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How to Better Prepare Accounting Students for A Data Heavy Curriculum? - An Empirical Study on Students' Attitudes and Beliefs about Mathematics

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Abstract

As accounting educators, how shall we better prepare our students for the future when data analytics becomes an important skill, with proficiency required for accounting graduates? This study is motivated by the above question and aims to provide some insights from the perspective of students' attitudes and beliefs about mathematics. Educators have been trying to raise students' positive attitudes toward mathematics, as these attitudes have been found positively related to students' mathematics achievement, which may affect students' learning of accounting and data analytics. And as students progress in their accounting learning, their attitudes and beliefs about mathematics might change. Using survey data, we examine whether accounting students' attitudes and beliefs about mathematics differ among sophomores, juniors, and seniors. We find that seniors tend to have more positive attitudes toward mathematics on average than sophomores and juniors, but beliefs do not differ among the three groups. Since accounting learning requires an application of a large amount of mathematics knowledge and skills in real-world contexts, our study suggests that an emphasis on problem solving might positively raise students' attitudes toward mathematics. Given the application nature of data analytics, our results imply that incorporating data analytics training into the accounting curriculum could potentially improve students' attitudes toward mathematics, which might in turn help students perform better in a data heavy accounting program.

1. Introduction

The accounting profession has been evolving more rapidly than ever. To recognize the rapidly changing skills and competencies the practice of accounting requires today and will require in the future, AICPA and NASBA have jointly launched a CPA Evolution initiative to transform the CPA licensure model and will launch a new Uniform CPA exam in 2024 (AICPA and NASBA, 2021). The ability to analyze a large amount of data has become an important skill, which accounting graduates must be proficient with. As accounting educators, how shall we better prepare our students for the future? Motivated by this question, this study aims to provide some insights from the perspective of students' attitudes and beliefs about mathematics.

A sizable number of college students take accounting courses. Not only are accounting major students required to take accounting courses, there are many non-accounting major students who also take accounting courses for various purposes. For example, business majors generally require one or two accounting courses. This is notable

given that, according to the National Center for Education Statistics, about one fifth of U.S. college graduates majored in business in 2018 (Hussar et al., 2020).

Accounting is a subject that discusses the process of identifying, measuring, and communicating business transactions, which demands analytical and quantitative skills. Even though it is not always true, it is not hard to see that in many colleges, students in business schools (including accounting majors) are required to take a certain number of mathematics courses. For example, according to Prudchenko (n.d.)., "Most Bachelor of Science programs in accounting require students to take two or three courses in mathematics." Also, in many colleges, accounting courses may not require any mathematics courses as a prerequisite; for example, at St. Thomas University, Principles of Accounting I does not require a mathematics course as a prerequisite course (St. Thomas University, 2021). However, it is also not rare that in many colleges, to take accounting courses, students must pass some prerequisite mathematics courses. For example, at the University of Wisconsin-Milwaukee, the Introduction to Financial Accounting course requires two prerequisite mathematics courses: Introduction to College Algebra and Algebraic Literacy II. Their Intermediate Financial Accounting course also requires two mathematics courses as prerequisites: Quantitative Models for Business and Survey in Calculus and Analytic Geometry (University of Wisconsin-Milwaukee, 2021). Similarly, at Southern Methodist University, prerequisites for Introduction to Financial Accounting include Introduction to Calculus for Business and Social Science or Calculus I (Southern Methodist University, 2021). Not every accounting instructor agrees, but these requirements appear to be suitable for providing the undergirding concepts for students to be successful in accounting and have been included for years in undergraduate education (Brown, 1962; Collier & McGowan, 1989).

Data analytics, one of the most important driving forces that shape the accounting profession today, enables accountants to help businesses better identify issues proactively, gain greater insights, predict future outcome, transform decision making, improve efficiency, and manage risks. Newly licensed CPAs are required to have deeper data analytics skills (Tschakert et al. 2016). Nonetheless, according to an Accounting Program Curriculum Gap Survey conducted by the AICPA and NASBA, more data analytics training is demanded for accounting students (AICPA and NASBA, 2021). A high level of mathematical ability is one of the key skills data analytics requires (Davenport, 2012). Incorporating data analytics training into the accounting curriculum might make mathematics skills more necessary.

However, to better prepare students for accounting courses, the role of mathematics in accounting learning deserves a deeper investigation. Even though colleges seem to assume that a certain level of mathematics preparation is needed for accounting courses, it remains unclear how students think about mathematics' role in accounting learning. Do college accounting students' attitudes about mathematics change as they progress? Do their beliefs about the role of mathematics in accounting learning change as they progress? Does the relation between students' attitudes and beliefs about mathematics and accounting performance change as they progress?

In this study, we seek to address some of the above-mentioned questions. Using survey data from a four-year college in the United States, we examine whether students' attitudes and beliefs about mathematics differ among sophomore, junior, and senior grades. We find that seniors tend to have more positive attitudes toward mathematics on average than sophomores and juniors. While more positive attitudes toward mathematics have been observed from students with better accounting performance, a negative relation is associated with students in the bottom 25 percentile of accounting grades. There is no significant difference in students' beliefs in mathematics among various college standing groups. Prior research documents that students' attitudes toward mathematics are positively related to students' achievement in mathematics application. Since accounting learning requires an application of a large amount of mathematics knowledge and skills in real-world contexts, our study suggests that an emphasis on accounting problem solving using mathematics knowledge and skills might positively raise students' attitudes toward mathematics. Given the association between students' attitudes toward mathematics and students' achievement in mathematics application, as well as the application nature of data analytics, our results imply that incorporating data analytics training into accounting curriculum could potentially improve students' attitudes toward mathematics, which might in turn help students perform better in a data heavy accounting program.

2. Literature Review and Hypotheses Development

Researchers have investigated how various factors may affect students' accounting learning. These factors include, but are not limited to, gender, Grade Point Average (GPA), American College Testing (ACT), and multiple aspects of their mathematics backgrounds. Multiple studies (Dockweiler & Willis, 1984; Fedoryshyn et al., 2010; Gist et al., 1996; Ingrain & Petersen, 1987; Phillips, 2015) find that students' GPA is a positive predictor for their accounting learning. Dockweiler and Willis (1984) state that a student's GPA is the single best factor for predicting success in future coursework. Some studies document that students who have high standardized test scores (such as ACT and SAT) are more likely to succeed in their accounting courses (Booker, 1991; Doran & Bouillon, 1991; Du et al., 2019; Fedoryshyn et al., 2010).

