The Efficacy of Virtual Learning: Student Achievement in Virtual, Hybrid, and Face-to-face Courses at a Medium-sized Community College in Virginia

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Doctor of Philosophy

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ABSTRACT

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This study examines the efficacy of virtual learning by comparing the final grades of students enrolled at a medium-sized community college in Virginia in either virtual, hybrid, or face-to-face sections. Achievement data from the Spring 2008 semester to the Spring 2013 semester of students enrolled in different sections of the same course taught by the same instructor were compared to determine the relative efficacy of each course modality. In many instances, students in face-to-face sections of the developmental math courses analyzed earned significantly higher final grades than students enrolled in the hybrid sections. Students enrolled in hybrid sections had significantly higher final grades than students in other sections of an English class and an Accounting class. In a veterinary studies class that was analyzed, students in the virtual sections earned significantly higher final grades than students enrolled in the hybrid sections. Gender differences were observed in the grade distributions from this community college, with females generally outperforming males. However, gender differences were not found to be significant themselves in courses that were found to contain significant differences in the achievement of students across modalities. The one exception to this finding was when the data was aggregated regardless of instructor, females enrolled in face-to-face sections of the developmental math course MTH 3 outperformed males enrolled in face-to-face sections. Although the number of students enrolled in virtual sections of courses at this community college increased steadily from 2008

to 2013 period of time, the grade distributions within the virtual and hybrid courses remained consistent over the timeframe.

DEDICATION

This dissertation is dedicated to the love of my life, my wife Audrey, and to our son Noah and daughter Sarah, who make all the hours spent pursuing this degree worthwhile.

This dissertation is dedicated to my parents and family, who have never stopped encouraging me and reminding me that they are proud of me.

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As this experience of writing a dissertation draws to a close, I would be remiss if I did not acknowledge all of the people that have helped make it possible. First and foremost, I need to thank my wife Audrey, for supporting me in a myriad of ways so that I might complete this journey that I began years ago. Without her encouragement, steadfast support, and constant love I do not believe I would have been able to finish this degree.

I would also like to acknowledge my in-laws, Kathy and Eddie, who provided childcare more times than I can count so that I could work on my dissertation. Without their help, I am not sure I could have found the time necessary to complete the work involved.

As alluded to above in my dedication, I would also like to acknowledge my parents, Sharon and Mill, for believing in me and helping me to understand that they are proud of me no matter what transpired, degree earned or not.

Finally, I would like to acknowledge Ellie Wilson and Joe Garofalo, without whom I would have been lost at several dead-end junctures along the way in writing this dissertation. Ellie never ceased cheering me on and providing valuable editing advice and Joe helped to procure the data that made conducting this research possible. There are many more people who helped along the way, from friends to coworkers, from family members to committee members. To all of these people, I say thank you.

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CHAPTER 1

Introduction

The growth of online courses for educational purposes is one of the fastest-growing trends in educational uses of technology today (Means, Toyama, Murphy, Bakia, & Jones, 2009). The National Center for Education Statistics, or NCES, estimated that the number of United States K-12 students enrolled in a virtual course increased by 65% percent between 2002 and 2005 (Planty et al., 2008). Picciano and Seaman (2009) estimated that over one million K-12 students took at least one online course in the 2007-2008 school year.

More recent data from the NCES finds that course enrollment is up from 220,000 in the 2002-2003 school year to an estimated 1.8 million in the 2010-2011 school year (Aud et al., 2011). It is worth noting that 74% of the enrollment was in high school courses, compared with only 9% and 4% for middle school and elementary courses, respectively. This clearly suggests that online courses have yet to pervade into the elementary levels as they have into high school coursework.

The expansion in the numbers of students at colleges and universities enrolled in online courses parallels the growth observed in K-12. A 2013 Babson Survey Research Group survey found the number of these higher education students taking at least one online course was over 7.1 million. The 2012 to 2013 annual growth rate of 6.1% in higher education, although the lowest in a decade, still translates to approximately 400,000 additional college or university students taking at least one online course. Interestingly, the percent of academic leaders who rate

the learning outcomes in online education as equal to or superior to the outcomes for face-to-face instruction grew from 57% in 2003 to 74% in 2013 (Allen & Seaman, 2014). At the same time, Allen & Seaman (2014) found that academic leaders indicated that students require more self-discipline to succeed in an online course than do students enrolled in traditional, face-to-face courses.

Consistent with this increased use of online learning and online courses at not only the K-12 level, but to an even higher degree at the university level, several states have passed legislation requiring students to complete at least some online coursework in order to graduate from high school. Generally, any online course that is district and/or state approved satisfies the requirement. Proponents contend that online course requirements will help better prepare students for college and the 21st century job market (Sheehy, 2012). Florida passed legislation requiring one online course as a graduation requirement that began with students entering ninth grade in the 2011-2012 school year. Alabama and Michigan have also passed similar legislation requiring online coursework in order to graduate. In 2011, Idaho legislators passed a law requiring two online courses before graduation. However, this legislation was subsequently repealed by Idaho's Board of Education in November, 2012 (Sheehy, 2012).

Most recently, Virginia joined the ranks of states requiring online coursework for a standard high school diploma, requiring students entering the ninth grade in the 2013-2014 school year to complete at least one online course. The law requires students to "complete at least one virtual course. The virtual course may be a noncredit-bearing course, or an elective or required credit-bearing

course that is taken online" (Means et al., 2009). Virginia has a state-run virtual school, which is a school that offers online courses. This online education provider is Virtual Virginia, which served 6,460 course enrollments in for-credit courses in the 2011-2012 school year. However, there are 18 multidivisional online education providers other than Virtual Virginia that were approved for the 2012-2013 school year and beyond in anticipation of burgeoning demand (Watson, Murin, Vashaw, Gemin, & Rapp, 2012).

Statement of the Problem

Given the clear and increasing growth rates of online learning, or virtual schooling, it is important to assess whether these new technologies are helping to deliver satisfactory learning experiences for students and whether they lead to increased student achievement for students. Although research regarding both K-12 students and students attending institutions of higher education are discussed in the literature review, this research paper will focus on community college students. The essential question in this study is: How do the final grades of community college students enrolled in different sections (virtual, hybrid, and face-to-face) of the same course compare with one another?

Along with hopes and expectations, the perceptions of students and educators help to drive the implementation of new educational technologies. These perceptions often predate any hard data regarding a given technology's efficacy in contributing towards increased student achievement. After a new technology (or any educational innovation, for that matter), such as online learning, enters "middle

age" and has become more universally implemented, learner satisfaction and teachers' perceptions continue to be major factors in determining the technology's fate. New technologies within online education (such as *Blackboard, Moodle*, social networking tools, and hand-held tablets) are continually being invented that have the potential to alter perceptions and attitudes toward online learning. Literature relating to the efficacy of prior developments should be examined in order to go further, since the future of virtual education relies, at least in part, on student and teacher perceptions of virtual learning's efficacy.

Likewise, it is essential to determine the effects of virtual instruction on student achievement when compared to hybrid and face-to-face instruction. Virtual (or online) instruction is defined in this study as instruction that occurs entirely on the internet. Most often, students and instructors enrolled in virtual courses never meet one another in person, but rather interact with each other and the subject matter via technology such as smart phones, tablets, and computers. Virtual courses may employ a variety of technologies to facilitate learning, the most common being web-based course modules, multimedia resources, discussion boards, and online collaboration. Face-to-face instruction is the traditional manner of learning, in which students and instructors meet together in person, most often in a classroom setting. Lectures, presentations, group collaboration, and discussions are the most commonly utilized tools in this course format. Hybrid (or blended) instruction, on the other hand, combines these traditional tools with online course components such as online discussion boards, online course modules, required online collaboration between students, and online multimedia resources. Given the fact

that the use of virtual instruction is increasing rapidly at all levels of education, it is of utmost importance to determine to what extent enrollment in virtual schooling course work helps to enhance and affect student learning.

It is also essential to understand why online learning is increasingly being utilized. At the high school level, online learning is most commonly used to offer courses otherwise not available at a particular school. However, the second-most often cited use for online learning for high school students is credit recovery (for a required course that was taken previously which resulted in a failing grade or an incomplete) in an attempt to increase graduation rates (Picciano & Seaman, 2012). Other reasons given by K-12 districts for employing online and blended instruction include providing additional AP courses, reducing scheduling conflicts, and preparing students for 21st century career skills (Picciana & Seaman, 2012).

With regard to higher education, a recent survey of more than 2,800 college and university executives indicates that the most-often cited rationales for offering online and blended courses include increased access to education, scheduling flexibility, preparing students for the job market, and increasing graduation rates through credit recovery and program completion (Allen & Seaman, 2014). While there are no national statistics regarding graduation rates of distance education students in higher education (Berge & Huang, 2004), determining this rate is further confounded by the fact that such large numbers of students are taking at least one online course, and as such a myriad of other factors could contribute to a change in graduation rates. However, there is anecdotal evidence that online education might help to increase the graduation rates in higher education in the form of testimonials

from people such as Paul Glader, a writer for *Forbes,* who details his experience of recently completing an online course in calculus, the one class that kept him from graduating from the University of South Dakota sixteen years ago. If the course had not been offered online, he writes, he would never have had the chance complete it, and thus to graduate (Glader, 2013). Historically, the dropout rate of students attending United States higher education institutions has remained steadily in the 40 to 45 percent range for more than a century (Berge & Huang, 2004). In the future, it will be interesting to note whether this steadfast dropout rate decreases as increasing numbers of students are offered the opportunity to take credit-recovering online courses.

Since online learning has become a requirement for earning a high school diploma in some states, including Virginia, and online courses are being offered to ever-increasing numbers of higher education students, it is imperative for educators and students alike to have faith that meaningful learning is possible through web-based instruction. Despite the growing use of research, results remain unclear with regards to the student achievement of students enrolled in online courses at all levels of education. Although the achievement of students enrolled in online and blended courses is important at all education levels, this study will examine the efficacy of online learning for community college students. The central questions remain: To what extent, if any, does the modality in which a course is taught (virtual, hybrid, or face-to-face) affect the final grades of community college students?

Research Questions

The following research questions guide this study:

1. How does the achievement of community college students taking virtual, hybrid, and face-to-face courses compare within and across subject areas (specifically math, English, veterinary studies, and accounting)?

2. When considering the above research question, how do changes over time or gender effects contribute to the differences in achievement of virtual, hybrid, and face-to-face learners?

A medium-sized community college in Virginia has given this researcher access to archival data including the final grades for all students in all courses (whether offered virtually, hybrid, or face-to-face) from the summer semester of 1998 to the spring semester of 2013. This community college uses the terms virtual and hybrid, rather than online or blended (respectively). These terms are used interchangeably in this research paper, as noted in the definitions section below. Because the tools available in virtual education were rapidly evolving until recently, the focus of this study will be on the time period from 2008 to 2013. For developmental math, the state-designed courses Algebra Basics I (MTH 3) and Algebra Basics II (MTH 4) were chosen. The state-designed developmental course Preparing for College English III (ENF 3) and College Composition I (ENG 111) were chosen for English. Two courses were chosen for veterinary studies: Introduction to Animal Science (VET 100) and Veterinary Hospital Management (VET 230). For

accounting, the course chosen was Principals of Accounting II (ACC 212). For more explanation of why specific courses were chosen, see Chapter 3.

The answers to the research questions will be useful for a host of reasons. First, the use of online courses, as previously stated, is already prevalent and is rapidly increasing. Educators and students wish to determine whether virtual education is a viable and worthy tool for learning and how the achievement of virtual learners compares to the achievement of traditional learners. It is also important to know whether virtual schooling is effective because online learning offers access to courses not otherwise available in rural areas. Additionally, online learning may have the potential to level the playing field somewhat between students from affluent homes to those students living in poverty.

One existing study compares the utility of switching to South Carolina's Virtual Charter School (SCVCS- which is tuition free) to staying at a local traditional school. This study found that students from high poverty schools almost always benefited by switching to SCVCS (Rauh, 2011). In a sense, this is similar in concept to students in low-achieving schools being offered school choice. In this study, quality of education offered to students was defined as the mean student score on the state-wide Language Arts and Math standardized tests. Rauh makes the assumption that higher test scores are the result of superior curricula and instruction. Because the means on these state-wide tests tend to be higher for SCVCS than the means at high poverty schools, Rauh concludes that this is a result of better curricula and instruction. Although the study has some clear limitations (a narrow definition of quality of education, for example) and makes a debatable key

assumption, it helps to underscore another reason the research questions are important- namely that online learning has the potential to provide access to higher quality curriculum and instruction to students in poor or rural areas than otherwise might be available.

Another key issue is low rates of internet access in poor and/or rural communities, although the trend of increasing access is certainly taking place. As the internet access rate increases, online learning rates will likely increase alongside it. Although the use of online learning is growing in availability and popularity, high rates of attrition and dropout remain a notable problem (Lee & Choi, 2011). Research studies such as Rauh (2011) can help to identify online and hybrid courses that have favorable student outcomes when compared with the outcomes in comparable face-to-face courses. Just as importantly, this type of research may help to identify what is not working- namely, which virtual and hybrid courses have underperforming student achievement levels relative to traditional courses.

Definitions

Virtual schooling- Schooling completed entirely online and/or through a computing device, devoid of a face-to-face component.

Web-based learning- Used synonymously herein with virtual schooling.

Online learning- Used synonymously herein with virtual schooling.

Electronic learning (or *e-learning*)- Used synonymously herein with virtual schooling.

Distance learning- Learning conducted entirely either online, through telephone, or written correspondence, devoid of a face-to-face component.

Face-to-face learning- Learning that takes place in person with the class and instructor in the same physical space at the same time.

Traditional learning- Used synonymously herein with face-to-face learning.

Blended learning- Learning that combines elements of traditional, face-to-face instruction with web-based instruction.

Hybrid learning- Used synonymously herein with blended learning.

Expository learning- Learning that is one-way in design, in which the student is a passive receiver of information. Examples include instructor designed lectures and PowerPoint presentations.

Active learning- Learning involving students researching, discovering, or contructing information and knowledge of their own accord.

Interactive learning- Learning that entails collaboration and discussion with peers, hypothesizing, and creating learning projects.

Synchronous online learning- Web-based learning that takes place at the same time. This term is often used to describe discussion groups in which students are online simultaneously (with or without the instructor) and are therefore able to ask and answer questions of one another or to post theories in real-time.

Asynchronous online learning- Web-based learning that occurs at different times for different students. This term is commonly utilized to describe threaded discussion groups that take place over an extended time period (often days or weeks).

Course modality- This term is used to describe which format a course is offered in; virtual, hybrid, and face-to-face are the three most common.

CHAPTER 2

Literature Review

This chapter aims to provide a discussion of existing studies related to online learning, with a particular emphasis on the use of online learning at the community college level. Although the research questions in this study concern community college students, it is useful to review the studies of online learning of K-12 students for several reasons. First, the content of the courses selected for this study overlaps the content of K-12 courses. In fact, there are studies suggesting that nearly sixty percent of incoming community college students are not fully prepared for college-level work and must take at minimum one 'developmental', or pre-college, math or English course before enrolling in any credit bearing class towards a degree (Le, Rogers, & Santos, 2011). The community college's state-designed MTH 3, MTH 4, and ENF 3 courses selected for this study are remediation courses specifically crafted to cover content previously encountered by students in upper elementary, middle school, and high school math and English. Because the content of the courses overlap, and the academic level of understanding of the students is similar, research on the achievement levels of online K-12 students likely has direct bearing to the student achievement of online community college students. However, given the adult age of community college students and the other content area of courses selected for this study (accounting and veterinary studies), this literature review also discusses research of online undergraduate and graduate students.

Another compelling reason to review literature of online learners at all levels of education is that some findings in education appear to be universal. For example, it is commonly accepted that increased levels of student engagement lead to increased levels of student achievement, regardless of a student's age. Therefore, it is not out of the realm of possibility that some findings concerning online learning may apply to students of all ages.

The primary tool utilized for this literature review was a search of the Ebsco Databases, accessed through the University of Virginia's computer networks. These seven databases from the Ebsco company include: Education Research Complete, ERIC, Education Index- Retro, Education Full Text, Psychology & Behavioral Sciences, Academic Search Complete, and SportDiscus. A Boolean phrase was employed that included search terms such as online learning, online education, web-based instruction, virtual schools, virtual learning, e-learning separated by "OR," followed by "AND" achievement "OR" outcomes "OR" performance "OR" perceptions. "OR" community college. It is interesting to note that roughly 9,300 results pare down quickly to just under 400 when subject search terms such as achievement or performance are added. This is evidence that this research focuses on a more recent area of study with a relatively limited body of research. Both 'Scholarly Journals/Peer Reviewed' and the time period 1995 to 2013 were used as qualifiers in the search for useful and current research. Of the approximately 400 search results returned, well over half did not pertain to the research questions at hand or to perceptions of online learning.

The abstracts of the remaining search results were then examined for relevance, age of participants, and as to whether or not they addressed the research questions in a useful and meaningful way. Hence, the studies chosen to be included in this literature review either directly address student achievement, perceptions of online learners and educators, or identify factors that may influence them. The studies selected primarily have experimental or quasi-experimental designs, with statistical controls for pre-existing differences between control and treatment groups. Other studies chose were descriptive in nature, with intentions of identifying perceptions of participants in virtual schooling. The studies chosen for close examination can be placed into one of three categories:

1. meta-analyses
2. studies involving K-12 learners as participants
3. studies involving adult learners (undergraduates, graduate students, and corporate employees) as participants, with an emphasis on community college students

Meta-Analyses

Web-based learning has as its origin distance education. Distance education dates back a century to early correspondence courses, eventually utilizing more modern telecommunications technologies such as telephone, video, and ultimately, the Internet (U.S. Department of Education, 2010). Results from early meta-analyses indicate no significant differences in efficacy of distance education and online learning when compared with face-to-face education (Cavanaugh, 2001;

Bernard, Brauer, Abrami, & Surkes, 2004). This suggests at the very least that distance education is a viable alternative to traditional face-to-face education, especially when distance education is the only option available.

However, generalizing to say that distance and face-to-face education result in essentially the same learning would be to ignore differences in findings across the individual studies examined. For example, Bernard et al. (2004) found effect sizes of online learning ranging from -1.31 to +1.41. In other words, some virtual courses resulted in significant and drastically lower student achievement levels whereas other virtual courses resulted in the opposite.

These findings suggest that variation in *how* distance education is employed may have at least as much bearing on student achievement as the *modality* in which the course was offered. In keeping with this theme, Bernard et al. (2004) found that distance education that used synchronous instruction had a significantly negative effect (-0.10), whereas the mean effect size for studies of distance education employing asynchronous communication was significantly positive (+0.05). However, the studies included in this meta-analyses that were categorized as using synchronous communication involved "yoked" classrooms in which the instructor's classroom was the center of activity in which one or more distant classrooms interacted with it in "hub and spoke" manner. These types of distance education courses are markedly different than the web-based communication technologies available to online learners today.

Likewise, although Machtmes and Asher's (2000) meta-analysis of higher education telecourses found no significant difference between face-to-face and distance learning overall, they did find results to be more positive for telecourses when classrooms had two-way interactions (between teacher and student), as opposed to one-way communications. Although early meta-analyses of distance education found its learning outcomes equivalent to face-to-face instruction, 21st century online education offers a new host of previously unavailable tools to increase student communication as well as interactive features and multi-media previously unavailable in distance learning. Thus, some researchers began to argue successfully that online learning was qualitatively different than traditional distance education. Proponents began to postulate that modern online learning could be expected to outperform previous forms of distance learning based on the multitude of engaging, interactive features and capabilities that the new technology offered. Therefore, further study was warranted to determine the efficacy of online learning when compared with traditional classroom education (Zhao, Lei, Yan, Lai, & Tan, 2005).

