73.00**	**0.20**	**Sum of Weighted Scores**	**=SUMPRODUCT(D2:D6,E2:E6)**
5	43.00	Project 2	**90.00**	**0.20**		
6	97.00	Final Exam	**72.00**	**0.25**	**Overall Grade**	
7	86.00					
8	78.00					
9	84.00					
10	32.00					
11	75.00					
12	71.00					
13	91.00					
14	73.00					
15	62.00					
16	70.00					

Spreadsheet

To compute the Overall Grade (H6), we need to divide the Sum of the Weighted Scores (H4) by the Sum of the Weights (H3).
In Cell H6, type "=H4/H3".



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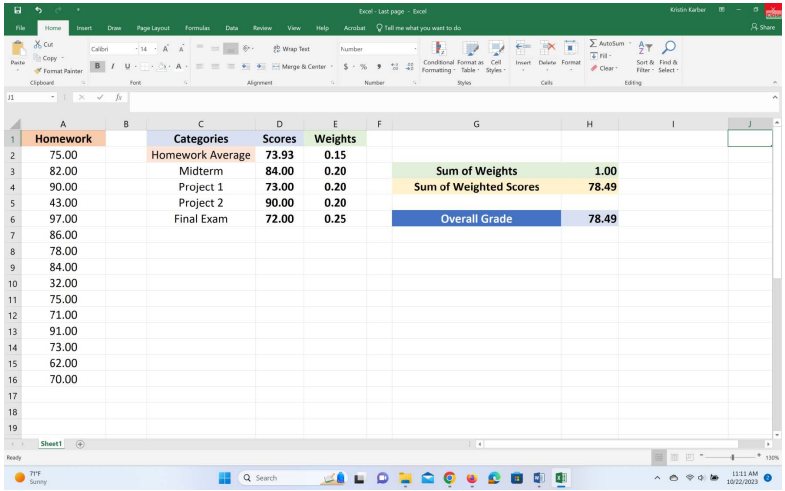
1	**Homework**	**Categories**	**Scores**	**Weights**		
2	75.00	Homework Average	**73.93**	**0.15**		
3	82.00	Midterm	**84.00**	**0.20**	**Sum of Weights**	**1.00**
4	90.00	Project 1	**73.00**	**0.20**	**Sum of Weighted Scores**	**78.49**
5	43.00	Project 2	**90.00**	**0.20**		
6	97.00	Final Exam	**72.00**	**0.25**	**Overall Grade**	=H4/H3
7	86.00					
8	78.00					
9	84.00					
10	32.00					
11	75.00					
12	71.00					
13	91.00					
14	73.00					
15	62.00					
16	70.00					

Spreadsheet

The completed spreadsheet should show the following quantities.



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3	82.00		Midterm	**84.00**	**0.20**		**Sum of Weights**	**1.00**		
4	90.00		Project 1	**73.00**	**0.20**		**Sum of Weighted Scores**	**78.49**		
5	43.00		Project 2	**90.00**	**0.20**					
6	97.00		Final Exam	**72.00**	**0.25**		**Overall Grade**	**78.49**		
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8	78.00									
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13	91.00									
14	73.00									
15	62.00									
16	70.00									
17										
18										
19										

Out-of-Class Activity

Use the spreadsheet to answer the following questions.

1. Suppose the student made a 0% on the first homework assignment instead of a 75%. What is the new homework average and the new overall grade?

2. Suppose the student ran out of time and did not turn in Project 1. How much do you think a zero for Project 1 will affect the overall grade? Insert a 0% for the score on Project 1 to see if your prediction is correct?
   Students may think the grade will go down by 20% since that is the weight of Project 1.

3. Suppose the student has all of the given scores, except the final exam.
   - What is the student's cumulative weighted grade prior to the final exam?
     Students need to recognize that they must remove both the score and weight for the final exam.
   - What score must the student make on the final exam to keep their overall grade at that score?

Out-of-Class Activity

Reflection

1. Create a new scenario by changing a score or weight. Discuss the changes you made and how it affected the overall grade.

2. What stood out about this assignment? Were you surprised by the results? Explain.

3. Did this activity influence the way you might approach your classes and grades in the future? Why or why not?

MIP Components of Mathematical Inquiry

Active Learning

"Students learn through engaging in deep problems requiring them to select, perform, and evaluate actions whose structures are equivalent to the structures of the concepts to be learned." [1]

Students will:

- Select, perform, and evaluate an action that computes an overall weighted grade.
- Utilize covariational reasoning through computations by hand and a spreadsheet.

[1] The Mathematical Inquiry Project

MIP Components of Mathematical Inquiry

Meaningful Applications

"Applications are incorporated in mathematics classes to support students in identifying mathematical relationships, making and justifying claims, and generalizing across contexts to extract common mathematical structure." [2]

Students will:

- Discover the relationship between various inputs (e.g. homework, test, and project grades), to an output (e.g. overall grade).
- Make and justify claims for several scenarios (e.g. receiving a zero on a homework assignment vs. a zero on a project).
- Generalize the concept of weighted averages from the scenario of computing grades to a scenario about financial portfolios.

[2] The Mathematical Inquiry Project

MIP Components of Mathematical Inquiry

Academic Success Skills

"Students construct an identity as learners in ways that enable productive engagement in their education and the associated academic community." [3]

Students will be able to:

- Apply this activity to their own unique grades and classes.
- Make informed decisions and understand the consequences of those decisions (e.g. missing a test).
- Use a spreadsheet to conduct "what if" analysis.
- Focus on mathematical relationships, instead of computations, which may lessen anxiety and build confidence.
- Develop an appreciation of math as useful to their careers as students and to their life beyond the classroom.

[3] The Mathematical Inquiry Project

Additional Activities with Spreadsheets

- Mean and Median with Spreadsheets Activity (Fulkerson, Karber)
- Financial Literacy CoRD (Harder, Karber, Lester, Moore-Russo, Regier)

1. Budgeting for Home Ownership

   Students create a budget for a family for four, assist them in selecting an optimal mortgage, and devise a sound strategy for loan repayment.

2. Credit Cards

   Students model credit card debt as an introduction to compounding interest.

3. Home Loans

   Students create a spreadsheet to compute the monthly payment for a home loan.

4. Savings

   Students are given the opportunity to utilize a spreadsheet to compute the future value of an IRA.

Additional Activities with Spreadsheets

- Statistical Literacy CoRD (Brenneman, Karber)

1. Sampling Error, Sampling Variability

   Students use a spreadsheet to compute the sample mean and sample standard deviation of data they collected.

2. Sampling Variability Revisited through Graphics and the Sampling Distribution

   Students use a spreadsheet to create a side-by-side boxplot.

3. One Sample Mean T-Confidence Intervals

   Students use a spreadsheet to create a histogram and a boxplot.

References

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Gaze, E. (2019). *Thinking Quantitatively: Communicating with Numbers* (2nd ed.). Pearson.

Harder, J. A., Karber, K., Lester, H., Moore-Russo, D. & Regier, P. (2023). *Empowering Financial Literacy: A Toolkit of Dynamic Classroom Activities for Active Learning & Practical Application*. Retrieved from https://okmip.com/financial-literacy/

The Mathematical Inquiry Project. okmip.com/