However, when it comes to students' mathematical background's role in their accounting learning, there are different findings, and some with opposite conclusions. On one side, various studies claim that students' mathematics backgrounds cannot predict their performance in accounting courses. For example, Burdick and Schwartz (1982) document that a student's performance in mathematics courses (including algebra and calculus) cannot significantly predict a student's performance in accounting courses. According to Fedoryshyn et al. (2010), students' arithmetic reasoning skills do not predict a major portion of the average final grades in accounting courses. Naser and Peel (1998) find that gender, age, and school English and mathematics grades, together with the type of school (public/private) attended, did not significantly impact student performance in the Principles of Accounting course. In another study (Barnes et al., 2009), research results indicate that students' performance in grade 12 mathematics was not significantly correlated to performance in Financial Accounting. Even though these studies do not find a positive relationship between students' mathematics background and their accounting learning, none of them find a negative relationship between them. That suggests a strong mathematics background at least will not hurt students' accounting learning.

Alternatively, many other studies report a positive relationship between students' mathematics background and their accounting learning. According to Gist et al. (1996), a B or better performance in a Calculus class is critically related to the successful performance of Black students in accounting coursework. According to Yunker, Yunker, and Krull (2009), there is an incremental effect of mathematics ability on student performance in Principles of Accounting. The studies conducted by Clark and Sweeney (1985) and Collier and McGowan (1989) show that students' mathematics preparation is positively linked to accounting coursework performance. Clark and Sweeney (1985) claim that college mathematics grades are a good predictor of success in accounting. Collier and McGowan (1989) conclude that students with higher performance in mathematics are more likely to succeed in intermediate financial accounting courses. Similarly, Uyar and Güngörmüş' (2011) research suggests that math grade is significantly and positively related to student performance in financial accounting courses.

Students' attitudes toward mathematics and their beliefs about mathematics play an important role in their mathematics learning. According to Mohamed and Waheed (2011), "Attitude is a central part of human identity. Everyday people love, hate, dislike, favor, oppose, agree, disagree, argue, persuade etc. All these are evaluative responses to an object." Hence, in this study we define students' attitude toward mathematics as summary evaluative responses to the subject of mathematics. We used a survey to evaluate students' attitudes toward mathematics, including questions such as "I like mathematics," and "Mathematics is interesting to me." Students' belief about mathematics is defined as students' perception on a subject that they know (Papanastasiou, 2000). Questions such as "Mathematics is important for accounting learning" and "My previous knowledge of mathematics helps me to learn accounting" are included in the survey.

Numerous studies have found that there is a positive relationship between students' attitude toward mathematics and their mathematics achievement (Ma & Kishor, 1997; Norhatta Mohd, 2011; Papanastasiou, 2000). Multiple researchers conclude that students with average and high levels of mathematics beliefs tend to perform better than students who have low levels of mathematics beliefs (House, 2006; Kloosterman & Cougan, 1994). Yet, these studies usually focus on the learning of mathematics.

There exists a lack of literature to examine how students' attitudes toward mathematics and students' beliefs about mathematics play a role in their other areas of study, including those subjects that require a high level of quantitative skills, such as accounting. Shotwell (1999), one of the few researchers that have investigated accounting, examines business and non-business students' performance in financial accounting and analyzes students' attitudes toward mathematics. The study reports that

> "…thirty-seven percent (37%) of business students and thirty-one percent (31%) of non-business students surveyed indicate that mathematics is one of their favorite subjects. Twenty-seven percent (27%) and 23%, respectively, report that they perform well in courses that have math. However, 22% and 23%, respectively, respond that math is their least favored subject, and 10% and 12%, respectively, claim that math intimidates them and that they try to avoid the subject." (p. 181)

The results suggest that business and non-business students' attitudes toward mathematics indeed vary. Since mathematics skills are necessary in studying many other subjects, there is a need for more studies to examine students' attitude toward mathematics when they apply mathematics under other contexts.

Du et al. (2019) find that students believe that being good at mathematics is a necessary, but not sufficient, condition for performing well in accounting learning. They also document that students who perform well in accounting courses also hold relatively positive attitudes toward mathematics (Du et al. 2019). However, students' attitudes and beliefs may change over time because they are influenced by external factors, such as achievement, motivation, peers, instructors, etc. (George, 2000). Many students tend to have negative attitudes and beliefs about mathematics (Department for Education and Child Development, 2017). By using longitudinal data, Wilkins and Ma (2010) find a substantial negative change in students' attitudes toward mathematics and their beliefs about the social importance of mathematics throughout secondary school. Educators and governments have been trying to find ways to help students develop a positive attitude toward mathematics (Northwest, 2017; Yusof & Tall, 1998). Yusof and Tall (1998) apply problem solving strategies in students' mathematics learning and successfully help students develop positive attitudes toward mathematics.

This paper aims to enrich the literature with an exploration of the relation between students' attitudes and beliefs about mathematics and accounting learning. Students may develop more positive attitudes and beliefs about mathematics as they need to use mathematics to solve realistic problems, such as accounting. Current literature is silent on whether students' attitudes and beliefs about mathematics differ among various college year groups. Therefore, we propose the following hypotheses:

H1a: On average, junior accounting students have more positive attitudes toward mathematics than sophomore accounting students.
H1b: On average, senior accounting students have more positive attitudes toward mathematics than junior accounting students.
H1c: On average, senior accounting students have more positive attitudes toward mathematics than sophomore accounting students.
H2a: On average, junior accounting students have more positive beliefs about the role of mathematics in accounting learning than sophomore accounting students.
H2b: On average, senior accounting students have more positive beliefs about the role of mathematics in accounting learning than junior accounting students.
H2c: On average, senior accounting students have more positive beliefs about the role of mathematics in accounting learning than sophomore accounting students.
H3a: On average, the relation between students' attitudes toward mathematics and accounting performance is more positive among junior accounting students than that among sophomore accounting students.
H3b: On average, the relation between students' attitudes toward mathematics and accounting performance is more positive among senior accounting students than that among junior accounting students.
H3c: On average, the relation between students' attitudes toward mathematics and accounting performance is more positive among senior accounting students than that among sophomore accounting students.
H4a: On average, the relation between students' beliefs about mathematics and accounting performance is more positive among junior accounting students than that among sophomore accounting students.
H4b: On average, the relation between students' beliefs about mathematics and accounting performance is more positive among senior accounting students than that among junior accounting students.
H4c: On average, the relation between students' beliefs about mathematics and accounting performance is more positive among senior accounting students than that among sophomore accounting students.

3. Data and Research Method

3.1 Data Collection

This study aims to investigate how students' attitudes and beliefs about mathematics differ among sophomore, junior, and senior accounting students. We also explore how the relations between attitudes and beliefs about mathematics and accounting performance differ among sophomore, junior, and senior accounting students. To

answer these questions, we collect accounting students' ACT math scores, accounting final grades, and an attitudes and beliefs survey. According to previous studies (Gist et al., 1996; Yunker et al., 2009), students' performance in mathematics is positively linked to students' accounting learning. Also, students' attitudes and beliefs about mathematics affect their mathematics achievement (House, 2006; Kloosterman & Cougan, 1994; Ma & Kishor, 1997). Thus, to better understand how students' attitudes and beliefs about mathematics affect their accounting courses learning, it is reasonable to include a variable regarding students' performance in mathematics. And we believe that students' ACT math scores serve this purpose well.

