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Using spreadsheets to develop applied skills in a business math course: Student feedback and perceived learning

Thomas Mays

Miami University, maysta@miamioh.edu

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Using spreadsheets to develop applied skills in a business math course: Student feedback and perceived learning

Abstract

This paper describes the redesign of a business math course and its delivery in both face-to-face and online formats. Central to the redesigned course was the addition of applied spreadsheet exercises that served as both learning and summative assessment tools. Several other learning activities and assignments were integrated in the course to address diverse student learning styles and levels of math anxiety. Students were invited to complete a survey that asked them to rank course activities and assignments based on how well they helped the student learn course material. Open-ended items were also included in the survey. In the online course sections, students reported higher perceived learning from the use of the spreadsheet-based application assignments, while face-to-face students preferred demonstrations. Qualitative remarks from the online students included numerous comments about the positive learning impact of the business application spreadsheet-based assignments, as well as the link between these assignments and what students considered the “real world.”

Keywords

Applied business spreadsheets, spreadsheet assignments, business math, course redesign

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1. Introduction

Spreadsheets are an integral part of organizational data analysis activities. In the modern era of “big data”, individuals and organizations are confronted by an increasingly data-driven world. As such, data analysis has become a key 21st century skill. As reported by the National Association of Colleges and Employers (NACE), data management and analysis skills and related software proficiencies are in high demand by today’s employers [8]. The Partnership for 21st Century Skills specifically highlights the need for today’s students to develop strong information and technology skills, including the ability to manage, evaluate and use information [10]. The use of computer-based spreadsheets in college courses provides a way to mesh information management and analysis skills with technology skill areas. This is particularly important in quantitative oriented courses.

To address these skill development needs, an introductory business math course was redesigned to both include applied spreadsheet activities and assignments, and deliver as an online course. The goal of this project was to create an applied course that enables students to transform learned concepts into practical business applications. A description of the redesign considerations and process, as well as the results of surveys administered at the conclusion of each course section, are presented here. The survey is provided in the appendix.

Prior to the redesign, the course focused primarily on developing business math skills with limited attention to application oriented spreadsheet use. For example, several lessons included instruction and resources on calculating descriptive statistics and ratios, then required students to complete textbook problems using a spreadsheet for reporting final answers. The course also included a limited number and variety of learning activities and assessments.

Three identified problems directed the course redesign process. The first problem involved addressing the need to foster the development of data, information and software skills through the use of applied spreadsheets. These spreadsheets involved merging the learning of quantitative business methods with business application and spreadsheet analysis exercises. This is important because spreadsheets are used in the course to help students develop applied skills appropriate for use in real world applications. The second problem involved optimizing the course for online delivery. The third problem involved student math anxiety and related issues with translating math concepts to real world applications. A review of the literature on online course design, spreadsheet use in classrooms, and anxiety mitigation was completed.

The redesigned course included a new focus on students developing applied quantitative skills using spreadsheets. This involves not only learning introductory quantitative concepts, but also the application of these concepts in a variety of real world accounting, finance, and decision making scenarios. The student learning outcomes for the course are listed below.

- Demonstrate the use of quantitative methods in solving common business problems.

- Apply quantitative techniques within the contexts of accounting, finance, and marketing.
- Present data and analysis in both written and visual forms.

2. Literature consulted during the redesign process

Several practices outlined by Richlin [11] were followed when redesigning the course. This included following a structured course design process involving alignment of course-level outcomes, lesson-level outcomes, learning activities, and assessments. Furthermore, Richlin [11] discussed the importance of understanding the variety of student learning styles and providing quality feedback to students. Kuh, Schuh, Whitt, and Kinzie [6] found that student satisfaction was tied to instructors providing timely and frequent feedback, as well as addressing the variety of student learning styles. Both Tagg [14] and Tinto [16] discussed the importance of providing frequent feedback to students. Clark and Mayer [1], Paloff and Pratt [9] and Lehman and Conceição [7] discussed these same practices within the context of online course design and facilitation.