Results from two more recent meta-analyses yielded more positive findings with regards to student achievement. Sitzmann, Kraiger, Stewart, & Wisher (2006) finds that web-based learning bests classroom-based learning with regards to declarative knowledge outcomes such as recitation of facts, with the two being equal with respect to procedural learning outcomes. Perhaps the most thorough and rigorous meta-analysis completed to date is the United States Department of

Education's meta-analysis (2010). This meta-analysis is different than earlier meta-analyses by restricting its focus to studies that:

1) Had an objective learning measure as the outcome measure
2) Investigated significant use of the Internet for instruction
3) Met higher criteria in terms of study design (requiring an experimental or quasi-experimental design for inclusion)

Of the 99 studies that met the above criteria and compared online and face-to-face learning, 45 provided sufficient data to calculate 50 independent effect sizes. This meta-analysis calculated effect size by the finding the difference between the means of the control group and comparison group and then dividing by the pooled standard deviation. The U.S. Department of Education meta-analysis categorized the type of learning being studied as online, blended (online and face-to-face), or face-to-face.

The main finding of the United States Department of Education's meta-analysis of online learning (Means et al., 2009) states:

> Few rigorous research studies of the effectiveness of online learning for K–12 students have been published. A systematic search of the research literature from 1994 through 2006 found no experimental or controlled quasi-experimental studies comparing the learning effects of online versus face-to-face instruction for K–12 students that provide sufficient data to compute an effect size. A subsequent search that expanded the time frame through July 2008 identified just five published studies meeting meta-analysis criteria. (p. xiv)

Of the 50 study effects calculated, 43 were drawn from research with learners older than K-12 students. This is important to note because the US Department of Education conducted its meta-analysis in part to serve as a tool helpful in guiding online learning decisions of K-12 stakeholders such as administration, parents, and teachers. However, the vast majority of data aggregated to calculate its findings and effect sizes came from studies involving undergraduates or other adult learners. With this important caveat in mind, the key findings of this meta-analysis include:

1. Studies comparing blended instruction, combining face-to-face and online elements, to face-to-face instruction had a mean effect size of +0.35, $p<.001$. The mean effect size for comparing purely online instruction to purely face-to-face was +0.05, but not statistically significant ($p=.46$).
2. Effect sizes were greater and statistically significant for collaborative online instruction (+0.25) and instructor-directed instruction (+0.39) when compared to effects sizes of online learners working independently (+0.05, not statistically significant).
3. The efficacy of online learning approaches appears to be wide in scope across different content and learner types. Online learning was an effective option for graduates and professionals (+0.10, $p<.05$) as well as undergraduates (+0.30, $p<.001$). Although positive, the mean effect size is not significant for the seven effect sizes calculated from studies involving K-12 students. However, the number of K-12 studies is too low to inspire confidence in the mean effect size estimate.

In summary, the findings indicate a lack of empirical research on K-12 online learner outcomes (Means, et al., 2009). The few studies that do exist have a mean effect size that is not significant. Blended instruction had the greatest positive effect size, although some caution is needed in interpreting this result. The blended instruction in many of the studies involved in the meta-analysis involved web-based instruction and resources offered *in addition to* the traditional face-to-face instruction. The additional learning time might very well contribute to the effect size of results in studies concerning blended learning. However, increased contact time between the student and the subject matter could very well be a desirable byproduct of blended instruction in the eyes of educators, and may not be a variable worth controlling for in designing a study. What instructor would not want his students to spend more time on task? Finally, both instructor-centered and collaborative models of instruction were found to be better than independent learning online. The US Department of Education meta-analysis was rigorous in design and informative. However, it included studies from 2008 and earlier. To get a fuller picture of the state of the literature as it stands today then, one must examine the research that has been published in 2008 to present.

K-12 Learner Outcomes

Keeping in mind that K-12 is the precursor to community college and that some of the courses in community college are taken for credit recovery of failed course in high school, it is important to look at K-12 learner outcomes with regard to student achievement. Searching the literature from 2008 to present (in search of studies to add to the body of literature reported on in the U.S. Department of

Education meta-analysis) yielded only two rigorous empirical studies that examine online learning and its relationship to student outcomes. One of these empirical studies is Heppen et al. (2012), which studied the effect of an online Algebra I course on future learning outcomes of eighth graders by targeting schools in Maine and Vermont that served eighth graders but did not offer a stand-alone Algebra I class in the 2007-2008 school year. There were 68 schools that participated in the three-year study. After stratifying the sample of schools by Maine or Vermont, and into one of three size categories, half of the schools in each sub-group were then randomly assigned to the treatment (an online Algebra I course) or the traditional face-to-face Algebra I course for the 2008-2009 school year. Herein lies ones possible limitation in generalizing the results of this study to other populations- the students in the control groups are taking general eighth grade math courses with Algebra I given only as supplemental materials. Therefore, they are in essence taking a different course than the online learners taking Algebra I. The difference in course may account for some of the differences found between control and comparison groups. A total of 1999 eighth grade students participated in the study.

The data collected included student characteristics, state assessment scores, standardized Promise Assessment pretests, online course activity data, site visits, teacher surveys, and proctor logs. Outcome measures included the Promise Assessment posttests and high school mathematics course taken in the years following the 2008-2009 school year. Heppen et al. (2012) offers this explanation of the Promise Assessments utilized:

> The Promise Assessment (Internet Testing Systems and SEG Assessment 2009) is a computer-adaptive mathematics assessment with both a general mathematics (pre-algebra) item bank and an algebra item bank. The general mathematics item bank was used for the pretest....The pretest presented 30 items that ranged in difficulty from the grade 5 to the grade 8 level....The items were distributed across six domains (number, computation and estimation, measurement, geometry, probability and statistics, and algebraic concepts)....Scores for the Promise Assessment are generated by a linear transformation of the underlying Rasch scale and are reported on a scale of 200 to 400....The Promise Assessment posttest was administered to all grade 8 students in participating schools in May and June 2009. The posttest was delivered as a 40- item that included 20 items from the general mathematics item bank and 20 items from the algebra item bank. (p. 26-27)

The study finds that students in the treatment group outscored their counterparts in the control group on the algebra posttest by 5.53 scale points, yielding a significantly positive effect size (+0.40, p=.001). The other key finding is that students in the treatment schools who were offered the online Algebra course were twice as likely to follow an advanced mathematics curriculum throughout high school (Heppen et al., 2012).

Although it compares students in a blended course rather than a purely online course to face-to-face learners, the findings of the other rigorous K-12 study on student outcomes are in opposition to Heppen et al. (2012). Cavalluzzo, Lowther, Mokher, & Fan (2012) utilized a two-cohort sample with 25 high schools in Kentucky for year one (the 2007-2008 school year) and 22 in year two (the 2008-2009 school year). Each year, the schools were close to evenly divided between treatment and control conditions. The treatment was a blend of web-based instruction and resources in addition to a traditional face-to-face class. The randomized sample included 6,908 ninth-grade students, of whom 61.4% attended rural schools. Data collection instruments included teacher surveys, math course

enrollment in grade 10, math achievement in the fall of grade 10 as measured by the American College Testing (ACT) PLAN, and classroom observations. As alluded to above, the findings indicated that the hybrid classes were not significantly more effective than the face-to-face classes at increasing student achievement, nor did it significantly influence future math course taking.

When considering these two studies with large numbers of participants and empirical designs, it might at first be difficult to explain. Why would one study involving an online learning treatment produce positive results and lead to higher probabilities of better future math course enrollment for treatment students when another study from the same year finds the opposite? In the case of Heppen et al. (2012), students were either offered an online Algebra I or were offered a general eighth grade math course with Algebra I supplements. In other words, students in the treatment and comparison groups were offered different curriculums, which may go a long way in explaining any differences in achievement. The other explanation as to why different studies yield different results is that not all treatments are equal. There are likely both good and some not so good online curriculums that have been developed and there are successful blended course implementations and some that are not successful. So, while we should continue to search for and identify patterns in the research comparing web-based learning to traditional learning, we should also be on the lookout for factors associated with successful online learning.

Dipietro et al. (2010) attempted to do exactly this by identifying best practices in teaching K-12 online. The participants were Michigan Virtual School teachers who met three criteria:

1. Three or more years teaching online

2. Teachers of Science, English, or Math

3. Teachers of General Education or Advanced Placement classes

Using these criteria, administrators chose 16 teachers who not only met the requirements above but also were judged to be highly successful teachers. Data collection consisted of several telephone contacts and interviews. The findings indicate that some of the best practices of Michigan Virtual School teachers include, but are not limited to: facilitating the formation of community by encouraging discussion, closely monitoring student progress, offering quick feedback, offering a variety of supplementary support tools, modeling formal communication, monitoring tone and emotion of their communication with students, consider student access to technology, use multiple channels of communication, form relationships to students through communication, embed deadlines, clearly organize content and structure to motivate students, and provide online classroom management techniques (DiPietro et al., 2010).

K-12 Student and Teacher Perceptions

Studies on teacher and student perceptions of virtual schooling can provide valuable insights, although they often lack experimental designs. For example,

Roblyer et al. (2009) surveyed 65 virtual schooling teachers and found that 75% of the teachers felt that virtual teaching had made their in-person instruction better. These results are consistent with an earlier study by Lowe (2005). Although this is encouraging, teacher perceptions of online learning are not always without pause. In surveys and focus groups, North Carolina Virtual Public School teachers suggested they could use better support through increased technology help, feedback, and through clear expectations. They also expressed a need for bite-sized professional development on online course management systems (Oliver, Kellogg, Townsend, & Brady, 2010)

A prevailing theme in the research of teacher and student perceptions of online learning is a lack of a sense of community and collaborative learning opportunities, resulting in feelings of isolation. For example, Kerr (2010) employed a multiple case study design following three online teachers and found that students had few opportunities for peer-to-peer collaborative learning. Similarly, recent qualitative interviews of 8 virtual high school teachers revealed that these teachers felt a sense of disconnection from students, their professions, and peers (Hawkins, Barbour, & Graham, 2012). Journell (2010) utilized a qualitative design to study a secondary US history online learning course in 2007. Both the teacher and the students reported a belief that online learning was best used for simple information transmission and for teaching declarative knowledge rather than being well-suited for active or social learning. Interestingly, although the teacher characterized the students as apathetic towards social contact with one another online, the students largely refuted this notion. Finally, K-12 students in Canada by and large enjoyed

their online learning experiences, although a common complaint was the lack of a sense of community and the asynchronous nature of their virtual courses (Barbour, McLaren, & Zhang, 2012).

One of the possible solutions to the sense of isolation that virtual learners report is to incorporate the use of Web 2.0 technologies and social networking. The primary reason that this paper focuses on community college student achievement from 2008 and beyond is because it was around this time that Web 2.0 and social networking fundamentally changed how users interact with the internet (and thus fundamentally change virtual education). Web 2.0 refers to the evolution from users utilizing the internet as passive consumers of information to users becoming active creators of internet content. In its early days, the internet was in essence a large database of information, much like an encyclopedia or almanac. However, as online technologies evolved, internet users began to create their own content in the form of blogs, wikis, video and photo sharing, and social media. For the online classroom, Web 2.0 tools enable instructors to increase interaction with and between their students in a variety of innovative manners. Rather than merely acting as passive consumers of information, Web 2.0 technologies allow online students to able to collaborate with classmates and to learn as a classroom community (Tunks, 2012). Fostering this sense of community within an online classroom is the antidote to the feelings of isolation often reported by virtual learners.

Barbour and Plough (2009) chronicle the development of the use of social networking in the Odyssey Charter High School (OCHS) from their initial attempt of using a popular existing social network to the creation of a closed virtual space. In

the 2007 to 2008 school year, OCHS had an enrollment of 1,405 students and utilized a blended model of instruction, with one day per week of face-to-face instruction followed by four days of online only instruction. Initially, OCHS employed a model in which each course had a Facebook group that students were asked to voluntarily join.

While this model garnered some level of success in building community between learners and online teachers reported lively and productive discussions, instructors did report some challenges. For example, some students lacked incentive to join the groups and Facebook limited interactions to discussions and wall posts. Ultimately, safety became a primary concern.

Although the classroom groups themselves on Facebook were closed, students could choose to make their profiles public, meaning that outsiders were privy to identifying personal information and could theoretically make contact with them. In the end, OCHS instructors decided to switch to another social network named Ning, which gave the instructors complete control of their students' profile security settings. This essentially created a 'walled garden' in which students and teachers could interact in a variety of ways unavailable on Facebook (such as music sharing, photo sharing, and blogging) while maintaining the privacy of the entire class and the students therein. At the conclusion of the pilot use of this social networking initiative, students expressed their appreciation of having a place to meet other kids, since this was a challenge at a virtual school such as OCHS (Barbour & Plough, 2009). Students also praised their experience with the social network

Ning because it engaging to them and offered an opportunity to collaborate with other students in the class.

Discussion

In summary, the literature comparing K-12 student outcomes of online, blended, and face-to-face education remains inconclusive. Some studies of online and blended instruction yield positive and significant effects and others do not. Also, studies comparing blended learning to face-to-face learning fail to take into account the extra learning time spent by the learners, making it difficult to gage how much of the effect is due purely to more time on task learning rather than the mode of instructional delivery. A key finding when studying student and teacher perceptions of online learning is that students and teachers alike can feel a lack of community and a lack of collaborative learning opportunities. Although preliminary findings are encouraging, the question of whether or not the exploding use of social networking will help to alleviate the sense of isolation some online learners and teachers feel is worth further examination. Are the findings from studies of K-12 virtual learners generalizable to virtual learning as a whole? More specifically, are the K-12 findings applicable to community college students? In order to answer these questions, this paper will next examine the current body of research regarding virtual education in adult learners.

Adult Learner Outcomes

As the prevalence of and demand for online education continues to increase (Puzziferro & Shelton, 2008), it is important to determine how online learning

compares to face-to-face learning with regards to student outcomes. To date, researchers have had difficulty establishing reliable conclusions in studies comparing traditional forms of learning (eg paper-based or classroom based) versus online learning in relation to student learning outcomes; no consistent results have emerged, and many studies have not been controlled for factors other than lesson mode (Emerson & MacKay, 2011). With this caveat in mind, some individual studies of adult online learners still may help to determine the efficacy of virtual learning.

Zi-Gang Ge (2012) compared the distance learning of English between two classes of 70 undergraduate students over one four-month semester at a university in Beijing, China. One of the classes was an asynchronous online-only course while the other offered a blended approach of face-to-face and online instruction. The study utilized a pretest posttest design. At the end of the semester, the scores of the two groups of participants on the end-of-course final were analyzed. The results indicate that although both approaches led to improved student performance in English, the blended approach yielded significantly better results for participants when compared to the asynchronous online-only learners. One must wonder whether learning a second language inherently yields itself better to human, face-to-face interaction than other subject matters might.

Other research is more consistent with the current state of the literature finding no significant differences in student outcomes between face-to-face learners and virtual learners. Hayward & Pjesky (2012) used a blind grading methodology to determine whether the performance of online students differed significantly from traditional students taking a macroeconomics graduate course at West Texas

Agriculture & Mechanical University. In addition to course delivery method, the study examined the role of gender, GPA, citizenship, and scores on other assignments in the course as co-variables that might be correlated to achievement on the end-of-course final term paper. Although the final term paper scores of online students were 5.82% higher than the face-to-face learners, the results were not statistically significant (Hayward & Pjesky, 2012). Only overall GPA and scores on other assignments within the course were significantly and positively correlated to the final term paper scores. The researchers suggest that these variables serve as a proxy for the effort of students, which accounted for any significant differences between participants on their final term papers.

Likewise, Rich & Dereshiwsky (2011) studied the efficacy of online learning and traditional face-to-face learning in an undergraduate intermediate accounting course at a large state university in the United States. Students were offered a choice between the two class formats and were scored on several objective assignments during the semester. The study found no significant differences between the two groups, meaning that students in the online course format scored as well as the traditional learners on the assignments. As in most of the research available regarding online learning, there was no random assignment of students to online versus traditional classrooms. It is therefore possible that students chose the format best suited for their learning style, thereby mitigating any chance of discovering differences between the groups that otherwise might have been found had random assignment been utilized. With this very question of students' learning styles in mind, Zacharis (2011) examined the learning styles and performance of an

online group of freshmen computer science majors with a comparable on-campus group at a university in the United Kingdom. The study found that student learning style did not play a role in the selection of course delivery method. Furthermore, no significant differences were found in student performance between the online learners and the face-to-face learners.

Schwartz (2012) compared the Standard Learning Outcomes Assessment Test (SLOAT) grades of 61 face-to-face sections to 70 online sections of accounting classes at National University in San Diego, California that took place between 2007 and 2009. The grades on this exam were converted into a standard GPA-like score of 0 (F) to 4.0 (A) for numerical comparison and mean calculations. The mean age of the participants was 32 years old. There were no significant differences in the demographics of the online learners and the onsite learners. Online instruction included asynchronous threaded discussions, live chat sessions, voice instruction via voice-over IP (VoIP)-based instruction, and visual presentations using PowerPoint, whiteboards, and spreadsheets. The study found that online accounting students had significantly lower levels of mean achievement (2.80 for online learners versus 2.93 for onsite learners) when compared to onsite learners' mean achievement. Although the results were significant, the difference between the means was merely 4.4%, representing a miniscule effect size.

One of the factors that makes comparing the achievement of online learners to face-to-face learners difficult is quantifying the hours of activity or amount of time spent by virtual learners interacting with the course material. It stands to reason that time on task and the quantity of interaction with course material would

increase the achievement of online learners, but is there evidence in the literature of this? In short, the answer is yes. Undergraduates at a university in the northwest United States participating in a Principles of Marketing course who completed more online learning modules were found to have higher course grades than their peers who completed fewer modules (Girard & Pinar, 2011). Likewise, Perera & Richardson (2010) found a positive correlation between Australian undergraduates' end-of-course examination performance and the number of online files viewed and online discussion messages posted.

If the amount of online activity is positively associated with student performance and outcomes, the goal from an instructor's point of view must be to increase this activity among virtual learners. But, how is this done? The answer, it appears, is for the instructor to be actively engaged in online activity as well. Studying online instructor and learner activity in undergraduate mathematics courses in the United States, Bliss & Lawrence (2009) found that both the quality and quantity of student posts and the extent of discussion board threading are significantly and positively correlated with instructor activity. In other words, an active online instructor begets active online learners. A research synthesis of chat and discussion board use by Blackmon (2012) provides caution to this claim, however. The findings indicate that although instructor facilitation is an important factor in increasing the quality and quantity of online students' posts, it is the manner in which the instructor facilitates the discussions that is paramount. Specifically, instructors who post more questions and who require more participation in online discussions and posts between their students, while at the

same time minimizing their own social presence online, have greater success in fostering interaction and collaboration between their students.

Because the profiles of community college learners are different from undergraduates and graduates at four-year universities and colleges, online learning in community college must be examined accordingly. High school students who have recently graduated and started community college may not know how to succeed in an virtual schooling environment (Kilic-Cakmak et al., 2009). Therefore, community college students taking an online course may have a different set of expectations or supports needed to be successful. Another reason to give online learning in community college particular attention is that is has the fastest growth rates of online learning in higher education. Until very recently, there had been a scarcity of research that focused on online students in community colleges (Ashby, Sadera, & McNary, 2011). Within the last several years, more studies of virtual schooling at the community college level have taken place. While current research findings of no significant differences between learning environments (face-to-face versus blended or online) are common, some recent research has suggested that the learning environment does have an affect on success and completion rates of developmental students at the community college level (Zavarella & Ignash, 2010).