In this study, ACT math scores are collected from the registrar's office. Since most of the students in this study take the ACT, instead of the SAT, we convert SAT math scores to ACT math scores using ACT-SAT Concordance Tables if a student only has an SAT math score (The College Board and ACT, 2018). To measure students' accounting performance, final grades are collected from accounting course instructors at the end of each semester. Nine accounting courses included in this study are Introductory Financial Accounting, Introductory Managerial Accounting, Intermediate Financial Accounting I, Intermediate Financial Accounting II, Accounting Information Systems, Auditing, Individual Income Taxes, Business Income Taxes, and Advanced Accounting. Students are assigned to sophomore, junior, and senior groups according to their college standing. We conduct an attitudes and beliefs survey online using Qualtrics. Figures 1 and 2 provide attitudes and beliefs measures used in this survey. The survey is sent out to students enrolled in any accounting courses listed above. Students' attitudes toward mathematics are measured by 14 questions, such as, "I like mathematics," and "I think mathematics is useful." Students' beliefs about the usefulness of mathematics are measured by six questions, such as, "Mathematics is important for accounting learning" and "My previous knowledge of mathematics helps me to learn accounting." Several questions in the survey are from or adapted from the Attitudes Toward Mathematics Inventory (ATMI) (Tapia, 1996). Other questions are developed by the authors.

3.2 Sample

We collect data from a four-year college in the United States. A total of 1,406 attitudes and beliefs surveys are sent to students who enrolled in Introductory Financial Accounting, Introductory Managerial Accounting, Intermediate Financial Accounting I, Intermediate Financial Accounting II, Accounting Information Systems, Auditing, Individual Income Taxes, Business Income Taxes, or Advanced Accounting. Introductory Financial Accounting and Introductory Managerial Accounting are open to sophomores, while Intermediate Financial Accounting I & II, Individual Income Taxes, and Business Income Taxes are open to juniors. Accounting students take Advanced Accounting in their senior year. We receive 1,022 complete surveys. The response rate is 72.7%[1].

3.3 Research Method

T-tests are chosen to address our hypotheses 1 and 2. We divide the sample based on their college standing: sophomore, junior, and senior. We intend to compare students' attitudes and beliefs about mathematics among different college standing groups to see if there is any difference among sophomore, junior, and senior accounting students. We also apply the quartile method to ACT math score, as well as accounting grade, to compare the top 25% of the sample with the bottom 25% of the sample to see if there is any difference in students' attitudes and beliefs about mathematics between the two groups.

Multiple regressions are employed in this study. We adopt Model 1 as a robustness check for the t-tests above.
Model 1:

$$Attitudes/Beliefs\ Measure = college_{standing} + final_{grade} + ACT_{math} + gender + major + accthighschool + instructor + cohort$$

Next, we use Model 2 to test hypotheses 3 and 4. We aim to investigate how the relations between attitudes and beliefs about mathematics and accounting performance differ among sophomores, juniors, and seniors. Accounting final grade is the dependent variable. Independent variables in the model are attitudes and beliefs. We control for ACT math, gender, major, college standing, whether they had any accounting in high school, instructor, and cohort.
Model 2:

[1] The students were offered extra credit for participating in the survey. Students who chose not to participate in the survey were offered alternative extra credit assignments.

$$final_{grade} = ACT_{math} + attitudes_{mean} + beliefs_{mean} + college_{standing} + attitudes_{mean} \times college_{standing} + beliefs_{mean} \times college_{standing} + gender + major + accthighschool + instructor + cohort$$

Where *Attitudes/Beliefs Measure* is attitudes or beliefs mean calculated based on responses to the attitudes and beliefs survey; *final_grade* is accounting final grade; *ACT math* is the math score of the ACT test; *college_standing* is a category variable that takes sophomore, junior or senior; *accthighschool* is a category variable that takes 1 when a student has had any accounting in high school; otherwise, it takes 0. Instructor and cohort are treated as factor variables.

4. Results

4.1 Descriptive Statistics

The descriptive statistics of the sample are shown in Table 1. Since the introductory financial accounting course is open to non-accounting majors, there are only 298 (29.2%) accounting major students in the sample. The other students are from business administration (34.9%), economics (3.2%), and non-business majors (32.7%). The gender ratio is close to 1. About 26% of the student participants transferred from other institutions. Sophomores account for 74% of the sample, followed by juniors (24%) and seniors (2%). About a third of the participants report that they have taken some accounting in high school. Among the 298 accounting majors, there are 70 (23.5%) sophomores, 203 juniors (68.1%), and 25 seniors (8.4%). Female students account for 43% and male students account for 57%. About 31% of the accounting major sample transferred from other institutions, and 48% report that they have taken some accounting in high school. Table 2 reports the descriptive statistics for accounting grade and ACT math score. The average accounting final grade is 83.10 and the average ACT math score is 23.04. Table 3 and Table 4 provide the descriptive statistics for attitudes and beliefs measures. To keep all the measures consistent in t-tests and regression analysis, we then reverse code the negative questions, which are the last four attitudes measures and the last two belief measures.

4.2 T-tests

Du et al. (2019) investigate the association between accounting students' attitudes toward mathematics and the students' accounting final grades. Our results, with a larger sample, confirm their findings that students performing better in accounting tend to have more positive attitudes toward math. Table 5 and Table 6 provides the t-tests results. The average attitudes score is 3.26 for students in the bottom 25% accounting grade group, while the average attitudes score is 3.98 for students in the top 25% accounting grade group. The mean difference is statistically significant at 0.01 level. Besides accounting grades, we also examine the students' attitudes toward mathematics and their ACT math scores. The mean difference between the ACT math 1st quartile group (2.93) and 4th quartile group (4.11) is even larger and statistically significant at 0.01 level. Figure 3 presents the boxplot for attitudes toward math by accounting grade quartiles, while Figure 4 presents the boxplot for attitudes toward math by ACT math quartiles.