A principal concern in online education is the notion of creating a sense of presence. While presence may seem elusive in online environments, various methods have been suggested to help build connections between teacher and student, as well as among students. The Community of Inquiry framework as presented by Swan and Ice [13] and the design and facilitation practices to encourage online presence as described by Lehman and Conceição [7] are also reviewed here.

Spreadsheets are a well suited tool for use in a quantitative oriented courses. Several researchers have reported positive results for the incorporation of spreadsheets into the classroom. Conrad and Donaldson [2] used spreadsheet simulations to engage online learners. To enhance student learning, Ray [12] used spreadsheet-based simulations to integrate math into a biology course. Topcu [17] used spreadsheets in an algebra course to improve student self-efficacy, and Warner and Meehan's [19] integration of spreadsheets led to enhanced statistics and computer skills, as reported by students.

Strategies to specifically address math anxiety within online learning environments include: the use of real world scenarios and giving meaning to tasks [4]; the use of discussion forums to foster support [18]; and the use of video in online classrooms [4,15]. Additionally, Furner and Gonzales-DeHass [3] provide a literature review on the effects of math anxiety and strategies for its mitigation. Interestingly, many of the anxiety mitigating approaches are also included as best practices in the course development literature.

3. Course Redesign

Historically, many students who enrolled in this course had not completed math courses beyond basic algebra. This necessitated retaining the math instruction part of the course while enhancing the application aspects of the course. To support student learning of spreadsheet formula development, tutorials were provided throughout

the course. In addition to the spreadsheet-based tutorials, the online course redesign included the development of a number of course-specific instructional videos that demonstrated solving common business math problems both by hand and using spreadsheets. Third party videos and resources were also integrated. Tutorials on creating formulas and using spreadsheet functions were also provided in the learning management system for both the face-to-face and online course sections. For the online course, opportunities for developing presence were created through the availability of instructor-developed videos, student discussion forums and a team-project option for the final project.

3.1. Assignments and Grade Weights

One of the more significant changes to the course was the increase in the number and type of assessments. This was done to increase the frequency of student feedback, increase course presence in the online section, and to address a variety of student learning styles. Integrating a number of lower-stakes assessments throughout the course increased opportunities to provide feedback (see Warnock [20] for a review of using multiple low-stakes assessments). Figure 1 illustrates the original assessment weights, while Figure 2 illustrates the revised course.