With this in mind, Ashby, Sadera, & McNary (2011) compared the unit test scores and the scores on a standardized Intermediate Algebra Competency exam of 167 participants in a Developmental Math course offered in three different learning environments (online, blended, and face-to-face) at a Mid Atlantic community college in the United States. The researchers utilized a one-way ANOVA and found

significant results. Students in the blended learning environment had the least success of the three, although data analysis with the attrition adjusted sample found that the face-to-face students performed most poorly (Ashby et al., 2011). The end of course class means in the attrition adjusted sample were 71.6% for face-to-face students, 73.1% for blended, and 81.6% for online students (p=0.008). The results of this study contradict the current consensus in the research of no significant difference in outcomes based on learning environment. Although online learners achieved at superior levels, it is important to note that the sample was attrition adjusted to account for those online students who did not complete the course.

Again, not all studies find positive differences in student achievement for online learners. Sami (2011) studied the learning outcomes and completion rates of students taking an introductory statistics course at Hartford Community College in Maryland. The course was offered in three formats: traditional lecture format, online, or blended. The instructor and the course materials (including the text, the assessments, and the homework) were identical for each of the three courses. In contrast to Ashby et al. (2011), but consistent with much of the literature regarding online education, no significant differences were found in learning outcomes, as measured by examination scores, between the three formats. However, the course completion rate was lower for online students when compared to students in the hybrid or traditional course formats.

Indeed, course dropout rates in virtual schooling remain a clear problem. A pair of parallel studies that focused on virtual schooling at community colleges in the states of Virginia and Washington corroborates this. Jaggars & Xu (2011)

investigated the enrollment patterns and student outcomes for online, hybrid, and face-to-face courses among students who enrolled in Washington state's community and technical colleges beginning in the fall of 2004. The researchers proceeded to track these students for five years. The findings indicate that students in online courses were significantly more likely to fail or withdraw than students in face-to-face courses. Adding insult to the cause of online learning, researchers also found that students who enrolled in a higher proportion of online courses were less likely to transfer to a four-year institution. The same researchers conducted a similar study for the state of Virginia. Again, a 2004 student cohort of incoming community college students was tracked until 2008 for educational outcomes and retention rates. While the study reports the positive fact that nearly half of Virginia's community college students enrolled in an online course during this period, the results were comparable to Washington's. Again, students were more likely to fail or withdraw from online courses, less likely to transfer to a four-year institution, and were less likely to return to school in subsequent semesters (Jaggars & Xu, 2010).

How can community college faculty who teach online help students complete their courses and achieve at high levels? To help answer questions such as this, Meyer (2014) interviewed eleven veteran community college faculty members to determine how they had improved student learning in their online courses. Two of the factors were deemed to have the greatest impact on increased student learning: a personal passion for online teaching and emphasizing approaches to increase student engagement. It appears that these online courses were best when students

were actively encouraged to be engaged and were led by instructors that were engaged and passionate with the subject matter themselves.

Other approaches to the attrition problem of online education include predicting or forecasting student outcomes and student needs based on statistical modeling. One such case study details community colleges in Arizona and Indiana who utilized existing student information systems to create learning analytics in order to forecast student outcomes (Smith, Lange, & Huston, 2012). These predictive models were able to identify at-risk students based on dozens on key variables, such as previous online course completion rates, GPA, and level of course taken. Likewise, Fair & Wickersham (2012) hoped to find evidence that the READI (Readiness for Education At a Distance Indicator) assessment helped to predict future online student success. The assessment scores students on six areas that students should score highly on in order to successfully complete and online course: 1) personal attributes; 2) learning styles; 3) reading rate and recall; 4) technical competency; 5) technical knowledge; and 6) typing speed. Seven introductory communications courses at two different community colleges were used in the study. Unfortunately, the results indicated no significant differences exist in READI assessment scores and final grades in the online course. Although the READI assessment was unsuccessful at predicting student achievement in this case, inventories like this and statistical modeling might one day offer opportunities to online educators in community colleges to offer student supports and services before a student fails or withdraws from an online course. Perhaps this could be one way of attacking the attrition problem of online learning in the future.

Adult Student and Teacher Perceptions

Although the use of online learning is increasing and the learner outcomes appear, at the very least, to be on par with the outcomes of traditional face-to-face learners, problems remain. Virtual learning is often correlated with high rates of student withdrawal, attrition, dissatisfaction, and isolation (Power & Gould-Morven, 2011). Indeed, students' sense of isolation is the antithesis of the collaborative learning model and of learners feeling as if they belong to a community. Owens, Hardcastle, & Richardson (2009) documented the sense of isolation that distance learners experience. Utilizing 45-minute telephone interviews of 49 undergraduate and postgraduate students who had studied at Deakin University in Australia between 2003 and 2007, the researchers found that many of the students experienced a sense of isolation during their online courses. Some reported that the faculty seemed to 'forget about remote students,' and that online discussion boards, although useful, were under-utilized due the fact that they were not required and not included in course grading. What can be done to foster a sense of community among virtual learners? Phelan (2012) finds that the very act of assessing students' experiences with their online coursework increases a student's sense of belonging to a community of learners. Simply feeling that they have a voice for feedback help foster's a sense of belonging.

One way to lower attrition levels is through increased student engagement (Tirrell & Quick, 2012). In this study, full and part-time faculty at three community colleges in Virginia (who had taught online courses in the last three semesters) completed online surveys to determine the extent to which they used specific

instructional strategies. Scores on the surveys were then compared to the attrition rates of online courses the faculty had taught. A moderate correlation was found between faculty whom, in the words of the survey, "encourage active learning" and lowered attrition rates. In other words, courses in which faculty made a concerted effort towards actively engaging students had higher retention and completion rates.

In a survey of approximately 800 undergraduate and graduate students, Bristow, Shepherd, Humphreys, & Ziebell, (2011) found that almost one-third (32%) of participants considered online learning a poor educational choice, with 13.6% of respondents rating their completion of an online course an extremely poor choice. Although this study does not delve deeply into why students perceived their online learning experiences this way, students did agree less to the following statement than with any of the other survey items: "In terms of student career preparation, employers consider online courses to be the equivalent of traditional format classes." Apparently, students at this university were worried that employers may not hold online courses in similar esteem when compared to face-to-face classes. Students also cited the lack of opportunities to work collaboratively with other students in online courses. Although these are the opinions of students at a single institution and may not be representative of university students across the nation as a whole, this sort of thinking does raise obvious concerns. As more education goes online, it behooves educators to design online courses that deliver experiences that compare favorably to the experiences that traditional students have and to develop online courses that students believe their future employers would consider equal in

merit to face-to-face courses.

An increasingly popular technique to counter online students' feelings of isolation and negative perceptions of virtual learning includes not only the aforementioned social networking platforms, but also the use of course management systems such as Moodle and Blackboard. These platforms help to streamline and organize course content in a manner that is easily navigated by students. With Blackboard, for example, students log-in to a website specific to their course, where they have access to course materials that may include text, video, images, and audio. Students also have access in Blackboard to discussion forums, a course calendar, their current grade book, and more. Although Blackboard has been shown to increase student engagement by fostering use of communication tools (Wang, 2011), it has a noted weakness in that it discourages real time student interactions, something that platforms such as Moodle excel at (Yau, Lam, & Cheung, 2009). These platforms are not a panacea, however, because proper training is needed for those students who may be unfamiliar with such technologies. Indeed, these platforms are only useful when participants have adequate working knowledge of them. In surveys and interviews of participants who completed online corporate training at a multinational corporation, two consistent themes emerged: self-efficacy was the strongest predictor of learner satisfaction and collegial support was the greatest predictor of learning outcomes (Gunawardena et al., 2010).

Discussion

In summary, much of the research in higher education finds no significant differences in student achievement between learners of online, hybrid, or face-to-

face courses. However, some studies do find significant differences. These studies offer an opportunity for researchers to not merely quantify the differences, but to attempt to determine *why* there are differences observed. If an online or blended course results in students with significantly better levels of achievement, it is incumbent on the researchers to find out what worked well. If studies can determine key factors that comprise a successful online course, then educators designing future online courses can incorporate some of these best practices when creating their curricula. Likewise, if a study finds that an online or blended course had significantly lower levels of student achievement associated with it, this also represents a learning opportunity for faculty developing online courses to be used in the future. In short, we can learn more from studies of online learning than simply whether or not students achieved at higher levels compared to face-to-face learners. We should attempt to learn why this was the case and utilize this information to inform future online curricular development.

Another important lesson to be gleaned from this body of research is the importance of students' sense of community in the learning process. When online learners feel isolated and disconnected from the community of learning, they feel less satisfaction with their education. This is likely a major factor that helps to explain the higher attrition rates found in online education. As previously stated, the arrival of Web 2.0 and the increasing presence of social media online present an opportunity to developers of online courses to not only mitigate the sense of isolation perceived in online learners, but to foster higher levels of collaboration and sense of community than was previously thought possible. The explosion in

numbers of users of internet social media platforms such as Facebook (over one billion users and rising) are evidence that web-based platforms can serve to help connect people. Ideally, developers of online course curricula can design future courses that help to relegate online learners' perceptions of feeling isolated to the past.

Conceptual Framework

The study of online learning is grounded in the research focusing on distance learning. Distance learning can vary along multiple dimensions. For example, it can be asynchronous or synchronous in nature (Means et al., 2005). Because much of distance learning was conducted by mail correspondence in the past, it was primarily composed of asynchronous learning. However, as distance learning evolved, telephone and television technologies allowed for the beginnings of synchronous learning to emerge, either through student-instructor voice calls, conference calls, or voice and video telecasts. This allowed progression on another dimension of distance learning, from expository learning experiences to active and interactive learning experiences (Zhang, 2005). A final dimension of distance learning worth noting is distance only versus a blended approach of remote learning and face-to-face learning.

In the 1990s, distance learning began to include online course delivery methods, opening the door for modern web-based instruction that varies along the same dimensions (synchronous versus asynchronous, blended versus purely online, etc.) as traditional distance learning. It is through this lens and framework that this

study approaches the research questions that pertain to online learning (Means et al., 2009). For example: Which method of course delivery and course material interaction is most effective in online learning, synchronous or asynchronous communications? Are course materials more effective in promoting learning when they are expository, active, or interactive in nature? Is purely online course delivery superior to a hybrid approach? Each of the studies aforementioned in the review of the literature can be viewed through this lens, as can this study itself. The vast majority of the learning activities employed in the virtual and hybrid courses in this study utilized asynchronous learning.

CHAPTER 3

Research Design and Data Analysis

Setting

The setting for this study is a medium-sized community college in Virginia. This community college is a public two-year institution and is accredited by the Southern Association of Colleges and Schools, Commission on Colleges. It offers subjects including liberal arts and project management and offers 11 certificates and 14 associate level degrees to students. Approximately five thousand students pursued degrees from the 21 programs at this community college in 2010. The institution is one of 23 community colleges in Virginia. The student body is 56% female and 44% male, the overwhelming majority of whom (over 95%) are Caucasian. The college currently employs 443 faculty with 15% of instructors employed full-time and about 84% of instructors serving part-time. Nearly half of the faculty is male. This community college has graduation rate of 16%.

Participants

This study utilizes archival data from every student in every course at the community college from 2008 to 2013. The data is anonymous, as students are only associated with the following variables: gender, course, semester, instructor, section (F, H, or V), and final grade. Instructors' identities are anonymous as well, although the administrator of the data from the college assigns each instructor a unique identifier code.

Data Collection

The data analyzed in this study was obtained through a contact my dissertation committee co-chair has at the community college. This contact introduced my co-chair to the community college's Coordinator of Institutional Research & Effectiveness. At that time, the coordinator indicated to my co-chair that the community college had kept data for the last 15 years which included every student's final grade for every course over this period of time. Although the coordinator intimated that the data was worthy of analysis, a lack of time was cited as the primary reason it had not been analyzed for trends and differences between student achievement in different course modalities. The data was received as a Microsoft Excel spreadsheet on a USB flash drive. Each semester is on its own sheet (or tab) in Excel. There is one row of data for every student in every course for each semester from Spring 1998 to Spring 2013, although the data selected for analysis are the semesters from Spring 2008 to Spring 2013. For the time period of interest to this study, there are 157,155 rows of data.

The data analysis found several statistically significant differences in the achievement of students enrolled in either virtual, hybrid, or face-to-face sections of the same course taught by the same instructor. After this data analysis, the department chairs were contacted and asked what factors they thought might have contributed to the significant differences found in this study. Thus, further data was collected that might help to explain the reason for the significant differences found in student achievement.

Data Analysis

End-of-course Grades

The primary data in this study is the end-of-course (EOC) grades assigned by the students' instructors, for every student in every course offered at the community college. Each row of data contains the following headings: Gender, Subject, Catalog, Course, Section, Instructor ID, Units (course credits), Grade, and Term. Although the instructor ID codes in the raw data already provide one layer of anonymity, this study converted each ID code to a second anonymous ID code, providing for another layer of security. *Figure 3-1* below is an example screenshot of the data from the spring semester of 2013. The number in cell A1 (11,976) denotes how many student grades were awarded in sum for the given semester.

	A	B	C	D	E	F	G	H	I
1	11,976								
2	Gend	Subject	Catalog	COURSE	Sectic	ID	Min Unit	Gra	Term
3	F	ITE	119	ITE 119	F	I1	3.00	W	2132
4	F	ITE	119	ITE 119	F	I1	3.00	A	2132
5	F	ITE	119	ITE 119	F	I1	3.00	W	2132
6	F	ITE	119	ITE 119	F	I1	3.00	B	2132
7	F	ITE	119	ITE 119	F	I1	3.00	W	2132
8	F	ITE	119	ITE 119	F	I1	3.00	B	2132
9	F	ITE	119	ITE 119	F	I1	3.00	W	2132
10	F	ITE	119	ITE 119	F	I1	3.00	B	2132
11	F	ITE	119	ITE 119	F	I1	3.00	A	2132

Figure 3-1. Screenshot of a small portion of the raw data from the spring semester of 2013.

The courses taken by the students are designated as virtual (V), hybrid (H), or face-to-face (F) in the "Section" column.

Courses

The courses chosen for the research questions were selected deliberately. In keeping with the goal of eliminating as many confounding variables as possible, for each target course analyzed, there were multiple sections (F, H, or V) taught by the same instructor which utilized identical syllabi. In other words, in theory, the only difference between the sections of the target courses analyzed was the manner in which the course material was presented to the students- either in face-to-face, hybrid, or virtual modality. Since different instructors, curricula, or objectives could account for any differences observed in student achievement, each course selected for the study had to meet two simple criteria:

1. The course was taught in different modalities, but by the same instructor.

2. The instructor utilized the same curriculum and syllabi in all the modalities in which he or she taught the course.

Developmental math courses in Virginia's community colleges follow the state-mandated curricula. The chair of the mathematics department at the community college in this study confirmed that each developmental math course has had, over the time period of interest, identical student objectives across teaching modalities and that the syllabi and textbooks used have remained the same. Although the chairs of the various departments at the community college state that instructors are using identical syllabi and curricula across teaching modalities, it is possible there may be a difference between the intended and enacted curriculum in some cases (see Assumptions and Limitations below). The courses MTH 3 and MTH 4

were selected because they were taught in both hybrid and face-to-face sections by the same instructor over the time period of interest to this study. Typically, the instructors chosen taught two sections of a target course per year, and taught one to two of these for a given semester (see *Table 3-2*). Although ideally an instructor would teach all sections offered for a given target course during the same semester, this was most often not the case. Changes in instruction over time is a possible confounding variable (see Assumptions and Limitations below).

Basic Algebra I (or MTH 3), is a one-credit module course which covers algebra basics, such as basic operations with algebraic expressions and solving simple algebraic equations involving integers. An emphasis is placed on applications throughout the course. In the next module course *Basic Algebra II* (or MTH 4), students learn to solve first degree equations and inequalities containing one variable, and to solve application problems. The emphasis in this course is on learning the steps to solving the equations and inequalities, applications, and problem solving (Serbousek, 2011). The title of the text used in MTH 3 was Introductory Algebra by Elayne Martin-Gay. MTH 4 used Intermediate Algebra also by Martin-Gay. Both textbooks use Pearson's MyMathLab online component. MyMathLab provides students with an online copy of the text, a study plan, practice tests, and homework problems. Access to Pearson's MyMathLab is restricted to customers who purchase the text. The learning tools available include a computer tutor, examples, and video lectures. Hybrid and face-to-face students use the same text. The primary difference between the face-to-face and hybrid sections of the course is the time spent per week with instructors. The students in

face-to-face sections have 5 hours per week of instructor time, whereas hybrid students have only 3 hours of instructor time per week.

Table 3-1

Course, Modalities Offered, Number of Instructors, and Total Sections

Course	Face-to-face	Virtual	Hybrid	Number of Instructors	Number of Sections
MTH 3	✓		✓	8	72
MTH 4	✓		✓	1	14
ENF 3	✓		✓	1	2
ENG 111	✓	✓	✓	2	25
VET 100	✓	✓		1	7
VET 230		✓	✓	1	11
ACC 212	✓	✓	✓	1	14

Developmental English courses also have state-mandated curricula in Virginia's community colleges, making them appealing candidates for this study. The course *English Fundamentals 3* (or ENF 3) was selected because it was taught in multiple modalities by the same instructor. The chair of the English department at the community college in this study confirmed that each developmental English course has identical student objectives across teaching modalities and that the syllabi used are the same. ENF 3 provides integrated reading and writing instruction for students who require minimal preparation in college-level English courses, but still need some preparation to succeed. Students in this course are co-enrolled in *College Composition I* (or ENG 111). Students are placed in this course based on the Virginia

Placement Test for English. ENF 3 was taught exclusively in face-to-face sections prior to 2013, so there was only one face-to-face section taught in Spring 2013 to compare to one hybrid section in the same semester (see *Table 3-1*).

ENG 111 was also chosen for analysis because there were two instructors who each taught the course in all three modalities. The chair of the English department indicated that teachers of ENG 111 utilize the same curriculum and identical syllabi across teaching modalities. There were 25 sections taught by the two instructors who taught in multiple modalities over the time period of interest (see *Table 3-1*).

The chair of the veterinary department at the community college in this study indicated that the offered VET courses do have an external organization which accredits their program and gives them permission to continue teaching. Although this mandate carries a set of expected learning outcomes, it does not outline a specific curriculum. Students' achievement of the objectives is determined by successful completion of state boards upon graduation. Although the curriculum is not state-mandated, the chair stated that instructors use the same objectives and syllabi across modalities. *Introduction to Animal Science* (or VET 100) is a 4-credit course which covers common breeds of large and small domestic animals, including identification, management, and restraint. *Veterinary Hospital Management* (or VET 230) is a 3-credit course which includes common business procedures used in veterinary practice, such as appointment scheduling, record keeping, merchandising, drug ordering and inventory, and supervision of employees. These courses were chosen because there were instructors who taught the same course in different teaching modalities. VET 100 had one instructor who taught 7 total

section in the time period of interest, whereas VET 230 had one instructor who taught 11total sections (see *Table 3-1*).

Although there is no state-mandated curriculum for accounting at the community college, the chair of the accounting department has indicated that all instructors use the same curriculum and syllabi when teaching accounting in different modalities. *Principles of Accounting II* (or ACC 212) is a 3-credit course with an emphasis on partnerships, corporations, and the study of financial analysis. The course includes an introduction to cost and managerial accounting. It was chosen because it had been taught by the same instructor across modalities while using an identical curriculum and syllabus. One instructor of ACC 212 taught 14 total sections over the time period analyzed in this study (see *Table 3-1*).

The data analysis for this study consists of both descriptive and inferential analysis. The descriptive analysis relies primarily on the use of pivot tables and pivot charts, whereas the inferential analysis utilizes the Chi-square test. The Excel functions of "IF", "SKEW", and "KURT" were also utilized in order to confirm the appropriateness of using non-parametric statistical analysis such as Chi-square.