We further examine whether there is any difference in students' attitudes toward mathematics among sophomore, junior, and senior students. The attitudes mean differences between sophomores (3.41) and juniors (4.13), between sophomores (3.41) and seniors (4.48), as well as between juniors (4.13) and seniors (4.48) are all statistically significant at 0.01 level. Hence, H1a, H1b, and H1c are supported. Figure 5 presents the boxplot for attitudes toward mathematics by college year. We next focus on each accounting grade quartile group individually. We observe a higher mean attitudes score within the 1st quartile accounting grade group among juniors than that among sophomores. However, seniors report a lower mean attitudes score within the 1st quartile accounting grade group than juniors. The attitudes mean difference between sophomores (3.43) and juniors (3.70) as well as the difference between juniors (3.70) and seniors (3.39) in the 1st quartile accounting grade group are both statistically significant at 0.01 level. The attitudes mean difference between sophomores (3.52) and juniors (3.99) in the 4th quartile accounting grade group is statistically significant at 0.01 level. The attitudes mean difference between sophomores (3.52) and seniors (4.00) in the 4th quartile accounting grade group is statistically significant at 0.01 level. These results indicate that, on average, seniors tend to have more positive attitudes toward mathematics than juniors and sophomores and more positive attitudes toward mathematics have been observed from the students with better accounting performance.

We next examine beliefs mean differences with ACT math quartiles, accounting grade quartiles, and college standing. The beliefs mean differences are not significant between any groups compared. Hence, H2a, H2b, and

H2c are not supported. Figures 6, 7, and 8 present the boxplots for grouping beliefs by accounting grade quartile, ACT math quartile, and college year, respectively.

4.3 Correlation

As shown in Table 7 and Table 8, ACT math score (0.34) and attitudes mean (0.28) are both positively associated with accounting final grade. Beliefs mean, however, has a relatively weak correlation with accounting grade (0.03) and ACT math score (-0.01). Among the 14 attitudes measures, the reverse coding of "Mathematics is a very difficult subject for me" (0.32) has the highest positive correlation with accounting grade. Attitudes mean (0.48) is also positively correlated with ACT math score. There is a positive association between belief measure "My previous knowledge of mathematics helps me to learn accounting" and accounting grade (0.16), while there is a negative association between belief measure "If a student is not doing well in accounting, that is because that student is not good at mathematics" and accounting grade (-0.14). The results suggest that while students believe that mathematics is a necessary condition for accounting learning, they do not consider mathematics a sufficient condition for accounting learning, which confirms Du et al.'s (2019) findings.

4.4 Multiple Regression

We conduct multiple regressions with attitudes and beliefs toward mathematics as a robustness check to our t-test results. As shown in Table 9 column (1), the coefficient for being a sophomore student is -0.253 and is significant at 0.01 level. This suggests that compared with junior students, sophomore students tend to have a lower attitudes mean toward math, which confirms our results from the t-tests above. Besides examining the attitudes mean, we also include several individual attitudes measures that have relatively high correlations with accounting grade. In Table 9 columns (3), (4), and (5), negative coefficients for sophomores are observed for "I like mathematics" (-0.404), "Mathematics is one of my favorite subjects" (-0.450), and the reverse measure of, "Mathematics is a very difficult subject for me" (-0.291), which are significant at 0.01, 0.01, and 0.05 levels respectively. These results suggest that seniors have a more positive attitude toward mathematics than juniors and sophomores and believe mathematics is getter easier for them.

No significant results on college standing are reported from regression models with belief measures as dependent variables, which indicates that students' beliefs about mathematics tend not to differ significantly among sophomores, juniors, and seniors. The results are consistent with the t-tests above.

As presented in Table 10, no significant results are reported for the interaction term between attitudes mean and college standing, nor for the interaction term between beliefs mean and college standing in Model 8. These results show that the relation between their attitudes and beliefs and accounting performance does not differ significantly among sophomores, juniors, and seniors. Therefore, hypotheses 3 and 4 are not supported.

5. Conclusion and Discussion

Using survey data, we examine whether students' attitudes and beliefs about mathematics differ among sophomore, junior, and senior accounting students. We find that compared with students having lower ACT math scores, students having higher ACT math scores hold more positive attitudes toward mathematics and on average perform better in accounting. Seniors tend to have more positive attitudes toward mathematics than juniors and sophomores on average. While more positive attitudes toward mathematics have been observed from the students with better accounting performance, a negative relation is associated with students in the bottom 25% of accounting grade. Seniors agree more than juniors and sophomores that mathematics is easy for them. While students believe that mathematics is a necessary condition for accounting learning, they do not believe that being poor at mathematics is the reason for not doing well in accounting. Students' beliefs about mathematics do not differ significantly among sophomore, junior, and senior accounting students. No significant results are reported to support that relations between attitudes and beliefs about mathematics and accounting performance differ among sophomore, junior, and senior accounting students.

For years, educators have been trying to raise students' attitudes toward mathematics, as these attitudes have been found positively related to students' mathematics achievement (Ma & Kishor, 1997; Mohd, Mahmood, & Ismail, 2011; Papanastasiou, 2000). Some researchers (Yusof & Tall, 1998) use problem solving strategies in students' mathematics learning and have successfully helped students develop positive attitudes toward mathematics in this way. Considering accounting learning requires an application of a large amount of

mathematics knowledge and skills in real-world contexts, our study suggests that an emphasis on problem solving might positively raise students' attitudes toward mathematics. Also, as students who are in the bottom 25% percentile of accounting grade develop negative attitudes toward mathematics, this may be because they do not see the value of mathematics in the application of accounting learning. Their lower attitude may at least partially explain their relatively lower grades in accounting. Educators may want to raise the awareness of the importance of the application aspect of mathematics in accounting and thus improve students' attitude toward mathematics. Furthermore, high school students could be encouraged to take accounting as a way of improving their attitude toward mathematics by seeing its usefulness in realistic accounting applications. As far as college education, given the association between students' attitudes toward mathematics and students' achievement in mathematics application, as well as the application nature of data analytics, our results imply that incorporating data analytics training into accounting curriculum, with emphases on the application of mathematics and analytical skills, could potentially improve students' attitudes toward mathematics, which might in turn help students perform better in a data heavy accounting program.

Since this study is conducted within only one institution and the sample size is relatively small, expanding this research to other institutions would help in generalizing the findings to a broader audience. Moreover, survivorship bias cannot be ruled out in current results and collecting data in more semesters and tracking the changes of the attitudes and beliefs about mathematics from the same group of students at different time spots would provide more insights and may eliminate the survivorship effect.