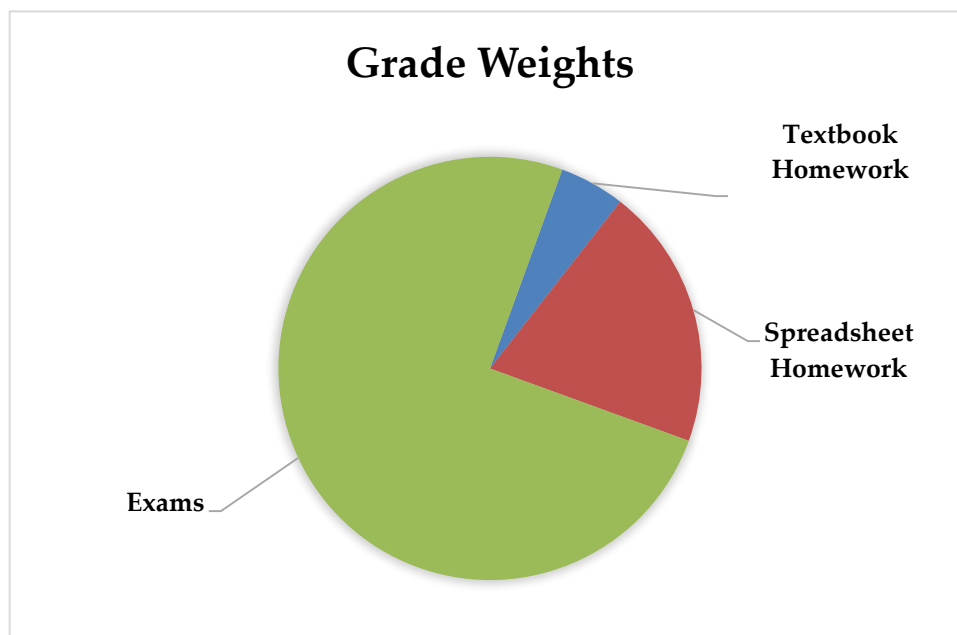


Figure 1: Assessment grade weights before course redesign

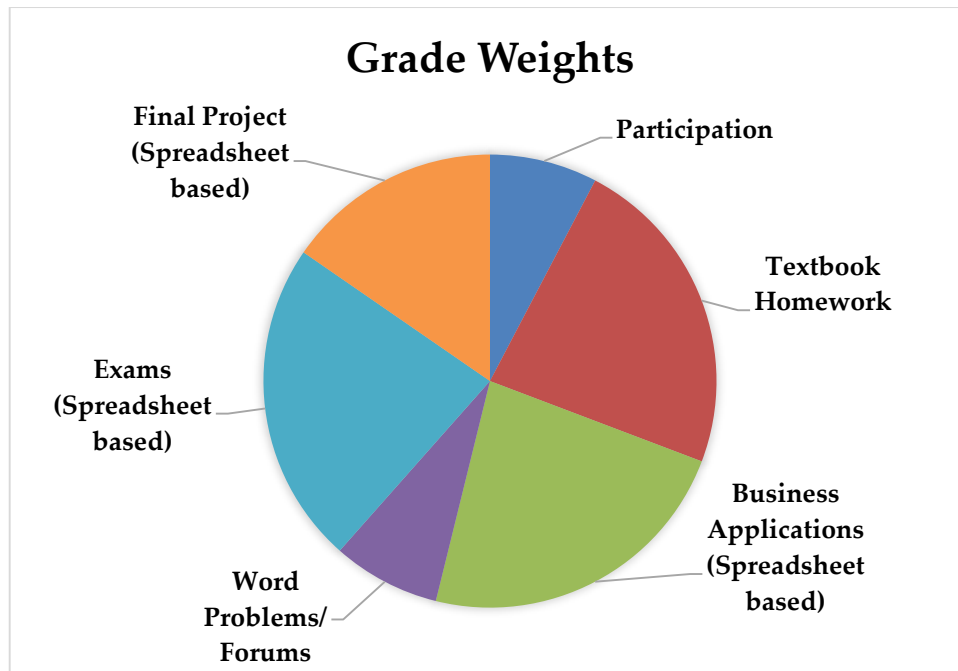


Figure 2: Assessment grade weights after course redesign

In the redesigned course, the core assignments included weekly textbook-based problems (provided in the course textbook). The weekly homework assignments generally involved scenarios from which the student needed to extract the relevant data, then solve the problem. To complete the weekly homework assignments, students were required to submit their work using a spreadsheet. Because of the introductory nature of the course and potentially limited spreadsheet experience of many students, the use of formulas in the spreadsheets was optional. However, students were informed that using formulas in their homework spreadsheets would result in partial credit being awarded for missed items.

3.2. Business Application Assignments

In addition to the weekly homework, spreadsheet-based business application exercises were also assigned. These business applications were designed to replicate quantitative scenarios faced by businesses in everyday situations, and they were based on the author's numerous years of small business ownership experience. The business applications were designed to provide opportunities for students to make connections between the textbook material and authentic application, and they formed the core of the students' applied spreadsheet work.

Developing the business application spreadsheets began with a review of course and module-level objectives. The objectives focused on students demonstrating the application of quantitative methods to solve common business problems. Additionally, students were expected to demonstrate the ability to use written and visual methods to communicate describe and analyse quantitative data. To help students meet these objectives, the business application spreadsheets were designed.

The business applications involved three key areas: data, formulas and functions, and analysis. Some spreadsheets required students to collect data, and others provided a dataset. Students would then use appropriate functions, formulas, and

visualizations, such as charts and conditional formatting, to address the problems presented in the worksheet. Finally, students would analyse the results and complete a short essay.