Descriptive Analysis

In this study, pivot tables and pivot charts are the primary tools utilized to create achievement profiles for comparisons between specific classes, subject areas, or gender. Pivot tables are well-suited for taking voluminous data and sorting it in a manner customizable to the user. For example, *Figure 3-2* below shows a pivot table created from the data sorted by Course, Instructor ID, Section, and Grade. The total

column is easily toggled between displaying percent or count of grade (shown). Row headings (such as Course, ID of instructor, Section, etc.) can be collapsed or expanded, and specific row headings can be selected or unselected. Pivot charts are the graphical equivalent of pivot tables, and are manipulated in an identical manner. Unless otherwise denoted, percentages in the discourse of this paper have been rounded to the nearest percent for ease of use.

Row Labels	Count of Grade
ACC 212	**100.00%**
A1	**100.00%**
Face-to-face	68.60%
A	20.77%
B	40.77%
C	21.54%
D	6.15%
F	9.23%
W	1.54%
Hybrid	17.68%
A	31.34%
B	38.81%
C	13.43%
D	2.99%
F	7.46%
W	5.97%
Virtual	13.72%
A	11.54%
B	34.62%
C	17.31%
D	5.77%
F	25.00%
W	5.77%
Grand Total	**100.00%**

Figure 3-2. Example Excel Pivot Table from Spring 2013

As can be seen in *Figure 3-2*, the accounting course ACC 212 was offered by instructor A1 in face-to-face (F), hybrid (H), and virtual (V) sections. As we can see in the ACC 212 course data, the hybrid section achieved at higher levels than the either the face-to-face or the virtual sections, as measured by the percent of students earning either an A or B. In the hybrid section, approximately 70% of students were scored an A or B, compared to 61% of students in the face-to-face section and 46% in the virtual section. Additionally, the hybrid class had a lower percentage of students earning a D, F, or W (16%) when compared with the face-to-face class (17%) and virtual class (37%).

Figure A-1, Figure A-2, and Figure A-3 (in Appendix) show three more examples of pivot tables created from the same Spring 2013 semester's data. All the pivot tables use the grade assigned by the instructor as the dependent measure to calculate the total in the final column. *Figure A-1* is sorted by Course (ACC 211), Section, and Grade. *Figure A-2* is sorted by Section and Grade, for all courses of the Spring 2013 semester. *Figure A-3* is sorted by Subject (ACC shown), Section, and Grade. Each variation of pivot table has its advantages depending on what answers are being sought.

Inferential Analysis

Wile the pivot tables will be useful for identifying and describing differences in student achievement profiles, the statistical significance of the results require a different set of analysis. For classes of interest to the research questions, the

students' grades were converted into numbers consistent with a standard GPA scale, with an 'A' equivalent to a 4, a 'B' equivalent to a 3, and so on (see *Table 3-2*).

Table 3-2

Grade earned and corresponding GPA Equivalent

Grade	GPA Equivalent
A	4
B	3
C	2
D	1
F	0
I (incomplete)	0
P (pass)	3
R (repeat)	1
S (satisfactory)	3
U (unsatisfactory)	0
W (withdraw)	0

First, this study used an "IF" function to convert standard letter grades into a GPA equivalent number. Next, the analysis utilized the "SKEW" and "KURT" functions to calculate the skewness and kurtosis of the grade distributions by class. *Figure 3-3* illustrates the two additional columns "GPA " and "Skew/Kurtosis" added to the sheet.

	A	B	C	D	E	F	G	H	I	J	K
1	11,976										
2	Gende	Subject	Catalog	COURSE	Section	ID	Min Units	Grad	Term	Skew/Kurtosis	GPA Equiv
3	F	ITE	119	ITE 119	F	X228739	3.00	W	2132	0.158587502	0
4	F	ITE	119	ITE 119	F	X228739	3.00	A	2132	-1.74258034	4
5	F	ITE	119	ITE 119	F	X228739	3.00	W	2132		0
6	F	ITE	119	ITE 119	F	X228739	3.00	B	2132		3
7	F	ITE	119	ITE 119	F	X228739	3.00	W	2132		0
8	F	ITE	119	ITE 119	F	X228739	3.00	B	2132		3
9	F	ITE	119	ITE 119	F	X228739	3.00	W	2132		0
10	F	ITE	119	ITE 119	F	X228739	3.00	B	2132		3
11	F	ITE	119	ITE 119	F	X228739	3.00	A	2132		4
12	M	ITE	119	ITE 119	F	X228739	3.00	F	2132		0
13	M	ITE	119	ITE 119	F	X228739	3.00	A	2132		4
14	M	ITE	119	ITE 119	F	X228739	3.00	C	2132		2
15	M	ITE	119	ITE 119	F	X228739	3.00	C	2132		2
16	M	ITE	119	ITE 119	F	X228739	3.00	C	2132		2
17	M	ITE	119	ITE 119	F	X228739	3.00	W	2132		0
18	M	ITE	119	ITE 119	F	X228739	3.00	F	2132		0
19	M	ITE	119	ITE 119	F	X228739	3.00	F	2132		0
20	M	ITE	119	ITE 119	F	X228739	3.00	B	2132		3

Figure 3-3. Screenshot of data with skew and kurtosis of class grade distributions added.

In the "Skew/Kurtosis" column, the top number for each course represents its grade distribution's skew and the bottom number denotes its kurtosis. After calculating skew and kurtosis for many courses, including the courses of interest to the research questions, it became apparent that the distributions were not normal distributions, since the mean skew was less than -1 and the typical magnitude of the kurtosis was near 2. Because the distributions are not normal, a non-parametric measure (specifically Chi-square) was utilized to test for significance. Given that the data is categorical in nature, the Chi-square test is a good fit.

The Chi-square test first involves organizing the observed frequency of end-of-course grades into a table. For example, the table for end-of-course grades for students taking MTH 3 from instructor M2 during the time period of Spring 2008 to Spring 2013 is show in *Figure 3-4* below. The F and H rows represent face-to-face and hybrid sections, respectively. The grades of R, S, U, and W represent Repeat, Satisfactory, Unsatisfactory, and Withdraw, respectively.

Column and Row Totals						
	R	S	U	W		*Row Totals*
F	31	27	14	1		73
H	12	14	16	1		43
Column Totals	43	41	30	2		116 (Grand Total)

Figure 3-4. Screenshot of example Chi-square table with column and row totals.

Next, the Chi-square statistic is calculated along with the probability (p-value) that the results are a result of chance alone, using $p < 0.05$ as the threshold. The expected and Chi-square values are shown in each cell, along with the overall Chi-square statistic and p-value immediately beneath the table in *Figure 3-5* below.

Results						
	R	S	U	W		*Row Totals*
F	31 (27.06) [0.57]	27 (25.80) [0.06]	14 (18.88) [1.26]	1 (1.26) [0.05]		73
H	12 (15.94) [0.97]	14 (15.20) [0.09]	16 (11.12) [2.14]	1 (0.74) [0.09]		43
Column Totals	43	41	30	2		116 (Grand Total)

The chi-square statistic is 5.2427. The P-Value is 0.154866. The result is *not* significant at $p < 0.05$.

Figure 3-5. Screenshot of example Chi-square table with Chi-square values and p-value.

Although the number of students earning an S (for satisfactory) is higher than expected for students in the face-to-face sections and lower than expected for the students in hybrid sections, the results are not statistically significant. This means that the results could very well be due to chance alone. For results in this study that were found to be statistically significant, Cramer's V has been calculated

in order to determine the effect size. The relative effect size by degrees of freedom is shown in *Table 3-3* below.

Table 3-3

Cramer's V effect sizes, per Cohen (2013)

df*	small	medium	large
1	.10	.30	.50
2	.07	.21	.35
3	.06	.17	.29

Note. *df is defined as the lesser of the rows minus 1 or the columns minus 1

In order to simplify the Chi-square analysis, grades from courses which utilize the traditional grading scale of A, B, C, D, F, and W were grouped into Highly Successful (A or B), Somewhat Successful (C or D), Unsuccessful (F, U, and R) and Incomplete (W). The primary reason for doing this is the difficulty of comparing a hypothetical face-to-face section with more grades of A and D, but less grades of B and C than a comparable virtual section of a course. Although the data may lose some granularity by collapsing the grades into categories, the hope is that the higher clarity with regards to student achievement will outweigh the possible loss in granularity. Despite the fact that withdrawing from a course (thus earning a grade of W) and failing a course (thereby earning an F) each represent an unsuccessful completion of the class, they can be thought of as fundamentally different by nature. Therefore, they were assigned to their own categories. Even though the data was

grouped for the Chi-square test, the descriptive analysis of student achievement includes discussion of individual letter grades.

Rather than presenting each individual Chi-square test table, results will be summarized by subject area in a table format which will include Chi-square test statistic along with other pertinent statistical information including sample size (n), p-value, and Cramer's V as a measure of effect size.

Assumptions and Limitations

For each of the research questions involved in this study, the primary assumption made is that any differences observed in student performance across teaching modalities is a result of the different teaching modalities themselves. Although every effort has been made to eliminate confounders such as different instructors or differing syllabi, there are other possible sources for any observed differences in student achievement. For example, one limitation of this study could be selection bias. Since there is no random assignment of participants to hybrid, virtual, or face-to-face sections of courses, it is possible that readiness levels of students choosing virtual courses could be different than the readiness levels of students choosing face-to-face courses. There could also be selection bias due to mere convenience and/or math avoidance. Perhaps not physically going to class is more convenient for some students, especially if learning math with an instructor or other students causes math anxiety and a tendency to want to avoid "doing" math.

Also, the amount of time spent by students interacting with course material could account for differences observed in student achievement across modalities. If students in hybrid sections are spending double the amount of time on task for a

given course, perhaps some of the differences in student achievement are due to this. Perhaps the efficacy of virtual courses could be due, at least in part, to the technological literacy of students choosing them. It is possible that students choosing virtual courses may do so for flexibility in scheduling their time, despite the possibility that using educational computing technologies is not something at which they excel.

Another possible limitation of this study is considering changes in instruction over time. Despite the fact that most of the comparisons made in this study contrast the achievement of students in enrolled in different sections (H, V, or F) of the same course by the same instructor, the semester in which the students completed the course may differ. For example, an instructor may have taught a hybrid section of the course in 2008 that this study is comparing to face-to-face sections taught in 2013. Because instruction may evolve over time, some of the difference seen could be due, at least in part, to this evolution of instruction.

Enrollment in community college courses can change over time as well. The gender, race, and age demographics of a students enrolled in a course can evolve. Successive incoming classes of students can have either higher or lower readiness levels than students from previous years. Although the time period examined in this study is only 5 years, it is possible some effects observed in this study are due to changing demographics within courses. Because the only demographic information available in the raw data is gender, this variable was included in the data analysis in this study.

The intended curriculum might be the same for a course taught in different modalities by the same instructor, whereas the enacted curriculum is actually different. This could happen because students in hybrid sections are not watching the video tutorials that explain how to solve a problem and instead skip right to the practice problems or homework. Students in hybrid sections might skip some of the online activities when compared to their virtual counterparts, believing they can make up for it by asking the instructor questions while in class. This difference between the intended and enacted curriculum could account for differences seen across the three teaching modalities.

These are merely a few of many possible limitations to this study. Although this study has clear limitations, by selecting courses taught in more than one modality by the same instructor using the same syllabi, an effort was made to reduce the number of key variables that could possibly account for differences noted in student achievement across teaching modalities.

CHAPTER 4

Results

Achievement of Developmental Math Students

The first research question in this study concerns the relative student achievement between hybrid and face-to-face sections of developmental math. The courses chosen for analysis were MTH 3 and MTH 4. Beginning in the Spring 2013 semester, the prefixes for developmental math courses changed to MTE at the community college participating in this study, although the texts used for the courses remains the same. At this time, the decision was made to teach developmental math in hybrid sections only (presumably to standardize the developmental math learning experience for all students). Therefore, the following analysis of developmental math examines the courses from the Spring 2008 semester to the Fall 2012 semester, since after this there are no face-to face sections with which to compare to hybrid sections. During this time period, 1,722 students were enrolled in MTH 3 and 384 students were enrolled in MTH 4. The grading scale for developmental courses is S (satisfactory), U (unsatisfactory), R (repeat), and W/X (withdraw or incomplete). A grade of R is considered superior to a grade of U, since a grade of R indicates that a student may re-enroll in the course without first meeting with the instructor and their academic advisor.

MTH 3

Upon examining the data for MTH 3 courses, eight instructors were found to have taught both hybrid (H) and face-to-face (F) sections. The pivot chart for the

grade distributions by percentage for these instructors are shown in *Figure 4-1* below. The instructor ID codes, from left to right on the chart, are: M1, M5, M6, M2, M3, M7, M8, and M4. For six of the eight instructors (all except M5 and M7), it is evident that the face-to-face sections had a higher percentage of students earning grades of S (for satisfactory) and a lower percentage of students earning grades of U (for unsatisfactory) and W (for withdraw). For all instructors except two (M2 and M3), higher percentages of students received grades of R (repeat) in the hybrid sections than in the face-to-face sections (see *Table 4-1*). Therefore, it appears on the surface that students enrolled in MTH 3 in face-to-face sections outperformed students in hybrid sections with regards to end-of-course grades.

Table 4-1

Grade breakdown in percent and sample size per section (n) for MTH 3 by instructor

Instructor	Face-to-face S	Hybrid S	Face-to-face U & W	Hybrid U & W	Face-to-Face R	Hybrid R	Face-to-face *n*	Hybrid *n*
M1	81	70	11	10	9	20	47	33
M5	50	86	50	14	0	0	4	7
M6	71	30	29	52	0	18	7	550
M2	37	33	21	40	42	28	73	43
M3	44	28	44	41	12	10	34	173
M7	37	40	53	40	10	20	129	15
M8	67	28	33	55	0	17	3	455
M4	42	5	41	64	16	31	113	39

Figure 4-1. Grade distributions for instructors who taught MTH 3 in both modalities (by percent of students per modality).

However, looking at the number of students by section in MTH 3 (rather than the percentage) offers additional insights. As can be seen in *Table 4-1*, four of the eight instructors taught a total number of students in a particular section that is too low with which to make comparisons meaningful (n<20). For example, instructor M5 taught only 4 students in face-to-face sections and 7 students in hybrid sections over the given time period (see *Figure A-4* in the Appendix). Likewise, instructor M6 taught only 7 students in face-to-face sections, instructor M7 taught only 15 students in hybrid sections, and instructor M8 taught only 3 students in face-to-face sections.

Removing the instructors with low numbers of students per section yields the following pivot chart, shown in *Figure 4-2* below. Again, for each instructor, the percentage of students earning grades of Satisfactory is higher for their face-to-face sections than in their hybrid sections. Likewise, the percent of students earning a grade of Unsatisfactory is lower in each instructor's face-to-face sections when compared to their hybrid sections. It appears for these instructors that students taking MTH 3 face-to-face outperformed students taking the course in hybrids sections with regards to end-of-course grades.

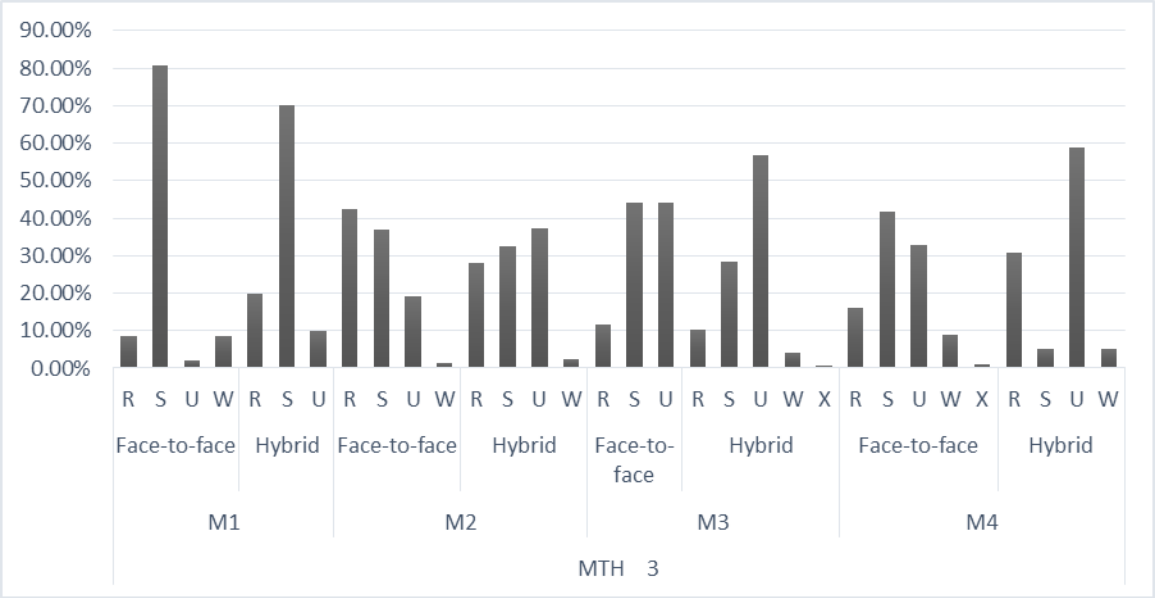

Figure 4-2. Grade distribution for instructors who taught MTH 3 in both modalities (by percent of students per section). Instructors with low numbers of students removed.

The grade distribution for these four instructors by number of students per section, rather than percent of students per section, is displayed in the pivot chart in *Figure A-4* in the Appendix. In order to test for statistical significance, these numbers will be used to calculate a Chi-square statistic for 'goodness of fit' for each instructor.

The statistical results, with their respective Chi-square statistic, p-values, and statistical significance for these four instructors are shown in *Table 4-2* below. As is evident, the results of the Chi-square tests were statistically significant (at the $p < .05$ level) in only one case, for instructor M4, whose face-to-face students earned significantly higher grades than the hybrid students earned. The p-value for the differences observed was 0.0001, which means that there is less than .01% chance

that the results were achieved by chance alone. The effect size as measured by Cramer's V was 0.371. As was referenced in *Table 3-3*, this denotes a medium to large effect size (1 degree of freedom). Not only did students in instructor M4's face-to-face sections earn significantly higher grades than their hybrid section peers, the difference between the two groups was considerable. Although not found to be significant, the effect sizes for instructors M1, M2, and M3 were 0.299, 0.213, and 0.151, respectively. The effect size for instructor M1 is considered medium and particularly noteworthy because the results were nearly significant. Because each MTH 3 instructor's students in face-to-face sections earned higher grades than students in hybrid sections, and because the effect sizes were small to medium even in instances where the results were found to be insignificant, this lends more evidence to the assertion that developmental math students in face-to-face sections achieve at higher levels than their hybrid section counterparts.

As *Table 4-2* indicates, the results were nearly statistically significant (at the $p < .05$ level) for instructor M1, yielding a probability value of approximately .076. This indicates that the probability of these results happening by mere chance alone is about 7.6%. Although it is not likely that the results for this instructor happened by chance alone, the findings are not statistically significant when using the $p < .05$ threshold. For instructors M2 and M3, the p-values are approximately 0.155 and 0.193, respectively.

Table 4-2

Summary of Results and Measures of Statistical Significance for MTH 3 at the instructor level

Course-Section	Instructor	Grading Scale	Comparison Groups	Group(s) with Highest Grades	*n*	Chi-square statistic	p-value	Cramer's V
MTH 3	M1	RSUW	F, H	F	77	6.880	0.076	0.299
MTH 3	M2	RSUW	F, H	F	116	5.243	0.155	0.213
MTH 3	M3	RSUW	F, H	F	207	4.732	0.193	0.151
MTH 3	M4	RSUW	F, H	F	152	20.967	0.0001*	0.371

Summary of MTH 3 by Instructor

For each of the four instructors who taught MTH 3 in two modalities, students in their face-to-face sections outperformed the students in their hybrid sections. However, the results were statistically significant for only one of the four instructors. In this case, the effect size was medium to large. It would be interesting to discover if this finding of higher achievement in MTH 3 face-to-face sections holds true when considering all of the data in the time period of interest. Therefore, this study collapsed the grades in all sections from all instructors for the course MTH 3 from Spring 2008 to Fall 2012 (see *Figure 4-3*).