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Appendix

Figure 1 Attitudes Measures

	1 Strongly disagree	2 Somewhat disagree	3 Neither agree nor disagree	4 Somewhat agree	5 Strongly agree
1. I like mathematics	○	○	○	○	○
2. Mathematics is one of my favorite subjects	○	○	○	○	○
3. Usually, I do very well in mathematics	○	○	○	○	○
4. I always enjoy mathematics classes	○	○	○	○	○
5. I consider mathematics is important in my life	○	○	○	○	○
6. I think mathematics is useful	○	○	○	○	○
7. Mathematics is interesting to me	○	○	○	○	○
8. Generally speaking, mathematics is easy for me	○	○	○	○	○
9. Mathematics is a very difficult subject for me	○	○	○	○	○
10. If possible, I want to avoid any mathematics classes	○	○	○	○	○
11. I am always nervous about mathematics	○	○	○	○	○
12. I am always nervous about courses related to mathematics	○	○	○	○	○
13. I don't consider myself as a math person	○	○	○	○	○
14. I don't think I need much mathematics in my life	○	○	○	○	○

Figure 2 Beliefs Measures

	1	2	3	4	5
	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
1. Mathematics is important for accounting learning	○	○	○	○	○
2. My previous knowledge of mathematics helps me to learn accounting	○	○	○	○	○
3. If I have better mathematics ability, it would be helpful to my accounting learning	○	○	○	○	○
4. If a student is not doing well in accounting, that is because that student is not good at mathematics.	○	○	○	○	○
5. I don't think I need much mathematics in accounting	○	○	○	○	○
6. I think mathematics doesn't matter in accounting	○	○	○	○	○