One example of a business application assignment required student's to conduct a breakeven analysis. Students generated their own data, then created formulas to complete the break-even analysis at different cost levels. Students were also required to create a chart visualizing their calculations. In the analysis section, students were required to review their spreadsheets, then describe the impacts or implications of the results. The business application worksheet assignments are listed in Table 1. Figure 3 illustrates part of one of these business applications.

Table 1. Business Application Spreadsheets

Business Application Spreadsheet	Concepts and Activities
Infographics and percentages	Reading and analyzing data reported in an infographic; use of percentages
Crowd funding services cost analysis	Creating formulas; analyzing results
Introductory statistics	Percent of total; MIN; MAX; AVERAGE; STDEV; Reading and analyzing data
Revenues and Expenses	Creating formulas; Reading and analyzing results
Calculating Sales Tax	Finding web-based data; Creating formulas; Reading and analyzing results
Cash Discount Policies	Creating formulas; Reading and analyzing results
Breakeven Analysis	Creating formulas; Reading and analyzing results
Income Statements; Balance Sheets	Creating formulas; Vertical analysis; Ratios; Reading and analyzing results
Depreciation	Creating formulas; Reading and analyzing results
Time Value of Money	PV; NPV; FV; Reading and analyzing results
Stock Market Research	Finding web-based data; Creating formulas, Reading and analyzing results

27											
28											
29	Part 1										
30	Create your table in this space. Fill in the orange tinted cells with the appropriate formulas.										
31											
32		Calculating the number of t-shirts sold needed to break even									
33	Price per t-shirt	\$	9	\$	10	\$	11	\$	12	\$	13
34	Contribution Margin										
35	Break Even Point										
36											
37											
38	Part 2										
39	And there's a change!										
40	Create a new table below that show breakeven points considering a 10% increase in Price per shirt, and a 5% increase in variable costs.										
41											
42		Calculating the number of t-shirts sold needed to break even									
43	Price per t-shirt										
44	Contribution Margin										
45	Break Even Point										
46											
47											
48	Part 3										
49	Answer the following questions...										
50											
51											
52	What might happen if the breakeven points calculated above are inaccurate, specifically if we have overestimated our prices?										

Figure 3. Example business application assignment

In another business application example, students were required to calculate sales tax on a number of items in a number of municipalities. Students were asked to find the appropriate sales tax data for each municipality through the official government website and subsequently calculate sales tax.

Many of the business applications were structured in such a way that students could use them as worksheets to solve problems outside of the course. Additionally, the business applications included instructional resources, serving as a roadmap for completing the assignments. Some business applications also included embedded instructional videos. Unlike the homework assignments, students were required to use formulas in all calculations in the business applications.

3.3. Final Project

The final project involved a multi-sheet workbook that was presented to students as a precursor to developing a full business plan aimed at evaluating the feasibility of a new venture. The workbook involved many of the key topics outlined in the course, highlighting key or important areas in business. Students were required to use formulas for all calculated cells. In addition, students were asked to create data visualizations on several sheets, then proved a written analysis of their financial plan. Table 2 lists the topics covered in the final project.

Table 2: Final project workbook tabs

Workbook tab	Concepts and functions applied
Business and product description	Descriptive information
Loan calculation	Loan payments (PMT); Simple formulas; Charting; Analysis

Prices and costs	Variable costs; Fixed costs; SUM; Charting
Breakeven analysis	Variable costs; Fixed costs; Contribution margin; simple formulas; Charting; Analysis
Income statement	Revenues and expenses; SUM; Simple formulas; Analysis
Balance sheet	Assets, liabilities, and equity; SUM; Analysis
Future revenues and expenses	Future value; FV; Charting; Analysis
Final analysis	Analysis across spreadsheets

The online and face-to-face course versions were the same with the exception of course modality. The course content, including the textbook, most learning resources and the assessments remained the same. Since the online course was designed to be delivered asynchronous, live classroom discussions and demonstrations were not possible. This was addressed by incorporating several concept introduction and problem demonstration videos to replicate the topics that would normally be presented in face-to-face classrooms. In addition, several discussion forums were added to the online course to foster interactivity among students. With the exception of many of the instructional videos and the use of online discussion forums, the online course site and related materials were also made available to the face-to-face students as a part of the curriculum. While not all videos were available to the face-to-face students, classroom-based demonstrations substituted for these learning materials.