MTH 3 in Aggregate

As is evident in *Figure 4-3* below, the percentage of students in face-to-face sections of MTH 3 earning a grade of Satisfactory is higher (41%) than students enrolled in hybrid sections (28%). Likewise, the percentage of students in face-to-face sections earning a grade of U or W (40%) is lower than students enrolled in

hybrid sections (54%). The percentage of students earning a grade of R was similar between the face-to-face sections (19%) and the hybrid sections (18%). The earlier finding of MTH 3 students enrolled in face-to-face sections outperforming students enrolled in hybrid sections appears to hold true when collapsing all of the data, but the statistical significance must be determined next.

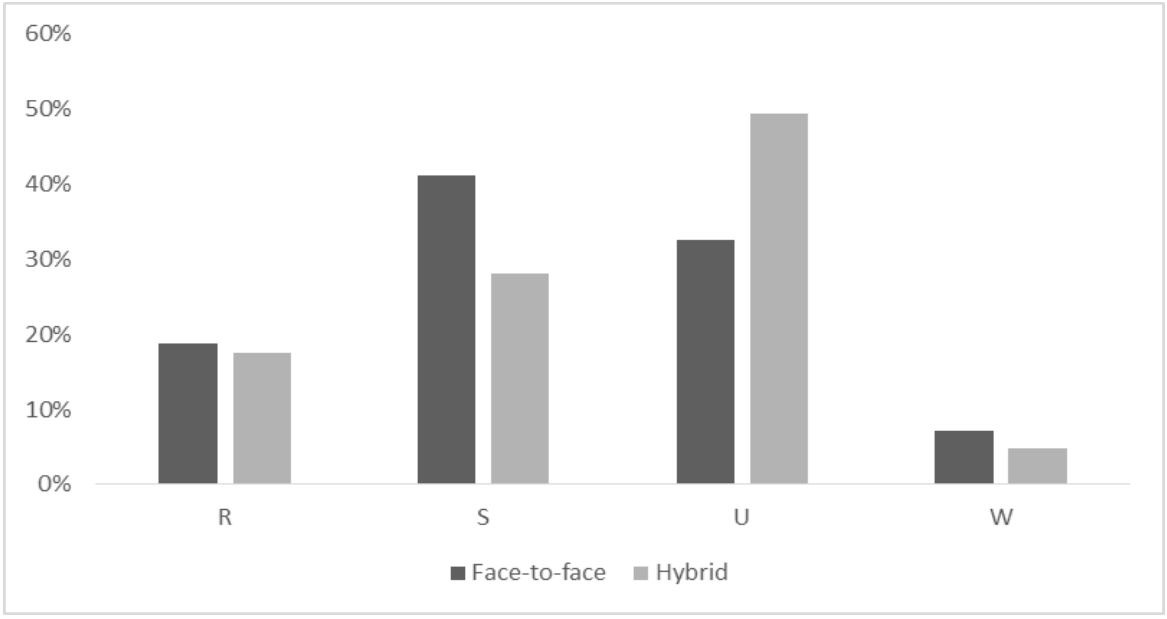

Figure 4-3. Grade distribution for all MTH 3 students (by percent of students per modality).

Using the data from the pivot chart seen in *Figure A-5* in the Appendix, a Chi-square test was executed. The Chi-square statistic, p-value, and statistical significance for the collapsed data is shown in *Table 4-3*. The p-value is less than 0.00001, meaning that the chance of these results occurring due to mere chance alone is less than 0.001%. The results are therefore significant at the $p < 0.05$ threshold. The effect size as measured by Cramer's V was 0.167, which denotes a small to medium effect size.

Table 4-3

Summary of Results and Measures of Statistical Significance for MTH 3 all instructors

Course-Section	Instructor	Grading Scale	Comparison Groups	Group(s) with Highest Grades	*n*	Chi-square statistic	p-value	Cramer's V
MTH 3	All	RSUW	F,H	F	2466	68.866	0.00001*	0.167

Summary of MTH 3 in Aggregate

Although there were clear indications that students enrolled in face-to-face sections of MTH 3 outperformed students enrolled in hybrid sections when considering one instructor at a time, the results were not always significant. However, when collapsing all of the data from MTH 3 sections over the time period of interest to this study, the finding becomes overwhelmingly apparent. When including all students who enrolled in MTH 3 in all sections over this time period, students enrolled in the face-to-face sections earned significantly higher grades than students enrolled in hybrid sections. The effect size was between small and medium.

MTH 4

For the course MTH 4, only one instructor (M3) taught both hybrid and face-to-face sections over the time period of interest (n = 244). The grade distributions by percent of section for this instructor are shown in *Figure 4-4* below. As was the case in MTH 3, students taking the course in face-to-face sections had a higher percent of Satisfactory grades earned (about 45% to 26%), and a lower percent of

Unsatisfactory grades earned (about 40% to 48%) than did students taking the course in hybrid sections.

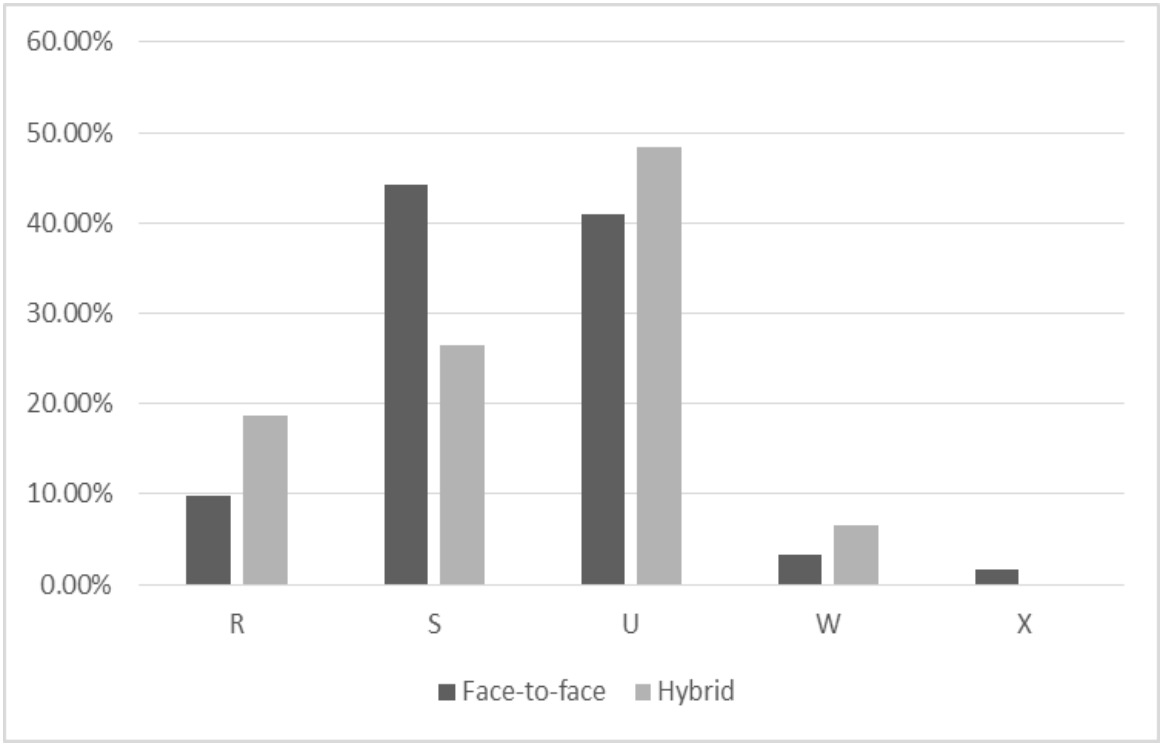

Figure 4-4. Grade distribution for MTH 4 students of instructor M3 in both modalities (by percent of students per modality).

Using the number of students earning a particular grade by section as reported in the pivot table in *Figure A-6* in the Appendix, the Chi-square test was performed, resulting in *Table 4-4*. Here, the Chi-square test determines the results to be statistically significant, yielding a p-value of approximately 0.038. This indicates that the probability of the results occurring by mere chance alone is roughly 3.8%. The effect size, in this case Cramer's V, was 0.185. This indicates a small to medium effect size. In other words, not only did students in students in face-to-face sections of MTH 4 with instructor M3 earn significantly higher grades

than students in hybrid sections, but the difference in achievement was considerable.

Table 4-4

Summary of Results and Measures of Statistical Significance for MTH 4

Course-Section	Instructor	Grading Scale	Comparison Groups	Group(s) with Highest Grades	*n*	Chi-square statistic	p-value	Cramer's V
MTH 4	M3	RSUW	F, H	F	244	8.403	0.038*	0.185

Summary of MTH 3 and MTH 4

For the developmental math courses chosen for this study, MTH 3 and MTH 4, over the time period in question (Spring 2008 to Fall 2012), there were only five cases in which instructors taught significant numbers of students in both the hybrid and face-to-face modalities. In each of these five cases, students enrolled in face-to-face sections outperformed students enrolled in the hybrid sections as measured by end-of-course grades. Students in the face-to-face sections had a higher percentage of Satisfactory grades earned and a lower percentage of Unsatisfactory grades earned than did students in the hybrid sections. However, the results were statistically significant in only two of the five instances. For three of the five cases at the instructor level, the percent of students earning a W (for withdraw) was higher for hybrid sections than for face-to-face sections, although the results were

significant only in the case of instructor M3 when teaching MTH 4 and M4 when teaching MTH 3.

For instructor M4 teaching MTH 3, the effect size was medium to large. For MTH 4 and instructor M3, the effect size was between small and medium. When all students' grades in MTH 3 were examined in aggregate regardless of instructor, students in face-to-face sections again earned significantly higher grades, with a small to medium effect size. Although this hints at the attrition problem detailed in the literature review section above, caution is needed when attempting to draw conclusions since the results were not statistically significant in three of the five cases.

Achievement of Students in other Subject Areas

Having found that students in face-to-face sections generally achieved at higher levels than students in hybrid sections of the developmental math courses MTH 3 and MTH 4, this study now turns its focus to other subject areas: English, Accounting, and Veterinary Studies. These subject areas were chosen in part due to their diversity from each other and the likely diversity in types of students that might choose to enroll in these subject areas. Students needing to enroll in developmental math likely have little in common academically with students enrolling in a 200-level Accounting course, for example. For this reason, the achievement profiles by course modality of students enrolling in these disparate disciplines may differ from one another significantly.

ENF 3

English Fundamentals 3 (or ENF 3) is a developmental English course designed to prepare students for college-level English classes. These developmental English courses prior to 2013 had a course prefix of ENG rather than ENF, and were taught exclusively in face-to-face sections. Accordingly, only one instructor at the community college (E1) over the time period of interest (Spring 2008 to Spring 2013) taught sections in both the face-to-face and hybrid modalities. The grade distributions by percent of section are displayed in *Figure 4-5*.

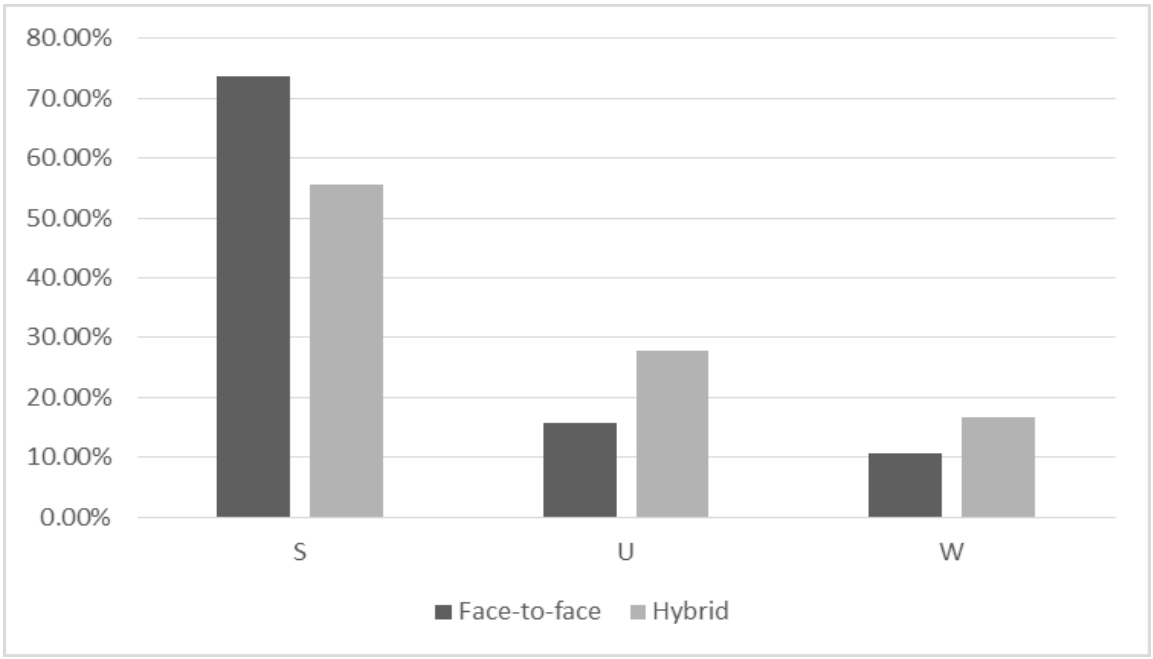

Figure 4-5. Grade distribution for ENF 3 students of instructor E1 in both modalities (by percent of students per modality).

As was the case in the developmental math courses analyzed, students in the face-to-face sections had a higher percentage of Satisfactory grades earned (approximately 74% to 56%) and a lower percentage of Unsatisfactory grades

earned (approximately 16% to 28%) when compared to students enrolled in the hybrid sections. Additionally, more students withdrew from the hybrid sections of the course (roughly 17%) than from the face-to-face sections of the course (roughly 11%).

However, as can be seen in the pivot chart in *Figure A-7* in the Appendix, the number of students who enrolled in these sections is so low (*n* = 37 for both sections combined) that the likelihood of significant findings is low. Nevertheless, a Chi-square test using the data contained in *Figure A-7* was conducted to determine statistical significance. As expected, the findings were not statistically significant, having approximately a 51% probability of occurring by chance alone (p = .51155). The effect size was 0.190. The findings are summarized in *Table 4-5.*

Table 4-5

Summary of Results and Measures of Statistical Significance for ENF 3

Course-Section	Instructor	Grading Scale	Comparison Groups	Group(s) with Highest Grades	*n*	Chi-square statistic	p-value	Cramer's V
ENF 3	E1	RSUW	F, H	F	37	1.340	0.511	0.190

ENG 111

Although all students enrolled in developmental English 3 (ENF 3) are co-enrolled in ENG 111, the reverse is not necessarily true. The majority of students who enroll in ENG 111 do not do so out of compulsion, but rather do so by choice. Because ENG 111 is a 100-level college English course that counts towards an

associate's degree, many degree seeking students enroll. Therefore, ENG 111 is a suitable candidate for analysis because the number of students taking this course is high. Searching the data for time period of interest yielded two instructors (E2 and E3) who taught ENG 111 in all three modalities- F, H, and V. Together, these two instructors taught 518 students during this time period. The grade distribution by percent of section for these two instructors is shown *Figure 4-6* and *Figure 4-7* below.

As one can see from the data in *Figure 4-6*, the students in the hybrid sections of the first instructor (E2) outperformed students in the face-to-face and virtual sections. This is evidenced by a higher percentage of students in hybrid sections earning an A (32%) than in either the virtual or face-to-face sections (29% and 18%), respectively. The same holds true for students in hybrid sections earning a B (36%) compared to students in virtual sections (18%) and face-to-face sections (29%). Likewise, the percentage of students earning a grade of F is lower in the hybrid sections (11%) than in either the face-to-face sections (15%) or virtual sections (16%). Notably, the virtual sections had a higher percentage of students who withdrew (11%) than did the hybrid sections (0%) and the face-to-face sections (4%). Although the data appears clear when examined grade by grade, the grades were collapsed into the categories outlined earlier in this paper for the Chi-square analysis.

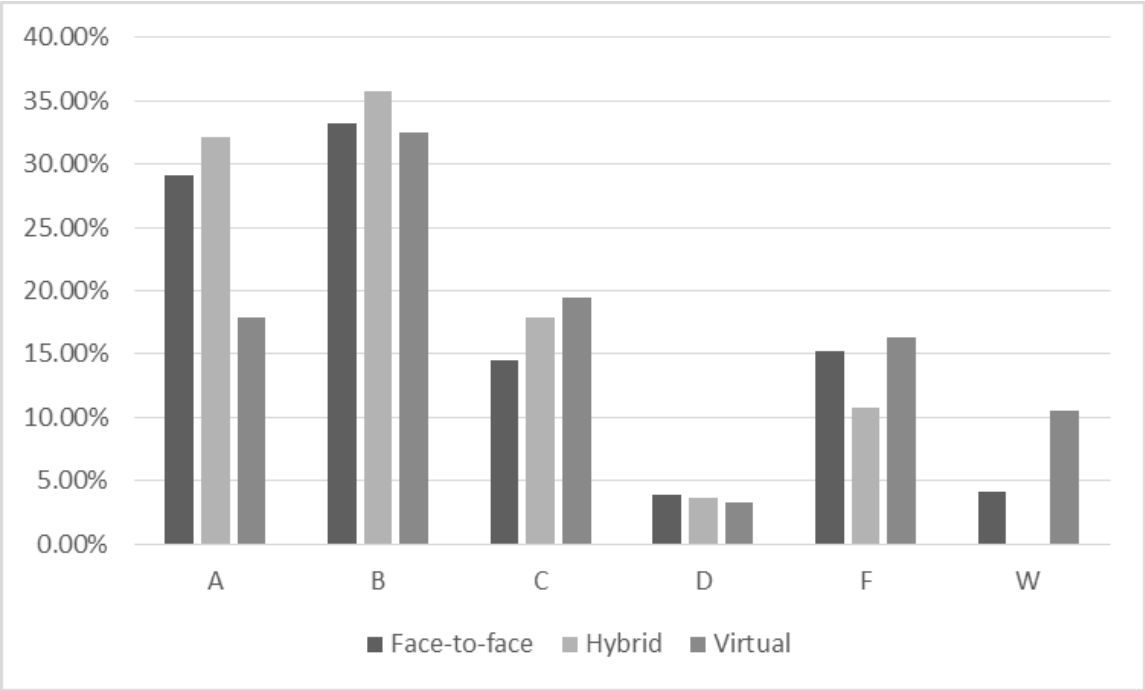

Figure 4-6. Grade distribution for ENG 111 students of instructor E2 in all three modalities (by percent of students per modality).