Figure 3 Boxplot for Attitudes toward Mathematics by Accounting Grade Quartile

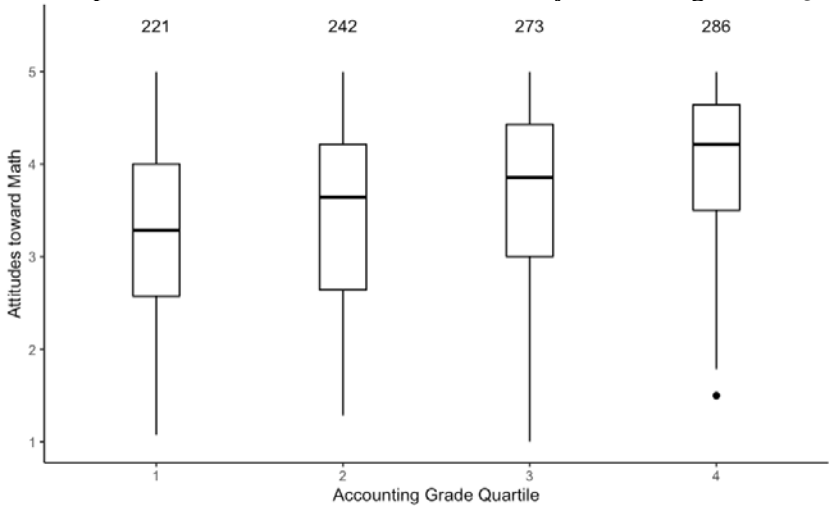

Figure 4 Boxplot for Attitudes toward Mathematics by ACT Math Quartile

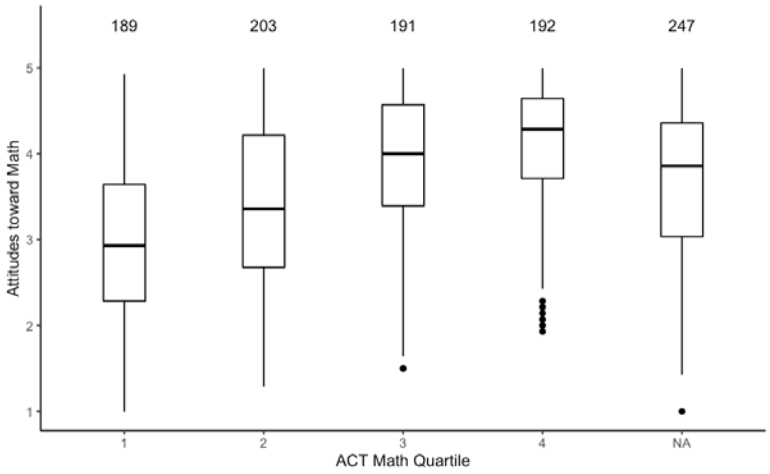

Figure 5 Boxplot for Attitudes toward Mathematics by College Year

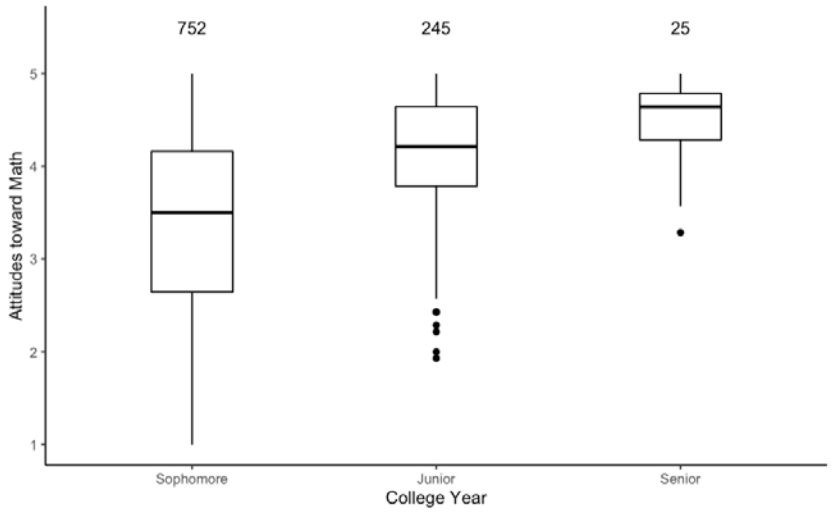

Figure 6 Boxplot for Beliefs about Mathematics by Accounting Grade Quartile

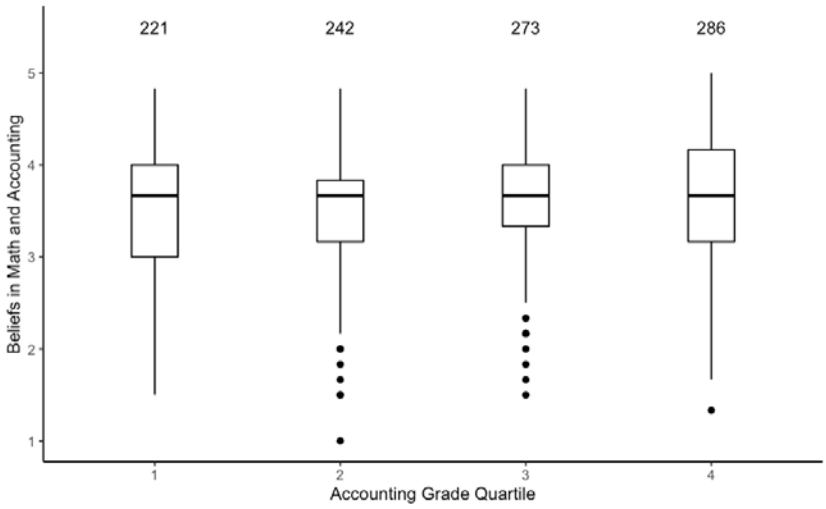

Figure 7 Boxplot for Beliefs about Mathematics by ACT Math Quartile

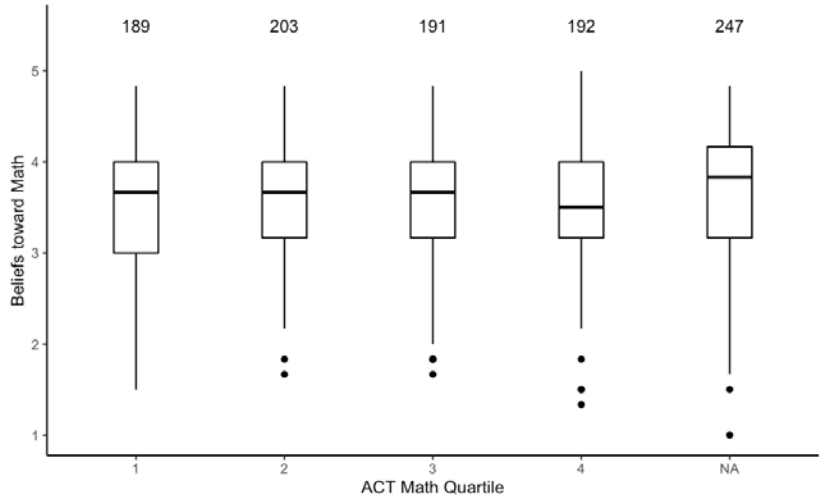

Figure 8 Boxplot for Beliefs about Mathematics by College Year

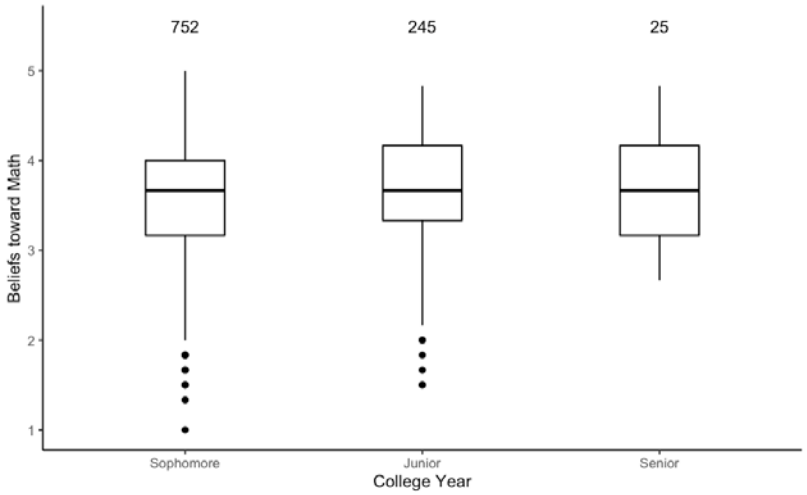

Table 1 Sample Descriptive Statistics

Panel A All Majors			
Total Count = 1,022		Count	Percentage
Major	Accounting	298	29%
	Business Administration	357	35%
	Economics	33	3%
	Non-Economics	334	33%
Gender	Female	497	49%
	Male	525	51%
Transfer	Yes	265	26%
	No	757	74%
College Standing	Sophomore	752	74%
	Junior	245	24%
	Senior	25	2%
Took Accounting in High School	Yes	325	32%
	No	697	68%
Panel B Accounting Major			
Total Count = 298		Count	Percentage
Gender	Female	128	43%
	Male	170	57%
Transfer	Yes	93	31%
	No	205	69%
College Standing	Sophomore	70	23%
	Junior	203	68%
	Senior	25	8%
Took Accounting in High School	Yes	143	48%
	No	155	52%

Table 2 Accounting Grade ACT Math Descriptive Statistics

Statistic	N	Mean	St. Dev.	Min	25%	75%	Max
Final Grade	1,022	83.10	10.71	31	76.5	91.2	100
ACT math	775	23.04	4	13	20	26	36

Table 3 Descriptive Statistics for Attitudes toward Math

Attitudes Measure	N	Mean	St. Dev.	Min	25%	75%	Max
I like mathematics	1,022	3.65	1.22	1	3	5	5
Mathematics is one of my favorite subjects	1,022	3.28	1.39	1	2	4	5
Usually, I do very well in mathematics	1,022	3.87	1.10	1	3	5	5
I always enjoy mathematics classes	1,022	3.29	1.23	1	2	4	5
I consider mathematics is important in my life	1,022	3.83	1.01	1	3	5	5
I think mathematics is useful	1,022	4.29	0.79	1	4	5	5
Mathematics is interesting to me	1,022	3.58	1.18	1	3	4	5
Generally speaking, mathematics is easy for me	1,022	3.45	1.19	1	3	4	5
Mathematics is a very difficult subject for me	1,022	2.43	1.25	1	1	3	5
If possible, I want to avoid any mathematics classes	1,022	2.65	1.31	1	2	4	5
I am always nervous about mathematics	1,022	2.55	1.29	1	1	4	5
I am always nervous about courses related to mathematics	1,022	2.45	1.27	1	1	3	5
I don’t consider myself as a math person	1,022	2.66	1.38	1	1	4	5
I don’t think I need much mathematics in my life	1,022	1.96	0.99	1	1	2	5

Table 4 Descriptive Statistics for Beliefs in Math

Beliefs Measure	N	Mean	St. Dev.	Min	25%	75%	Max
Mathematics is important for accounting learning	1,022	4.19	0.80	1	4	5	5
My previous knowledge of mathematics helps me to learn accounting	1,022	3.78	1.01	1	3	4	5
If I have better mathematics ability, it would be helpful to my accounting learning	1,022	3.61	1.08	1	3	4	5
If a student is not doing well in accounting, that is because that student is not good at mathematics	1,022	2.08	0.98	1	1	3	5
I don't think I need much mathematics in accounting	1,022	2.38	1.02	1	2	3	5
I think mathematics doesn't matter in accounting	1,022	1.91	0.90	1	1	2	5

Table 5 T-tests Results for Attitudes Mean

	Mean 1	Mean 2	Mean Difference	t	p value	df
Female vs Male	3.53	3.68	-0.14	-2.43	0.02	1003
Accounting vs Business Administration	4.18	3.33	0.84	13.84	0.00	644
Took High School Accounting vs Not	3.75	3.55	0.20	3.22	0.00	664
Grade Quartile 1st Q vs 4th Q	3.26	3.98	-0.71	-9.08	0.00	445
ACT Quartile 1st Q vs 4th Q	2.93	4.11	-1.19	-14.29	0.00	347
Sophomore vs Junior	3.41	4.13	-0.72	-12.85	0.00	594
Sophomore vs Senior	3.41	4.48	-1.07	-10.66	0.00	31
Junior vs Senior	4.13	4.48	-0.35	-3.43	0.00	35