4. Methodology and data collection

To measure student perspectives on learning in the redesigned course, a survey was distributed to students in both the face-to-face and online course sections. In addition, student assignments were analysed for the use and accuracy of formulas and analyses. The first semester course was facilitated in a traditional face-to-face setting in a computer lab. After the first semester, the course was only delivered as an online course. The research questions were as follows:

- Which learning activities and assignments do students perceive as being most helpful in learning the course material?
- What are the differences between the online and face-to-face sections of the course?

At the end of each semester, an instrument was distributed to gather data about how students ranked course activities and assignments in terms of the impact on student perceived learning. Students were asked to respond to the statement, "The following activities and assignments helped me learn in this course," after which a list of course activities and assignments followed. A five-point Likert scale ranging from strongly

disagree to strongly agree was used for responses. Students were also asked open-ended questions including “Which activity or assignment was the most helpful in this class?” and “Which activity or assignment was least helpful in this class?”. The open-ended questions were analysed for common elements to help supplement the survey data.

5. Results

The face-to-face course included 11 enrolled students as of the final day of class, with seven students completing a survey instrument (n=7). The online courses included students from four course sections, including 79 enrolled students with 32 completing a survey instrument (n=32). The course had only been offered once during the study period using the face-to-face mode, thus a larger sample was not possible. Tables 3 and 4 include frequencies and descriptive statistics for the survey responses. Figures 4 and 5 illustrate the percent of total statistics for each activity and assignment and survey responses. Frequency tables are included in the appendix.

Table 3. Face-to-face student feedback on assignments, percent of total, sorted by Agree + Strongly Agree

Face-to-face course section: The following activities and assignments helped me learn in this course, n=7						
	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree	Agree + Strongly Agree
Problem demonstrations	0%	0%	0%	14%	86%	100%
Textbook homework	0%	14%	0%	57%	29%	86%
Discussion	0%	0%	14%	29%	57%	86%
Business applications	14%	0%	0%	14%	71%	85%
Summary sheets	0%	0%	14%	14%	71%	85%
Final project	0%	0%	29%	29%	43%	72%
Textbook readings	29%	14%	14%	14%	43%	57%
Word problems	14%	0%	43%	14%	29%	43%

Table 4. Online student feedback on assignments, percent of total, sorted by Agree + Strongly Agree

Online course sections: The following activities and assignments helped me learn in this course, n=34						
	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree	Agree + Strongly Agree
Business Applications	0%	0%	12%	24%	65%	89%
Final project	0%	3%	9%	41%	47%	88%
Textbook homework	0%	3%	15%	56%	26%	82%
Textbook readings	0%	3%	24%	53%	21%	74%
Summary sheets	0%	0%	29%	38%	32%	70%
Problem demonstrations	3%	6%	26%	35%	29%	64%
Discussion	0%	3%	35%	50%	12%	62%
Word problems	0%	6%	44%	24%	26%	50%