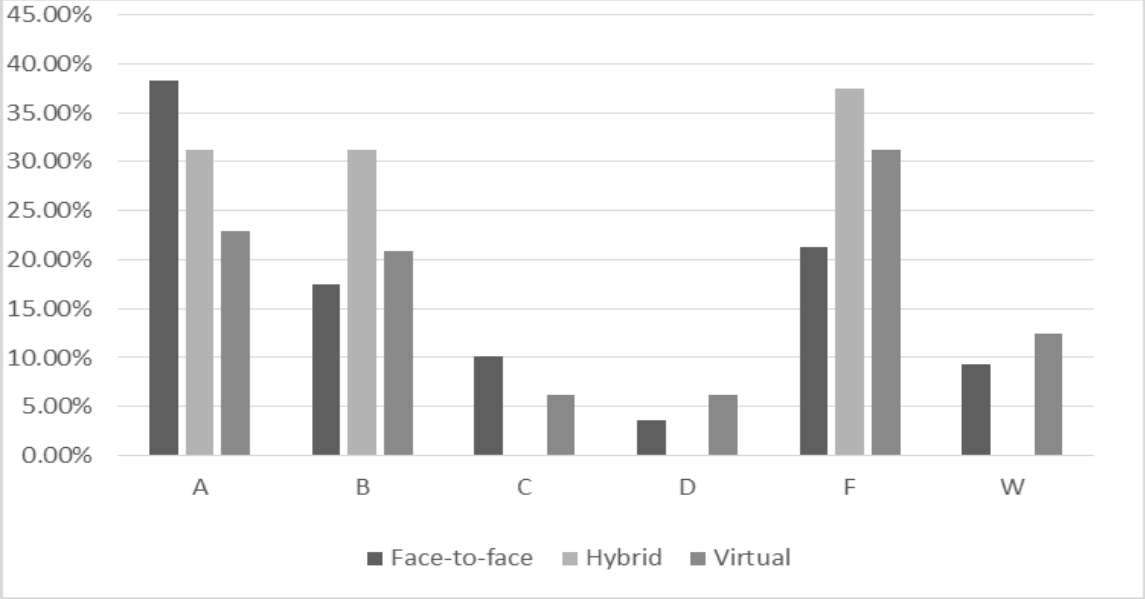

Figure 4-7. Grade distribution for ENG 111 students of instructor E3 in all three modalities (by percent of students per modality).

The results for the different sections of ENG 111 taught by the second instructor (E3) are less clear (see *Figure 4-7*). The face-to-face sections had the highest percentage of students earning an A (38% compared to 31% for hybrid sections and 23% for virtual sections) and the lowest percentage of students that failed (21% compared to 37.5% for hybrid and 31% for virtual). Despite these findings, the hybrid sections had the highest percentage of students that were Highly Successful, with 62.5% of students earning either an A or B, compared to 56% in face-to-face sections and 44% in virtual sections. However, given that the hybrid sections also led the way in students earning an F as noted above, it is fair to say that the results are mixed. As was the case with the first instructor of ENG 111 discussed above, the students in the virtual sections had the highest percentage of withdrawals (12.5%) when compared to the hybrid (0%) and face-to-face sections (9%). It is worth noting that the hybrid sections had no withdrawals, although the low number of students (evidenced below) may at least partially account for this.

The number of students earning each grade (by instructor by section) in ENG 111 for the two instructors of note are displayed in the pivot table in *Figure A-8* in the Appendix. Notice that the number of students taking the course in hybrid modality is low for both instructors. This not only plays a role when determining the statistical significance of the results previously detailed, but also will play a role in deciphering the educational significance of the findings. The data from this pivot chart was used in the Chi-square tests for both instructors teaching ENG 111 in all three modalities.

The Chi-square test results, along with other key statistics, are shown in *Table 4-6.* The results are statistically significant for instructor E2, with a p-value of 0.047. This indicates that the probability that the results observed were merely a function of chance alone is about 4.7%, or highly unlikely. Therefore, the finding that the hybrid section students performed best is statistically significant. The effect size was small for this result (0.111), as measured by Cramer's V.

Table 4-6 also details the Chi-square test results for instructor E3. While students in hybrid sections of ENG 111 had the highest percentage in the Highly Successful category and students in the face-to-face sections achieved at the highest levels overall, the results were not statistically significant with a p-value of 0.177529. This number portends that the likelihood of these results occurring by chance alone are relatively high (approximately 17.8%), and is much higher than the $p < .05$ threshold utilized to determine significance in this study.

Table 4-6

Summary of Results and Measures of Statistical Significance for ENG 111

Course-Section	Instructor	Grading Scale	Comparison Groups	Group(s) with Highest Grades	*n*	Chi-square statistic	p-value	Cramer's V
ENG 111	E2	ABCDFW	F, H, V	H	518	12.768	0.047*	0.111
ENG 111	E3	ABCDFW	F, H, V	F, H	459	8.930	0.178	0.098

Summary of ENF 3 and ENG 111

Although the students of instructor E1 enrolled in face-to-face sections of ENF 3 appeared to achieve at higher levels than students who enrolled in hybrid sections, the *n* for both sections was very low and the results were not nearly significant. Regarding ENG 111, students of instructor E2 in hybrid sections earned significantly higher grades than students in either face-to-face or virtual sections, although the effect size was small. The students in the hybrid sections of the second instructor (E3) had the highest percentage in the Highly Successful category, but also the highest percentage of students earning an F. Overall, the face-to-face students appeared to have the slight edge over hybrid students for this instructor, but the results were not statistically significant.

ACC 212

For the accounting course ACC 212, only one instructor was found who taught multiple sections. Instructor A1 taught 379 students in either virtual, hybrid, or face-to-face sections over the time period of the Spring 2008 semester to the Spring 2013 semester. The grade distribution by percent of students per section is shown in *Figure 4-8*. The hybrid sections of this course have the highest percentage of students earning an A (31% compared to 21% for the face-to-face and 12% of the virtual sections) and the lowest percentage of students who earned an F (7% compared to 9% for the face-to-face and 25% for the virtual sections). The hybrid sections also have the highest percentage of students earning a grade in the Highly Successful category, with 70% of students earning an A or B. Sixty-two percent of

students in the face-to-face sections were Highly Successful, while 46% of the students in the virtual sections were Highly Successful. Once again, the hybrid and virtual sections had higher withdrawal rates (about 6% each) than the face-to-face sections (2%).

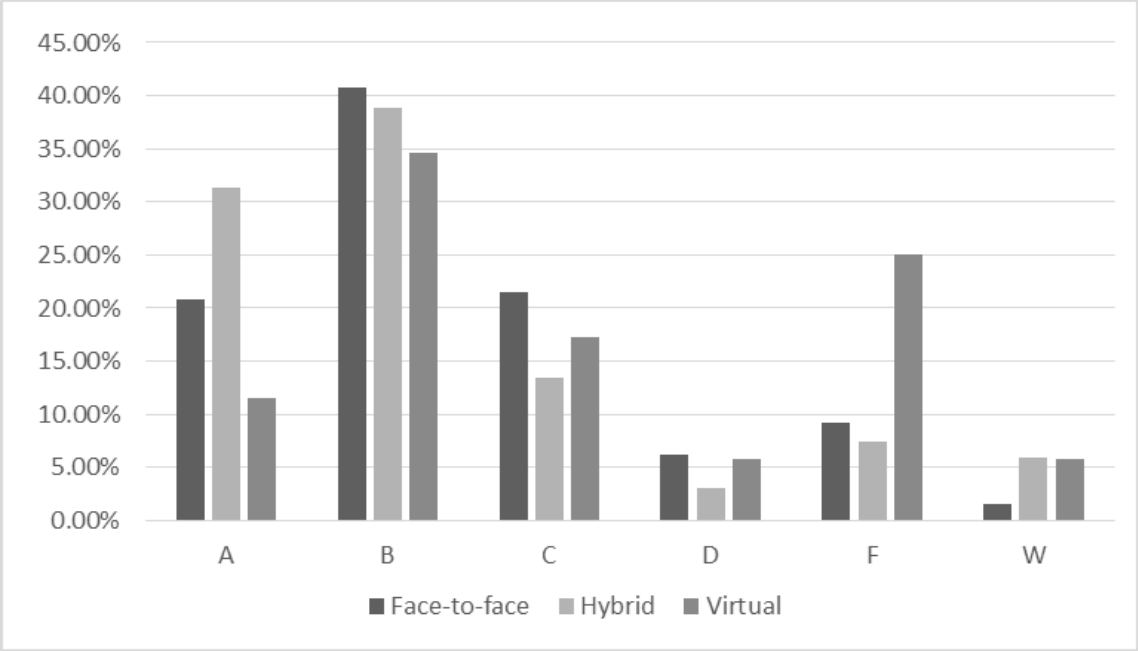

Figure 4-8. Grade distributions for ACC 212 students of instructor A1 in all three modalities (by percent of students per modality)

The grade distribution for the sections of ACC 212 taught by instructor A1 by number of students per section is displayed in the pivot table in *Figure A-9* in the Appendix. The virtual and hybrid sections had much lower enrollment numbers over this time period when compared to the face-to-face sections. These numbers were used to conduct the Chi-square test for goodness of fit. The results of this test, along with other relevant statistics are shown in *Table 4-7*. The results are significant, with a p-value of 0.001426. This translates to approximately a 0.14%

chance that the results occurred by chance alone, which is not very likely at all. Based on 2 degrees of freedom, the Cramer's V of 0.239 for this significant result is considered between a medium and large effect size. By a good margin, students enrolled in hybrid sections of ACC 212 with instructor A1 earned significantly higher grades than students in either the face-to-face or virtual sections.

Table 4-7

Summary of Results and Measures of Statistical Significance for ACC 212

Course-Section	Instructor	Grading Scale	Comparison Groups	Group(s) with Highest Grades	*n*	Chi-square statistic	p-value	Cramer's V
ACC 212	A1	ABCDFW	F, H, V	H	379	21.607	0.001*	0.239

Summary of ACC 212

In the accounting course ACC 212, the students in the hybrid sections earned the highest grades. The hybrid sections had a higher percentage of students earning a grade of A, a higher portion of students in the Highly Successful category, and the lowest proportion of students earning a grade of F than the other two teaching modalities. The hybrid and virtual sections had a higher percentage of students who withdrew than the face-to-face sections. The results were statistically significant, while the effect size was between medium and large.

VET 100

The veterinary studies course VET 100 had only one instructor who taught the course in multiple modalities over the time period of interest. Instructor V1 taught 238 students in either face-to-face or virtual sections. The grade distribution by percent per section is seen below in *Figure 4-9*. The face-to-face sections had a higher percentage of students earning a grade of A (25% versus 17% for virtual). However, the virtual sections had a higher proportion of students in the Highly Successful category (73%) than the face-to-face sections (67%), as well as a lower percentage of students earning an F (0%) than the face-to-face sections (5%). The proportion of students in the Somewhat Successful category was similar between the two sections, with 25% of face-to-face students in this category compared to 23% of virtual students. The withdrawal rate was essentially the same (3%) when comparing the two modalities. By virtue of the fact that the virtual sections had a higher percentage of Highly Successful students, a similar percentage of students who were Somewhat Successful or who withdrew, and a lower proportion of students who were Unsuccessful, the students in the virtual sections did slightly better than the face-to-face students.

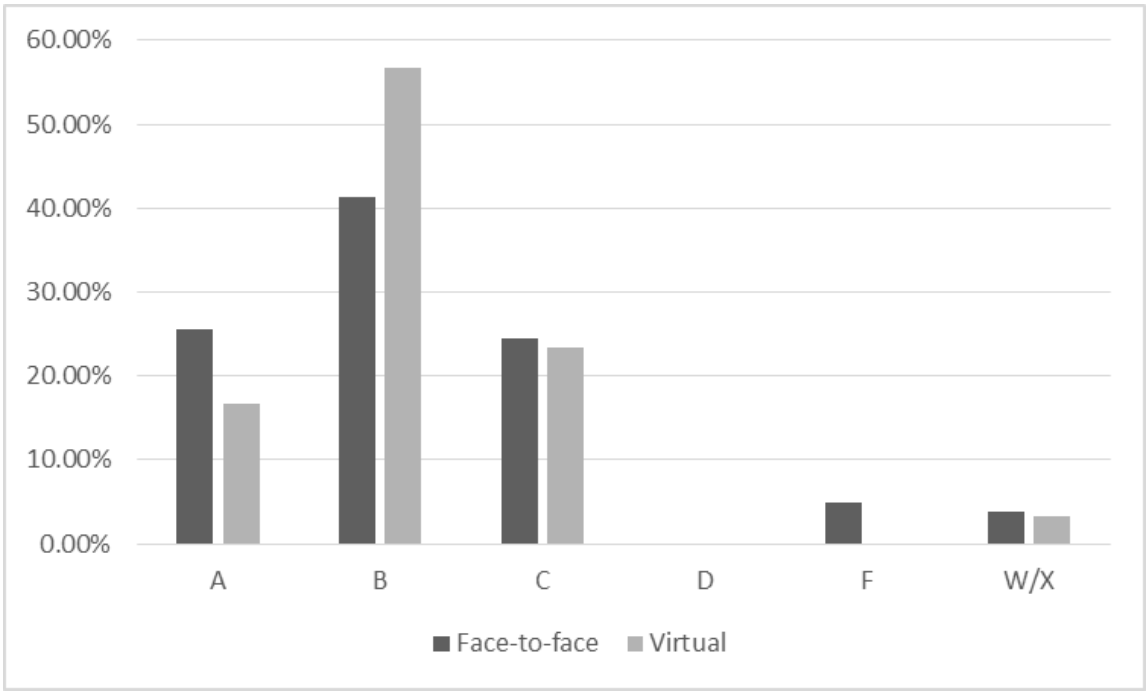

Figure 4-9. Grade distribution for VET 100 students of instructor V1 in two modalities (by percent of students per modality).

The grade distribution by number of students per modality is shown in the pivot chart in *Figure A-10* in the Appendix. Note that the number of students taking the virtual section of the course is low (n = 30). This suggests that the likelihood of achieving statistically significant results is low. Nevertheless, the data were used to perform a Chi-square test for statistical significance, the results of which are seen in *Table 4-8.* Not surprisingly, the p-value was 0.650, meaning that there was roughly a 65% chance that any differences observed between the virtual and face-to-face sections occurred merely by chance. Therefore, the results are not significant. The effect size was minimal (0.083).

Table 4-8

Summary of Results and Measures of Statistical Significance for VET 100 and VET 230

Course-Section	Instructor	Grading Scale	Comparison Groups	Group(s) with Highest Grades	*n*	Chi-square statistic	p-value	Cramer's V
VET 100	V1	ABCDFW	F, V	V	238	1.640	0.650	0.083
VET 230	V2	ABCDFW	H, V	V	292	11.389	0.001*	0.197

Summary of VET 100

For the course VET 100 taught by instructor V1, students in both the virtual and face-to-face sections did well. Although the students in the virtual sections appeared to achieve at slightly higher levels, the results were not nearly statistically significant. Therefore, it is difficult to draw meaningful conclusions from this data.

VET 230

Over the time period of interest to this study, only one instructor (V2) was found who had taught VET 230 in more than one modality. This instructor taught 301 students in either virtual or hybrid sections. The grade distribution by percent of students per section is displayed in *Figure 4-10*. Students in this course earned high grades in both sections offered. However, a higher percentage of students in the virtual sections earned a grade of A (91%) when compared to the hybrid sections (73%). Additionally, 99% of the students in the virtual sections fell into the Highly Successful category, compared to 95% of students in the hybrid sections. So,

although both groups of students did very well, students in the virtual sections appeared to earn higher grades.

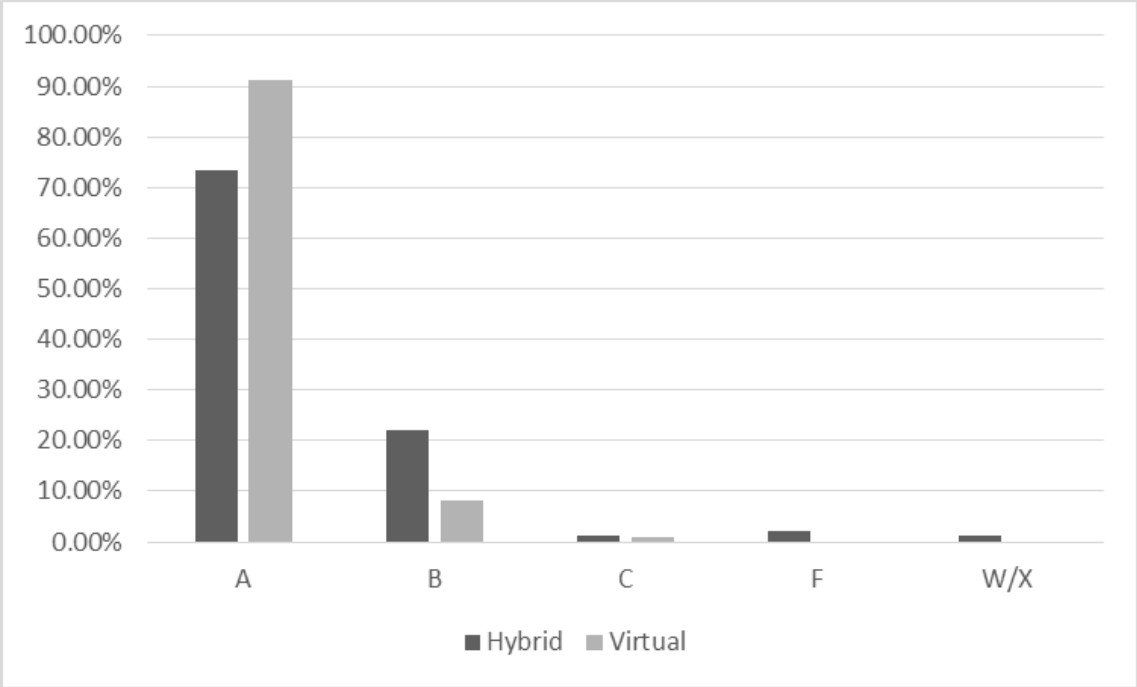

Figure 4-10. Grade distribution for VET 230 students of instructor V2 in two modalities (by percent of students per modality).

The grade distribution by number of students per section is shown in the pivot table in *Figure A-11* in the Appendix. It is notable that a vast majority of students earned either an A or a B. Because of this, collapsing the grades of A and B into a Highly Successful category for the Chi-square test was not advisable. In fact, since 292 of 301 students (combined) earned either an A or B, the pertinent question is whether taking the course in hybrid or virtual sections contributed to whether the student earned an A or B. Keeping this in mind, a 2 by 2 Chi-square test

was conducted, with the 9 grades that were not an A or B left out. The resulting Chi-square test results are displayed in *Table 4-8* above. The p-value was 0.000739 (rounded to 0.001 in the table), meaning that there is approximately 0.07% likelihood that the findings were a result of mere chance alone. The effect size, or Cramer's V, was 0.197. This indicates a small to medium effect.

Summary of VET 230

Students in both the virtual and hybrid sections of VET 230 did extremely well, with nearly all students earning an A or B. However, students in the virtual sections earned a grade of A at a much higher rate than students in the hybrid sections. The results were statistically significant with a small to medium effect size.

Gender and Changes over Time

After examining the performance of developmental math, English, accounting, and veterinary studies students taught in different modalities and finding significant differences in some instances, the next research question centers on how gender effects or changes over time might help to explain some of the differences found.

Gender

MTH 3

The first statistically significant finding in this chapter was found in students enrolled in MTH3 with instructor M4. For this course, students in the face-to-face sections achieved at higher levels than students in the hybrid sections. A new pivot

table/pivot chart combination was created to determine what part, if any, did gender have to play in the difference observed between student achievement in the two modalities (see *Figure 4-11*). Putting aside the question of statistical significance for the time being, in terms of percentage, males earned lower grades at a higher rate than females in the hybrid sections. This is evidenced by a higher percentage of males earning a grade of U or W, and a lower percentage of males earning an R. Conversely, males earned grades of S at a higher rate than females in the face-to-face sections (see Figure 4-12). This is supported by a higher proportion of males earning a grade of S than females, and a lower percentage of males earning a grade of W or U.