Table 6 T-tests Results for Attitudes Mean Difference

	Mean 1	Mean 2	Mean Difference	t	p value	df
Grade Quartile 1st Q Sophomores vs Juniors	3.43	3.70	-0.27	-4.74	0.00	901
Grade Quartile 4th Q Sophomores vs Juniors	3.52	3.99	-0.47	-9.43	0.00	1059
Grade Quartile 1st Q Sophomores vs Seniors	3.43	3.39	0.05	0.70	0.48	409
Grade Quartile 4th Q Sophomores vs Seniors	3.52	4.00	-0.49	-8.51	0.00	641
Grade Quartile 1st Q Juniors vs Seniors	3.70	3.39	0.32	4.17	0.00	497
Grade Quartile 4th Q Juniors vs Seniors	3.99	4.00	-0.01	-0.22	0.83	641

Table 7 Attitudes Correlation Table

	Accounting Grade	ACT Math	Attitudes Mean	a1	a2	a3	a4	a5	a6	a7	a8	a9	a10	a11	a12	a13
Accounting Grade																
ACT Math	0.34***															
Attitudes Mean	0.28***	0.48***														
a1	0.29***	0.41***	0.89***													
a2	0.29***	0.40***	0.89***	0.87***												
a3	0.23***	0.49***	0.82***	0.72***	0.70***											
a4	0.20***	0.35***	0.85***	0.80***	0.83***	0.71***										
a5	0.16***	0.26***	0.64***	0.53***	0.52***	0.45***	0.51***									
a6	0.14***	0.27***	0.53***	0.43***	0.40***	0.40***	0.39***	0.62***								
a7	0.22***	0.37***	0.83***	0.79***	0.78***	0.64***	0.74***	0.56***	0.48***							
a8	0.23***	0.51***	0.85***	0.73***	0.72***	0.80***	0.70***	0.46***	0.38***	0.65***						
a9	0.32***	0.49***	0.83***	0.70***	0.67***	0.72***	0.63***	0.40***	0.31***	0.61***	0.81***					
a10	0.23***	0.32***	0.85***	0.73***	0.75***	0.61***	0.72***	0.48***	0.36***	0.68***	0.64***	0.68***				
a11	0.21***	0.39***	0.84***	0.67***	0.68***	0.64***	0.65***	0.40***	0.30***	0.59***	0.71***	0.76***	0.75***			
a12	0.22***	0.39***	0.83***	0.66***	0.67***	0.64***	0.64***	0.41***	0.31***	0.56***	0.69***	0.74***	0.72***	0.90***		
a13	0.26***	0.41***	0.86***	0.74***	0.76***	0.68***	0.69***	0.46***	0.36***	0.68***	0.72***	0.73***	0.73***	0.74***	0.72***	
a14	0.18***	0.26***	0.60***	0.49***	0.45***	0.37***	0.41***	0.57***	0.57***	0.50***	0.37***	0.41***	0.49***	0.42***	0.41***	0.48***

Table 8 Beliefs Correlation Table

	Accounting Grade	ACT Math	Attitudes Mean	Beliefs 1	Beliefs 2	Beliefs 3	Beliefs 4	Beliefs 5
Accounting Grade								
ACT Math	0.34***							
Beliefs Mean	0.03	-0.01						
Beliefs 1	0.04	0.02	0.75***					
Beliefs 2	0.16***	0.07*	0.75***	0.60***				
Beliefs 3	0.01	-0.05	0.80***	0.54***	0.58***			
Beliefs 4	-0.14***	-0.19***	0.42***	0.14***	0.15***	0.34***		
Beliefs 5	0.01	0.01	0.75***	0.47***	0.40***	0.47***	0.11**	
Beliefs 6	0.05	0.09*	0.68***	0.48***	0.42***	0.35***	-0.01	0.67***

Table 9 Attitudes Regression Results

	Dependent variable:						
	Attitudes Mean	Beliefs Mean	Attitudes 1	Attitudes 2	Attitudes 9	Beliefs 2	Beliefs 4
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
college_standing Senior	0.196	-0.123	0.153	0.083	0.468	-0.044	0.023
	(0.217)	(0.184)	(0.297)	(0.332)	(0.292)	(0.271)	(0.253)
college_standing Sophomore	-0.253**	0.008	-0.404***	-0.450***	-0.291**	0.015	0.036
	(0.100)	(0.084)	(0.136)	(0.152)	(0.134)	(0.124)	(0.116)
final_grade	0.008**	0.001	0.006	0.008*	0.010**	0.013***	-0.005
	(0.003)	(0.003)	(0.004)	(0.005)	(0.004)	(0.004)	(0.003)
ACT_math	0.093***	-0.003	0.107***	0.115***	0.130***	0.006	-0.031***
	(0.008)	(0.007)	(0.011)	(0.012)	(0.010)	(0.010)	(0.009)
gender Male	0.063	-0.002	-0.003	0.126	0.045	-0.022	0.050
	(0.059)	(0.050)	(0.081)	(0.090)	(0.079)	(0.073)	(0.069)
major Business Administration	-0.506***	-0.150*	-0.478***	-0.705***	-0.443***	-0.220*	0.072
	(0.096)	(0.081)	(0.131)	(0.146)	(0.128)	(0.119)	(0.111)
major Economics	-0.234	-0.320*	-0.202	-0.311	-0.036	-0.295	-0.465**
	(0.198)	(0.167)	(0.270)	(0.302)	(0.266)	(0.246)	(0.230)
major Non-business	-0.498***	-0.165*	-0.519***	-0.789***	-0.335**	-0.273**	0.121
	(0.102)	(0.086)	(0.139)	(0.155)	(0.137)	(0.127)	(0.118)
accthighschool Yes	0.010	-0.074	0.088	0.039	0.064	-0.019	-0.139*
	(0.062)	(0.052)	(0.085)	(0.095)	(0.083)	(0.077)	(0.072)
Constant	1.455***	3.794***	1.125**	0.671	0.688	3.133***	2.359***
	(0.377)	(0.319)	(0.515)	(0.576)	(0.506)	(0.470)	(0.438)
Observations	775	775	775	775	775	775	775
R^2	0.355	0.037	0.276	0.296	0.327	0.055	0.110
Adjusted R^2	0.337	0.010	0.256	0.277	0.308	0.029	0.086
Residual Std. Error (df = 753)	0.783	0.663	1.071	1.196	1.053	0.976	0.911
F Statistic (df = 21; 753)	19.745***	1.363	13.678***	15.088***	17.404***	2.103***	4.450***

Note 1: *p<0.1; **p<0.05; ***p<0.01
Note 2: Attitudes 1: I like mathematics; Attitudes 2, Mathematics is one of my favorite subjects; Attitudes 9: Mathematics is a very difficult subject for me.
Note 3: Beliefs 2: My previous knowledge of mathematics helps me to learn accounting; Beliefs 4: If I have better mathematics ability, it would be helpful to my accounting learning.
Note 4: accthighschool: whether a student has taken any accounting courses in high school.