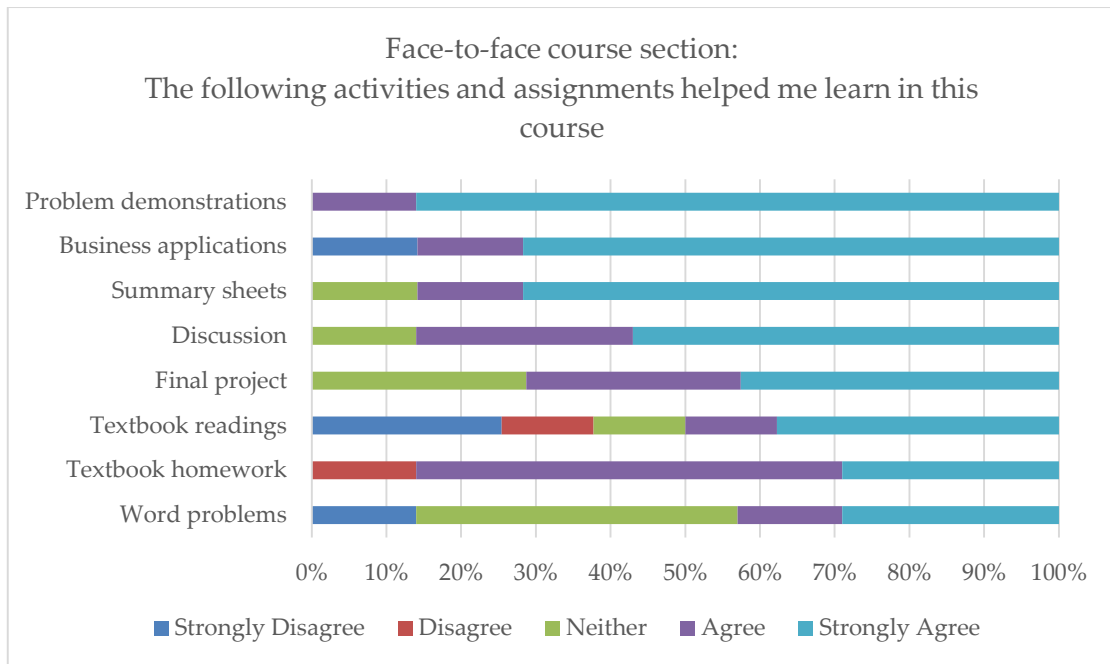


Figure 4. Face-to-face student feedback on assignments

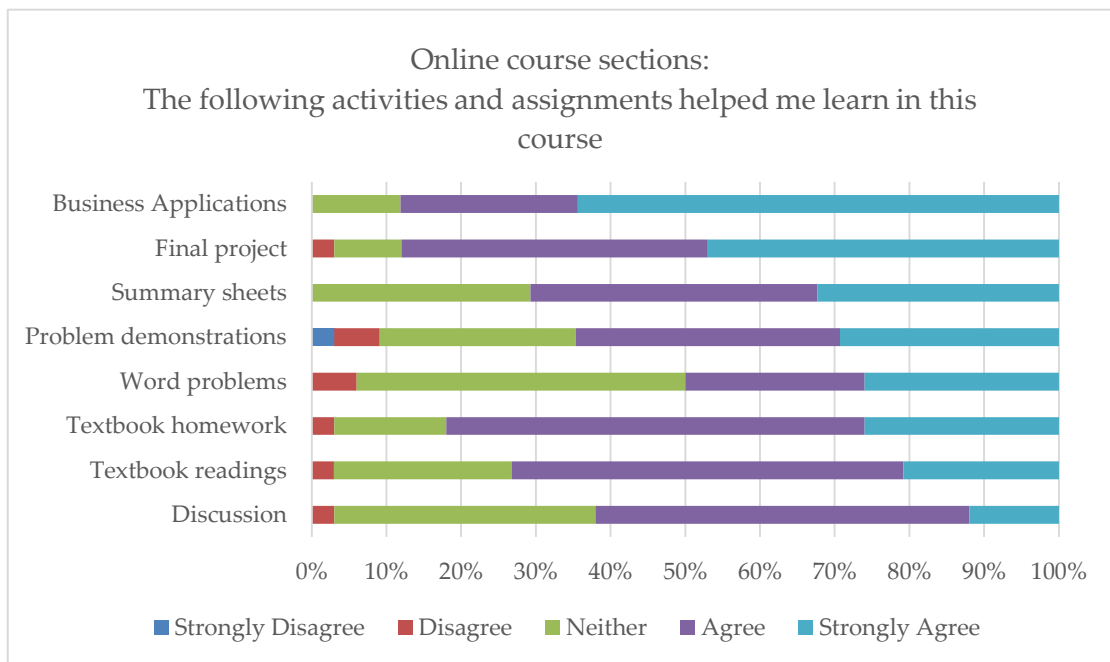


Figure 5. Online student feedback on assignments

For the face-to-face course section, the highest percent share of strongly agree responses occurred with demonstrations (86%), business applications (71%) and summary sheets (71%). Summing the strongly agree and agree responses, the highest responses were with problem demonstrations (100%), textbook homework (86%), discussion (86%), business applications (85%), and summary sheets (85%).