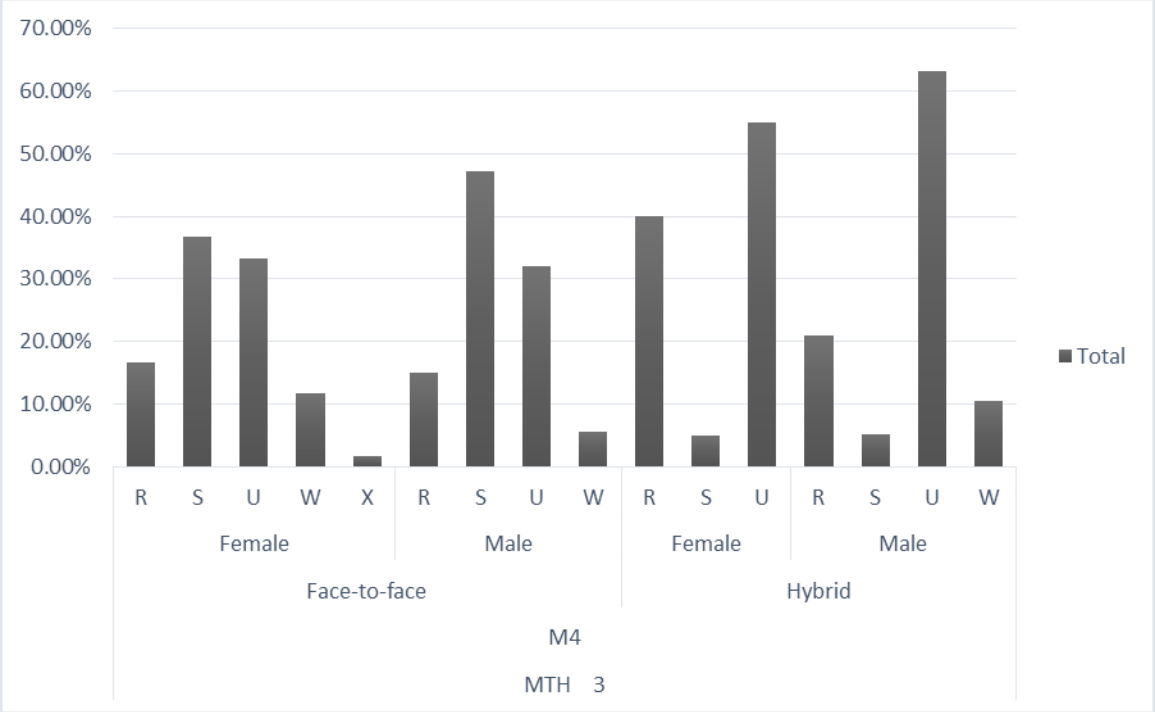

Figure 4-11

Grades earned by MTH 3 students of instructor M4 by modality, by gender (in Percent)

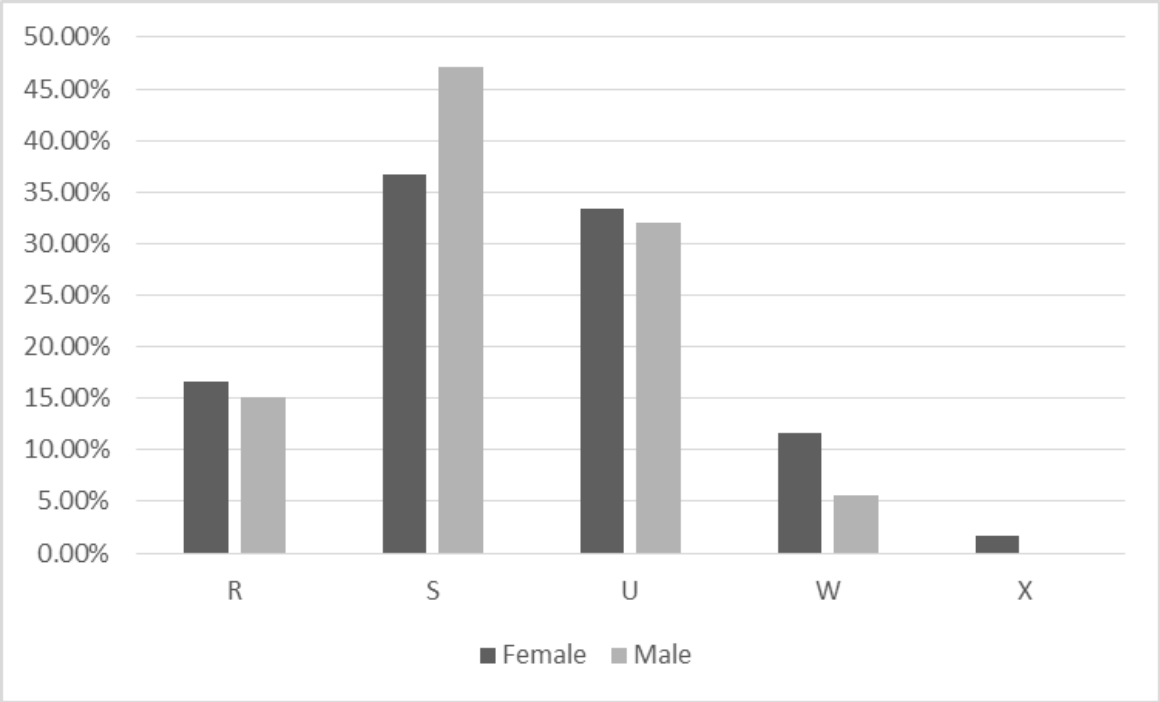

Figure 4-12. Grade distributions of face-to-face MTH 3 students of instructor M4, by percent of students by gender.

Using the pivot table to generate a second pivot chart (*Figure A-12* in Appendix) with number of students per gender, it is evident that the number of students in the hybrid sections by gender is likely too low (n=20, n=19) to find statistically significant differences. However, since the numbers are greater for the two genders in the face-to-face sections, a chi-square test was employed to test for significant differences. The Chi-square statistic, along with other pertinent statistical data, is reported in *Table 4-9* below. The difference between the grades earned by males and females was not statistically significant ($p = 0.474$), with a minimal effect size of 0.095.

Table 4-9

Summary of Results and Measures of Statistical Significance for Gender Effects

Course-Section	Instructor	Grading Scale	Comparison Groups	Group(s) with Highest Grades	*n*	Chi-square statistic	p-value	Cramer's V
MTH 3-F	M4	RSU	Females, Males	Males	113	2.506	0.474	0.095
MTH 3-F	All	RSU	Females, males	Females	795	8.131	0.043*	0.101
ACC 212- F	A1	ABCDF	Females, Males	Males	260	2.722	0.437	0.102

The question begging to be answered at this juncture is whether gender differences exist when the data is collapsed from all students taking MTH 3 over the time period of interest to this study. When all of the data is considered, rather than the data from one instructor alone, it again appears that females achieved at higher rates than did males in face-to-face sections of MTH 3 (see *Figure 4-13*). This is evidenced by a higher rate for females of earning a grade of Satisfactory (43% to 39%), and a lower rate for females in earning a grade of Unsatisfactory (29% to 38%).

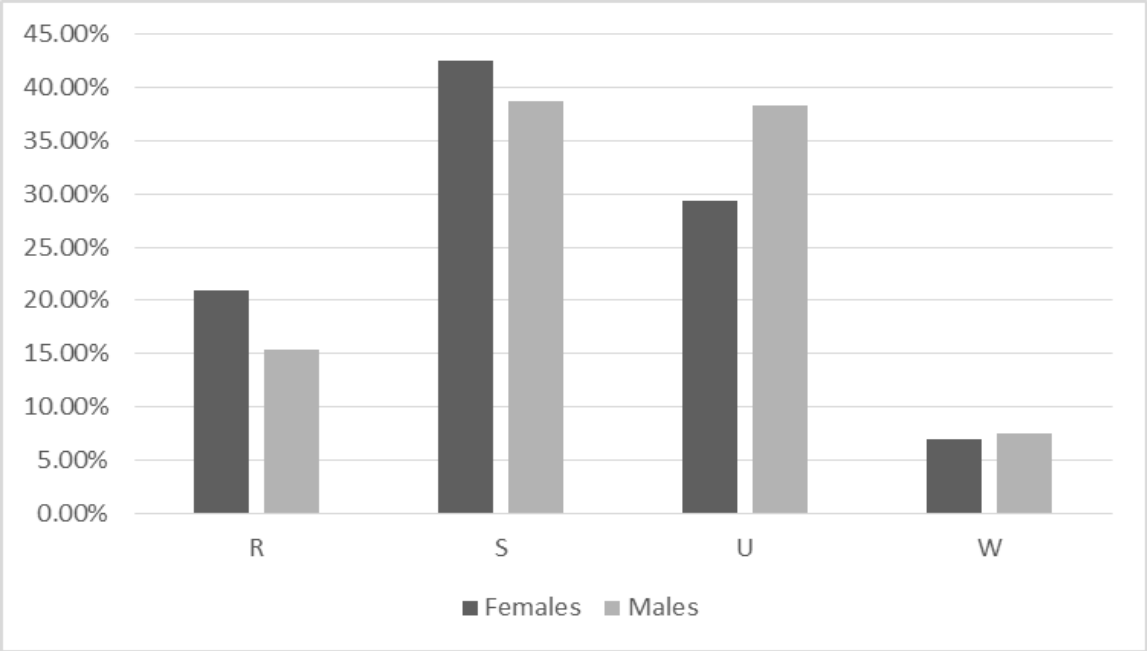

Figure 4-13. Grade distributions of face-to-face MTH 3 students of all instructors (by percent of gender).

In order to decide statistical significance, the numbers of students earning particular grades in face-to-face sections of MTH 3 by gender for all instructors need to be utilized (see *Figure A-12* in the Appendix). A Chi-square test was performed for all face-to-face sections of MTH 3 to determine whether there were statistically significant gender differences present. The relevant statistics are shown in *Table 4-9* above. The results of this test indicate that gender differences observed in face-to-face sections of MTH 3 were statistically significant, with $p = 0.043$. This indicates approximately a 4.3% probability that the results were a product of chance alone. The effect size was 0.101, which is considered a small effect.

Summary of MTH 3 by Gender

Students in face-to-face sections of MTH 3 (with instructor M4) earned significantly higher grades than students in the hybrid sections. However, as evidenced by a Chi-square test, any apparent gender differences in the face-to-face sections of MTH 3 (with instructor M4) were not statistically significant. When all of the grades from all face-to-face sections of MTH 3 were aggregated regardless of instructor, the results were statistically significant. Females earned significantly higher grades than males in face-to-face sections of MTH 3 over the time period of interest to this study, although the effect size was small.

ACC 212

Students enrolled in hybrid sections of ACC 212 with instructor A1 earned significantly higher grades than students in the virtual or face-to-face sections. To search for gender differences, the pivot table (and thus pivot chart) was changed by selecting the appropriate course and instructor number. *Figure 4-14* displays the grade distributions of females and males in the three sections of ACC 212 in question by percent. Putting aside statistical significance for the time being, females appeared to earn higher grades at a greater rate than males in the hybrid sections. Conversely, a lower percentage of females scored either an A or B than males in the face-to-face sections (see *Figure 4-15*).

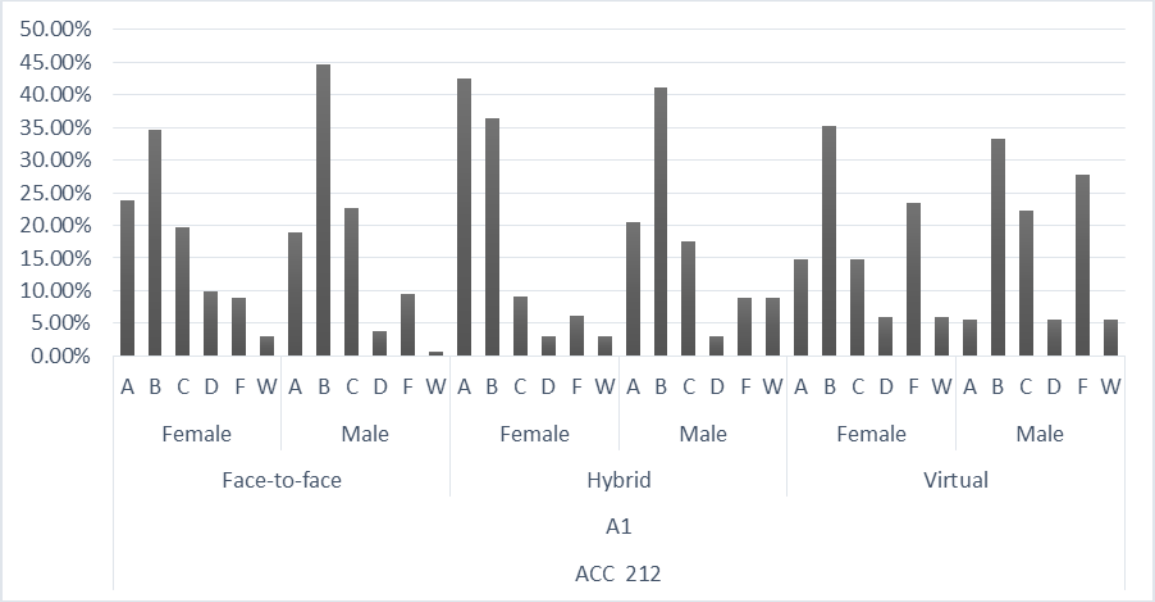

Figure 4-14. Grades earned in ACC 212 for instructor A1 by section, by gender (in percent).

In order to determine whether the gender differences in these sections are statistically significant, frequencies must be used. Therefore, a pivot chart with the same data was created showing grade distributions of numbers of students scoring a grade by section, by gender (see *Figure A-13* in the Appendix). Because a large portion of the cells in contingency tables for the hybrid and virtual sections would have expected values less than 5, a Chi-square test was only conducted for the face-to-face sections in order to search for statistically significant gender differences. As can be seen in *Table 4-9*, the results were not statistically significant, with a p-value of 0.437 and a small effect size of 0.102.

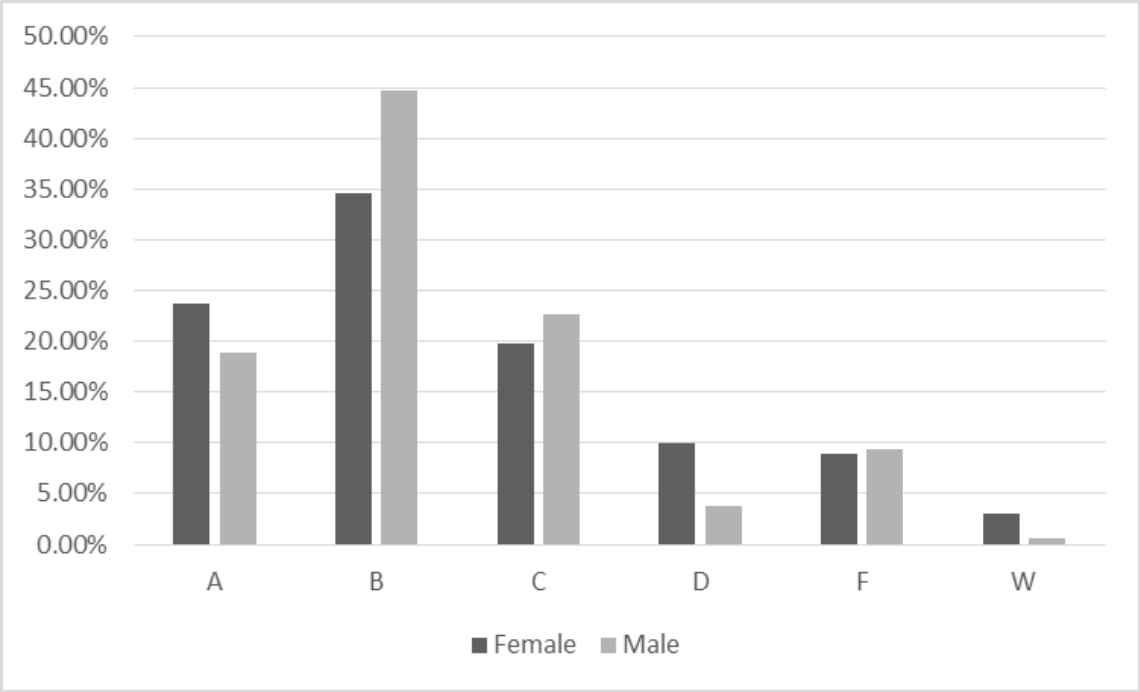

Figure 4-15. Grade distributions for face-to-face ACC 212 students of instructor A1 by gender.

Summary of ACC 212 by Gender

Students enrolled in hybrid sections of ACC 212 with instructor A1 earned significantly higher grades than students in the virtual or face-to-face sections. After sorting the data from the three sections by gender, differences in the grade distributions by gender were observed and noted. A Chi-square test was run for the face-to-face sections only, due to the fact that the low numbers in the hybrid and virtual sections would render the Chi-square test unreliable. The results were not statistically significant.

Other Gender Comparisons

Although gender differences were observed for the two courses above, the gender differences were not statistically significant at the instructor level. When all sections of the course MTH 3 were collapsed regardless of the instructor, the findings indicated that females earned significantly higher grades than males in the face-to-face sections. Given the low numbers of students involved when looking at a relatively short time period (2008-2013), then parsing by course, by instructor, by section, and finally by gender, the likelihood of having the statistical power sufficient to find statistically significant gender differences is low. Therefore, this study now turns to comparisons made with markedly higher numbers of students, albeit with a far less rigorous method. Although the student population is a fairly evenly split between females (56%) and males (44%), one cannot assume that for every female who enrolled in a course with a given instructor that there was a corresponding male counterpart.

Nevertheless, with these caveats in mind, several pivot charts were created in order to determine if any macro trends with regard to gender are present. Figures *4-16*, *4-17*, *4-18*, *4-19*, and *4-20* below display grades distributions by section (F, H, or V), by gender for all courses, math courses, English courses, accounting courses, and veterinary courses, respectively. When looking at all courses (*Figure 4-16*), females have notably higher grade distributions than males at this community college. This general trend holds true across the subject areas, with the possible exception of students enrolled in virtual sections of veterinary studies, in which males had a higher grade distribution than did females. Overall, females

achieve at higher levels than males at this community college regardless of whether the course was taken in face-to-face, hybrid, or virtual modalities.

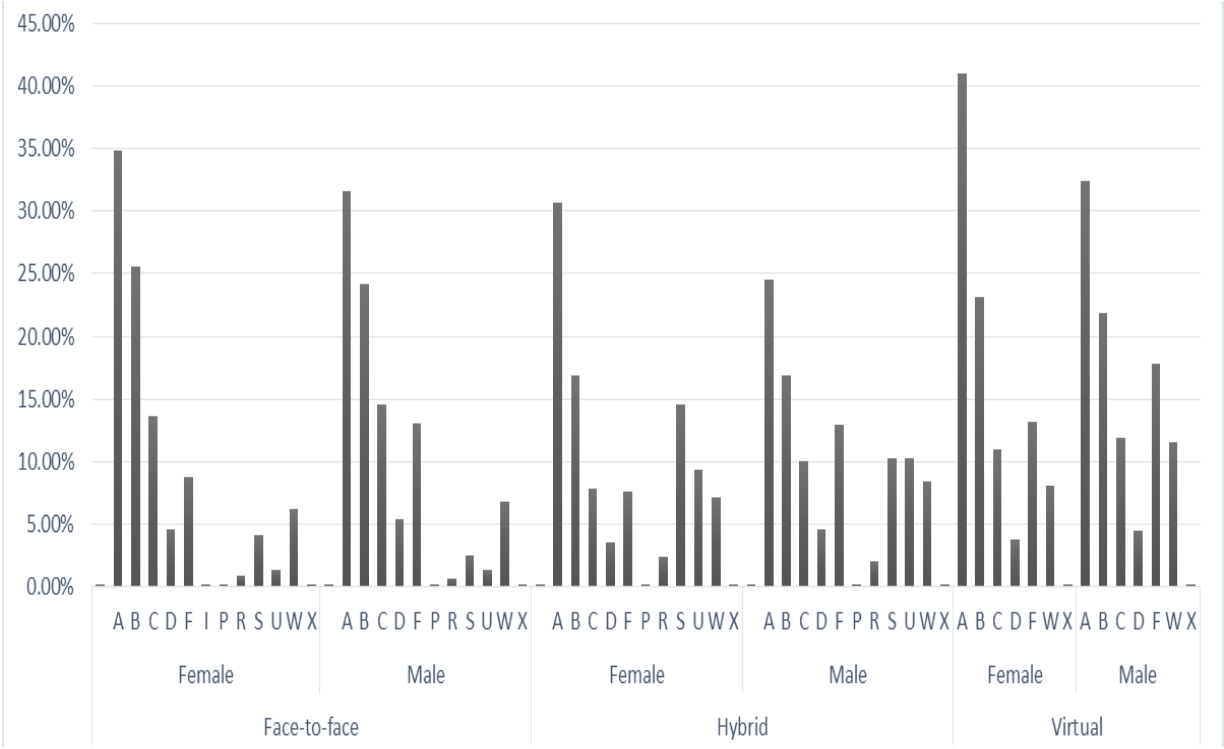

Figure 4-16. Grade distribution for all courses (Spring 2008-Spring 2013) by modality, by percent of gender.