Table 10 Final Grade Regression Results

	Dependent variable: Final Grade				
	(8)	(9)	(10)	(11)	(12)
ACT_math	0.757***	0.761***	0.893***	0.895***	0.761***
	(0.105)	(0.104)	(0.094)	(0.094)	(0.105)
college_standing Senior	-0.794	12.074	-0.478	-8.718	-3.596
	(2.510)	(22.310)	(2.519)	(15.743)	(28.596)
college_standing Sophomore	1.656	9.395*	1.349	8.027*	12.092**
	(1.182)	(5.017)	(1.183)	(4.809)	(6.055)
attitudes_mean:college_standing Senior		-3.002			-2.197
		(4.934)			(4.988)
attitudes_mean:college_standing Sophomore		-1.912			-1.642
		(1.206)			(1.273)
beliefs_mean:college_standing Senior				2.382	3.481
				(4.433)	(4.466)
beliefs_mean:college_standing Sophomore				-1.851	-1.050
				(1.292)	(1.353)
attitudes_mean	1.333***	3.004***			2.759**
	(0.471)	(1.141)			(1.219)
beliefs_mean	0.071		0.350	1.688	0.709
	(0.556)		(0.550)	(1.123)	(1.194)
gender Male	-2.021***	-1.937***	-1.952***	-1.955***	-1.955***
	(0.744)	(0.746)	(0.747)	(0.747)	(0.747)
major Business Administration	-3.300***	-3.304***	-3.971***	-4.062***	-3.369***
	(1.231)	(1.230)	(1.214)	(1.214)	(1.234)
major Economics	-1.754	-1.788	-2.143	-2.422	-1.964
	(2.268)	(2.258)	(2.274)	(2.280)	(2.276)
major Non-business	-4.382***	-4.413***	-5.052***	-5.140***	-4.474***
	(1.282)	(1.280)	(1.266)	(1.267)	(1.284)
accthighschool Yes	0.583	0.638	0.619	0.625	0.638
	(0.794)	(0.794)	(0.797)	(0.797)	(0.795)
Constant	62.540***	55.749***	63.867***	59.044***	54.229***
	(3.207)	(5.100)	(3.187)	(4.769)	(5.800)
Observations	775	775	775	775	775
R^2	0.156	0.159	0.148	0.151	0.161
Adjusted R^2	0.145	0.147	0.138	0.138	0.146
Residual Std. Error	10.065 (df = 764)	10.055 (df = 763)	10.111 (df = 765)	10.106 (df = 763)	10.064 (df = 760)
F Statistic	14.161*** (df = 10; 764)	13.134*** (df = 11; 763)	14.712*** (df = 9; 765)	12.306*** (df = 11; 763)	10.414*** (df = 14; 760)

Note 1: *p<0.1; **p<0.05; ***p<0.01

Note 2: accthighschool: whether a student has taken any accounting courses in high school.

Attitudes and Beliefs Survey

What is your student ID number?

_____

What is your name?

O First Name _____

O Last Name _____

What is your age?

_____

What is your gender?

O Male

O Female

O Gender identity not listed

O Prefer not to answer

What is your current standing in college?

O Freshman

O Sophomore

O Junior

O Senior

O Other

Please specify your current standing in college

_____

Please choose the number of years you have been in college.

- O 1
- O 2
- O 3
- O 4
- O More than 4

What is your major? Choose all that apply.

- ☐ Accounting
- ☐ Business Administration
- ☐ Economics
- ☐ Non-business

Please specify your major

_____

Do you minor in_____? Choose all that apply.

- ☐ Accounting
- ☐ Business Administration
- ☐ Economics
- ☐ None of the above

Are you a transfer student?

- O Yes
- O No

Please describe to what extent you agree or disagree with the following statements regarding mathematics. (1 = strongly disagree, 5 = strongly agree)

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
1. I like mathematics	O	O	O	O	O
2. Mathematics is one of my favorite subjects	O	O	O	O	O
3. Usually, I do very well in mathematics	O	O	O	O	O
4. I always enjoy mathematics classes	O	O	O	O	O
5. I consider mathematics is important in my life	O	O	O	O	O
6. I think mathematics is useful	O	O	O	O	O
7. Mathematics is interesting to me	O	O	O	O	O
8. Generally speaking, mathematics is easy for me	O	O	O	O	O
9. Mathematics is a very	O	O	O	O	O

difficult subject for me					
10. If possible, I want to avoid any mathematics classes	O	O	O	O	O
11. I am always nervous about mathematics	O	O	O	O	O
12. I am always nervous about courses related to mathematics	O	O	O	O	O
13. I don't consider myself as a math person	O	O	O	O	O
14. I don't think I need much mathematics in my life	O	O	O	O	O

Please describe to what extent you agree or disagree with the following statements regarding mathematics and accounting performance. (1 = strongly disagree, 5 = strongly agree)

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
1. Mathematics is important for accounting learning	O	O	O	O	O
2. My previous knowledge of mathematics helps me to learn accounting	O	O	O	O	O
3. If I have better mathematics ability, it would be helpful to my accounting learning	O	O	O	O	O
4. If a student is not doing well in accounting, that is because that student is not good at mathematics.	O	O	O	O	O
5. I don't think I need much	O	O	O	O	O

mathematics in accounting					
6. I think mathematics doesn't matter in accounting	O	O	O	O	O

Which area of mathematics do you think matters the most in accounting learning?

O Arithmetic

O Algebra

O Geometry

O Calculus

O Trigonometry

O Other

Please specify which area of mathematics you think matters the most in accounting learning.

_____

Which mathematics courses have you taken in college? Please choose all that apply.

☐ Applied Calculus or equivalent

☐ Calculus I or equivalent

☐ Elementary Statistical Methods or equivalent

☐ Other

What mathematics courses have you taken in high school?

_____

Which of the following exams have you taken?

O SAT

O ACT

O Both

O None of these

What is your score on SAT for the mathematics section? Put down 0, if you don't remember.

_____

What is your score on ACT for the mathematics section? Put down 0, if you don't remember.

_____

Have you taken any accounting course in high school?

O Yes

O No

On average, how many hours per week did you study for Acct 210?

O <= 2 hours

O 3-4 hours

O 5-6 hours

O 7-8 hours

O >= 9 hours

What is your GPA?

_____