For the online course sections, the highest percent share of strongly agree responses occurred with business applications (65%), final project (47%) and summary sheets (40%). Summing the strongly agree and agree responses, the highest responses were with business applications (89%), final project (88%), and textbook homework (82%).

Qualitative survey responses were positive towards the business application assignments as learning tools and as ways to connect course material with the “real world.” Students were first asked which activity or assignment was the most helpful. In the face-to-face section, the business applications were mentioned most often as being helpful, with students referencing the link between the assignments and the real world. Of the 30 responses to qualitative items, 17 specifically mentioned the business applications assignments as being the most helpful in learning course material. The following are responses from students in the face-to-face course sections:

- “Business applications, it applied to real life circumstances.”
- “Business Application assignments. They allowed you to see the bigger picture as to why the information you learned was important.
- “Business Application exercises because they were like real life situations.”

The following are responses from students in the online course sections:

- “I think each time we had to complete an Excel sheet it not only helped us learn the material but allowed us to see it used in a business sense. Using particular calculations and formulas helped to round our skills and personally my confidence in the problem solving.”
- “The business applications was the most helpful because I was able to learn a lot of stuff on researching about personal finance and other business activities.”
- “The business applications put in perspective how you might use math every day.”
- “I liked the Business application assignments. I also think the final project gave us a good insight into the business world of problem solving and business ethics. I particularly liked the way it was structured into having a business and accounting for the financial part of the business.”
- “The business applications. Gave you practical assignments to work on that had real world applications.”
- “I like the business applications because I felt like it gave me hands on experience in real situations.”
- “The business applications and final project were really good. I think they helped me see how I can use Excel to help in business operations.”

Students were asked about the kinds of activities or assignments that would be helpful in reducing anxiety and increase learning. Of the 22 responses, 15 reported no having no anxiety or that anxiety was not an issue. Several items were mentioned once, and increasing the use of spreadsheets was mentioned three times.

Students were also asked about how did their thoughts and attitudes towards math change during the semester. In the responses listed below, Excel was mentioned positively several times, as was the application of learned skills in life or business.

- “I learned more about how math is really applied in everyday life.”
- “I liked it more at the end of the semester. Excel was very useful!”
- “I like math more and how it relates to business.”

- “Math is usually the last sought after subject but when you're able to apply it towards business concepts successfully, it becomes clear to you how easy it is to use but also how sensitive computing and calculating data really can be.”
- “I guess I can see how Excel can help me with math problems now.”
- “It seems to be easier to do through formulas through Excel, I still don't like math.”
- “I have always liked math...not always great at it but enjoy doing it and learning about it. The fact that math was interpreted into business situations made it so much more interesting and practical.”
- “I feel more comfortable with using Excel.”

Finally, students were asked which activities and assignments were least helpful. The face-to-face course students mentioned word problems and the textbook most often, with one participant mentioning the business applications, and another stating that “Nothing was unhelpful”. In the online course sections, one participant remarked on how they struggled with the business applications, while other responses included “Not sure,” “None”, “It was all helpful,” and “No assignments were without learning tools. All were helpful for the financial part of the business world.” Speaking to the variety of learning preferences of students, while business applications and the final project were mentioned most often, respondents also referred to the summary handouts, discussions, word problems, and problem demonstration videos as being helpful.

6. Discussion and Conclusion

This project focused on the development of applied spreadsheet assignments, the migration of a course to online delivery, and the mitigation of student math anxiety. It was found that students, particularly those online, valued the business application and final project assignments as ones that most impacted their learning of course material. Furthermore, the open-ended questions revealed that many students regarded the business application assignments as gateways to real world experiences in using spreadsheets. Math anxiety was not found to be a concern of students in the studied course sections.

6.1. Most helpful assignments reported by students

The survey data suggest that the business application and final project assignments impacted student perceived learning of course material, specifically in the online course sections. Furthermore, the open-ended responses reflect favouritism for the spreadsheet-based activities and assignments as aiding students' perceived learning. A consistent theme in the open-ended responses was the focus of the business application and final project assignments on providing real world experience in the use of spreadsheets in business, which was a goal set out by the author. This illustrates that students in the studied course sections reported value in using spreadsheets as learning tools, and these results warrant development of additional applied spreadsheet assignments in this course.

6.2. Differences between face-to-face and online sections

Unsurprisingly, there were differences between the face-to-face and online course sections. While face-to-face students reported that the business application assignments were helpful in learning course material (85% agree plus strongly agree), other learning activities and assignments ranked higher. Since online students did not have a synchronous class interaction experience, other modes of instruction and resources were provided. Survey participants in the online section preferred the applied exercises using spreadsheets, while the face-to-face section preferred in-class demonstrations. However, any comparison of the two modalities using the collected data must recognize the small sample size for the face-to-face course section. If this question is to be further studied, a larger sample of face-to-face students would be necessary.

6.3. Conclusion

The connection that students reported between the spreadsheet assignments and real world applications was important; it is key that students make connections between classroom material and application, and that they find value in completing coursework. Since data analysis skills continue to grow in importance to employers, the development and use of applied spreadsheet assignments should continue to be emphasized. Future research in this area should explore the impact of applied spreadsheet assignments on student motivation, grade performance, and retention.

The course redesign process involved a thorough review of course objectives, structure, learning materials, and assessments. The process was guided by reviewing literature from Richlin [11], Palloff and Pratt [9], and Lehman and Conceição [7], and the redesign was completed with online course delivery in mind. One of the primary goals of the process was to create an online learning experience that focused on students developing practical spreadsheet skills. This was accomplished through creating the business application and final project assignments. Based on the analysis of student work as well as the survey responses, future iterations of this course will continue to emphasize applied spreadsheets, and instructors and course designers are encouraged to develop similar assignments.

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Appendix A: Survey instrument

1. The following activities and assignments helped me learn in this course:
 - Textbook readings: SD, D, N, A, SA
 - Textbook homework problems: SD, D, N, A, SA
 - Business Applications exercises: SD, D, N, A, SA
 - Word problem exercises: SD, D, N, A, SA
 - Problem demonstrations: SD, D, N, A, SA
 - Handouts (Summary sheets): SD, D, N, A, SA
 - Discussion: SD, D, N, A, SA
 - Final Project: SD, D, N, A, SA
2. Which activity or assignment was the most helpful in this class? Please explain why.
3. Which activity or assignment was least helpful in this class? Please explain why.
4. What kinds of activities or assignments would be more helpful to reduce your anxiety and increase learning?
5. How did your thoughts and attitudes towards math change during this semester?
6. Do you have any other thoughts on this class you would like to share?

Appendix B. Additional data tables

Table 5. Face-to-face course section end-of-semester survey frequency count, n=7

Activity	SD(1)	D(2)	N(3)	A(4)	SA(5)	Mean	SD
Problem demonstrations	0	0	0	1	6	4.86	0.38
Summary sheets	0	0	1	1	5	4.57	0.79
Discussion	0	0	1	2	4	4.43	0.79
Business application	1	0	0	1	5	4.29	1.50
Final project	0	0	2	2	3	4.14	0.90
Textbook problems	2	1	1	3	0	4.00	1.00
Word problems	1	0	3	1	2	3.43	1.40
Textbook readings	2	1	1	3	0	2.71	1.38

Table 6. Online course sections end-of-semester survey frequency count, n=35

Activity	SD(1)	D(2)	N(3)	A(4)	SA(5)	Mean	SD
Business applications	0	0	4	8	22	4.53	0.71
Final project	0	1	3	14	16	4.32	0.77
Textbook homework	0	1	5	19	9	4.06	0.74
Summary sheets	0	0	10	13	11	4.03	0.80
Textbook readings	0	1	8	18	7	3.91	0.75
Problem demonstrations	1	2	9	12	10	3.82	1.03
Word problems	0	2	15	8	9	3.71	0.94
Discussion	0	1	12	17	4	3.71	0.72