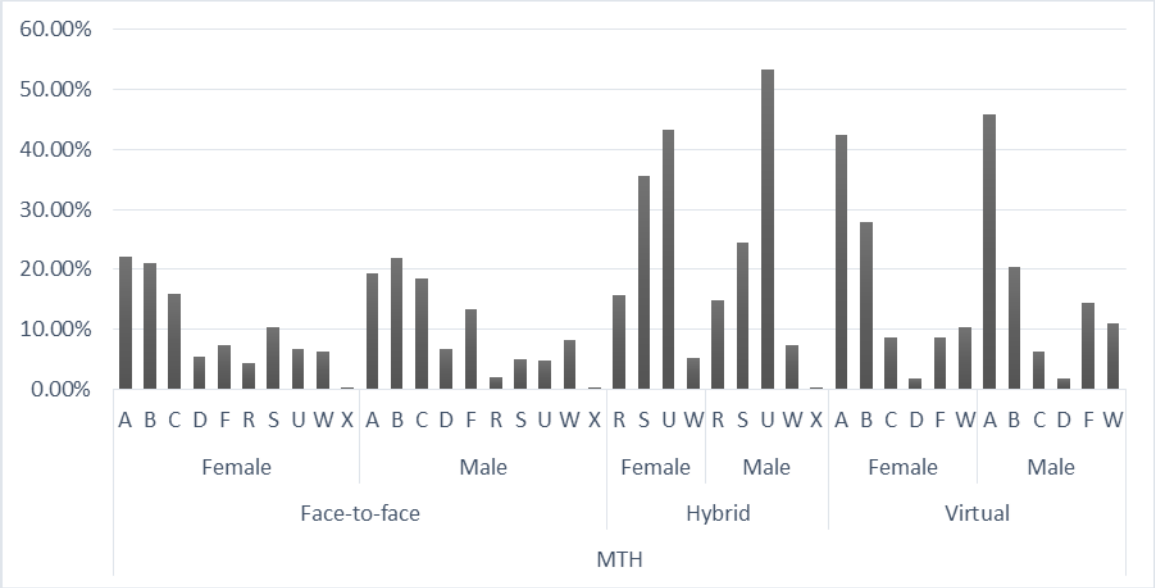

Figure 4-17. Grade distribution for all MTH courses (Spring 2008-Spring 2013) by modality, by percent of gender.

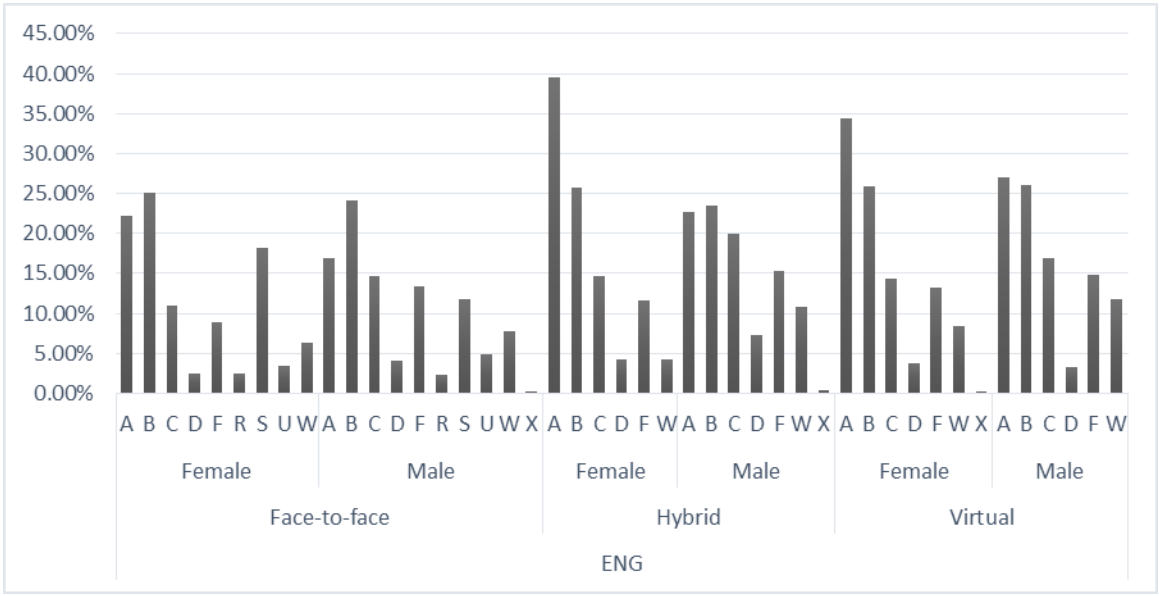

Figure 4-18. Grade distribution for all ENG courses (Spring 2008-Spring 2013) by modality, by percent of gender.

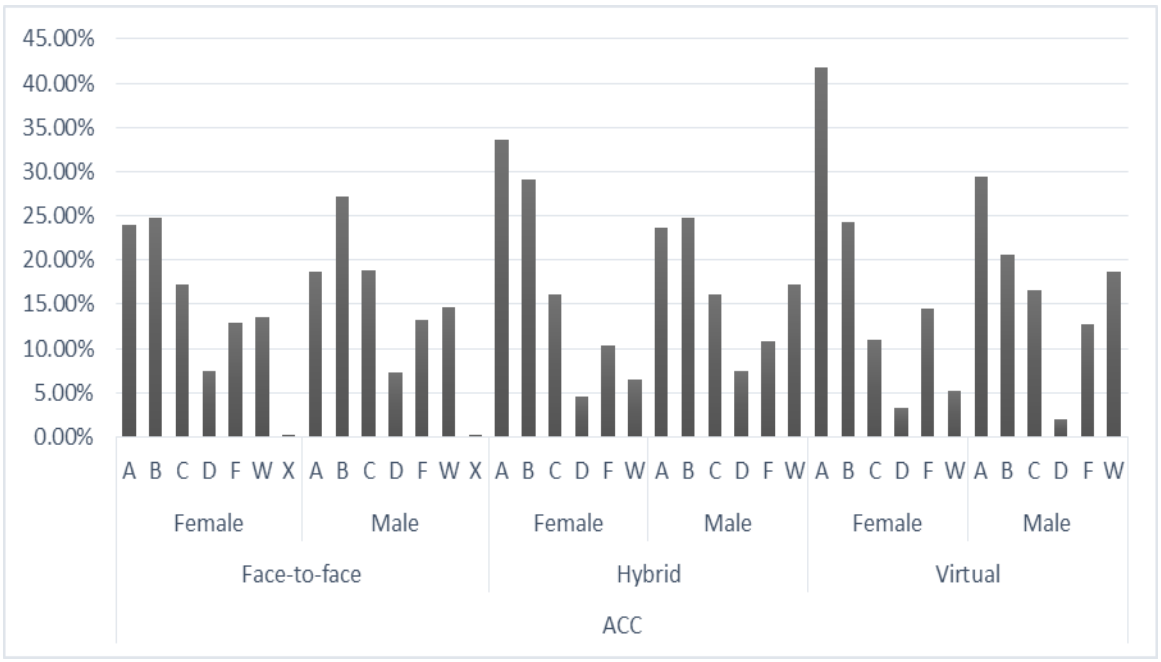

Figure 4-19. Grade distribution for all ACC courses (Spring 2008-Spring 2013) by modality, by percent of gender.

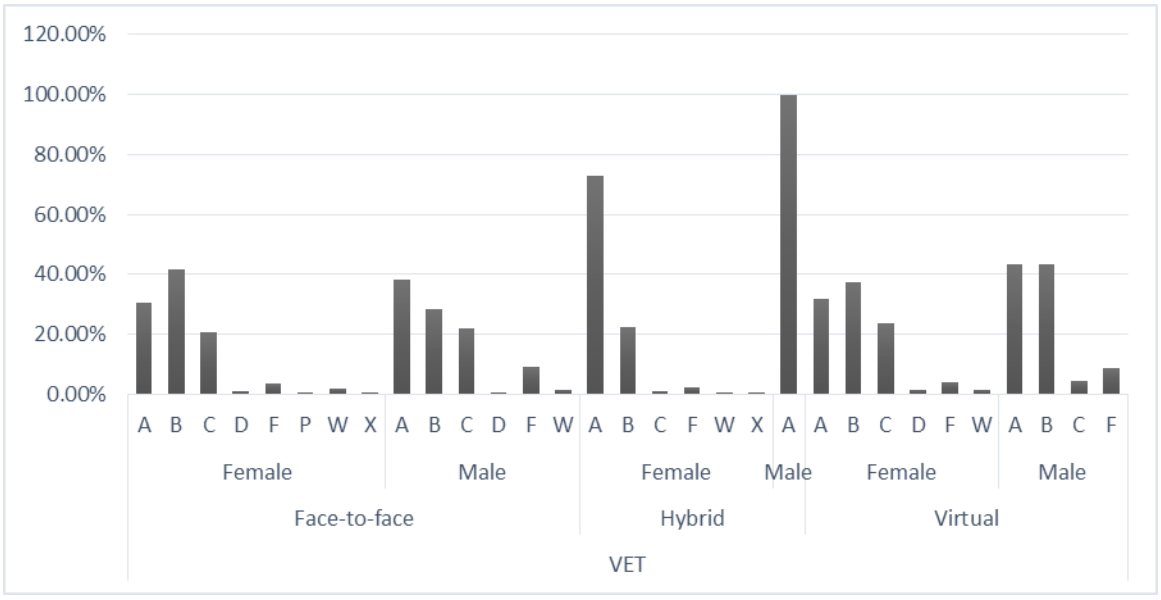

Figure 4-20. Grade distribution for all VET courses (Spring 2008-Spring 2013) by modality, by percent of gender.

Changes over Time

In order to identify any changes over time that might be occurring, pivot tables and their corresponding pivot charts were created to show grade distributions of virtual and hybrid sections by semester (Spring 2008 to Spring 2013). The summer semesters were omitted in order to condense the graphs enough to display properly. *Figure 4-21* shows that grade distributions for virtual sections have remained fairly consistent over this time period, although the percentage of A's earned appears to have peaked in the Fall 2008 semester. However, the number of students enrolled in virtual sections has steadily increased over this time period, consistent with literature as noted in Chapter 2 of this study (see *Figure 4-22*).

When considering hybrid sections of courses offered at the community college, the grade distributions have also remained fairly consistent. However, as was the case with the virtual sections, the number of A's earned appears to have peaked in the Fall 2008 semester (*Figure 4-23*). The percentage of students earning a grade of F or W has remained fairly consistent over time, whereas there was a noticeable peak for students earning these grades in virtual sections of courses in Spring 2012. Unlike the virtual sections of courses, the enrollment of students in hybrid courses increased steadily until the Fall 2010 semester before embarking on a downward trend (*Figure 4-24*).

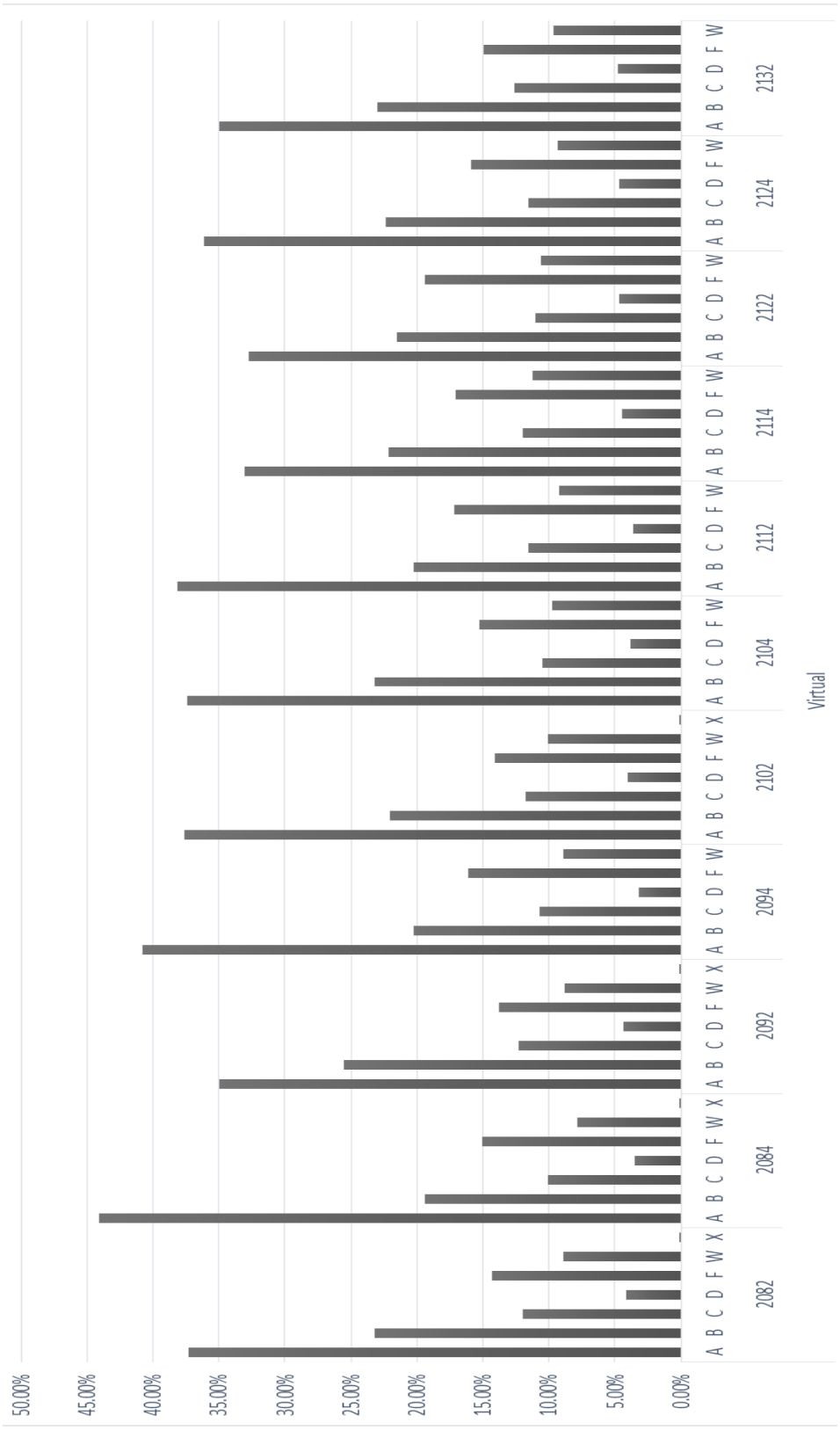

Figure 4-21. Grade distributions in virtual courses, by semester (in percent).

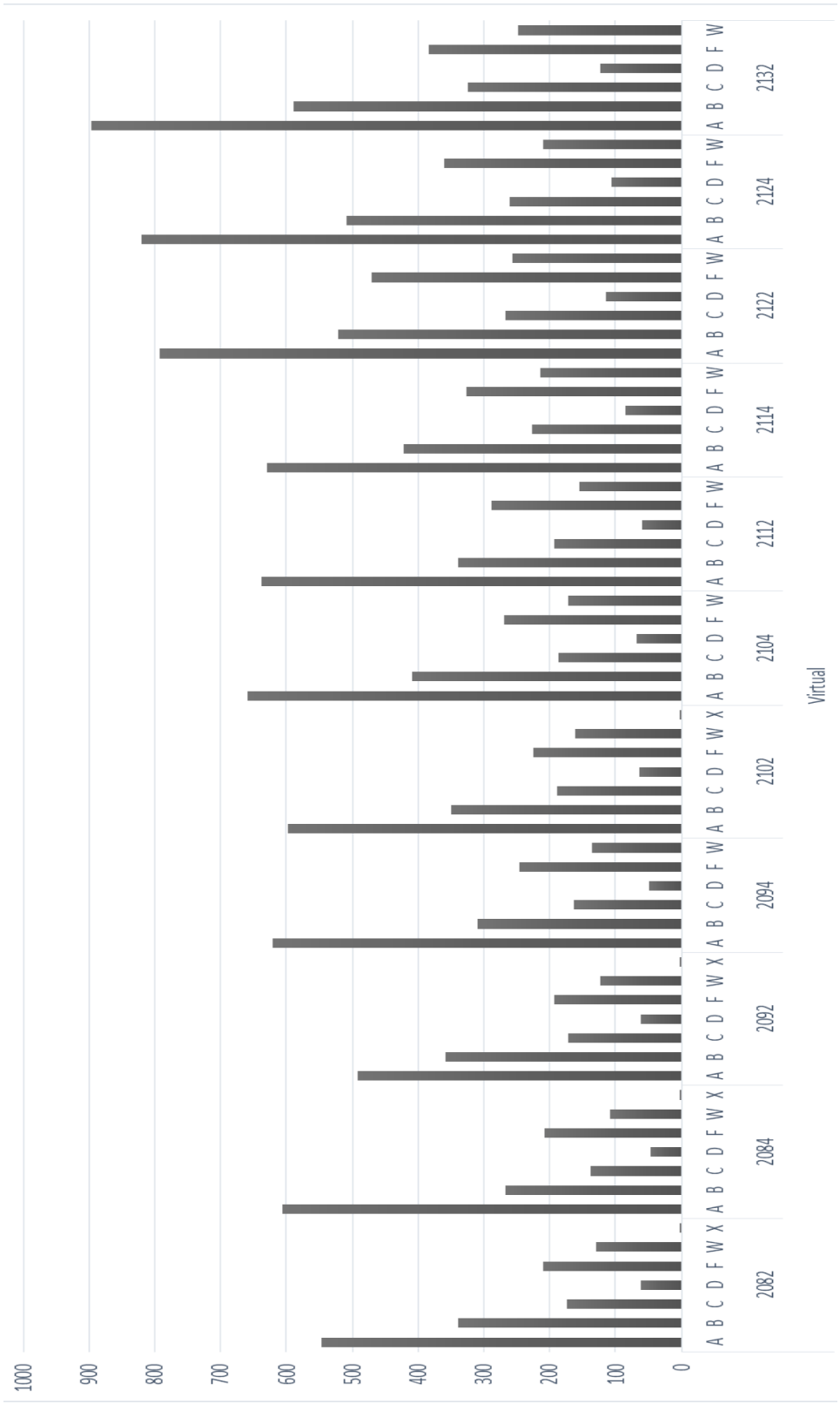

Figure 4-22. Grade distributions in virtual courses, by semester (by number of students).

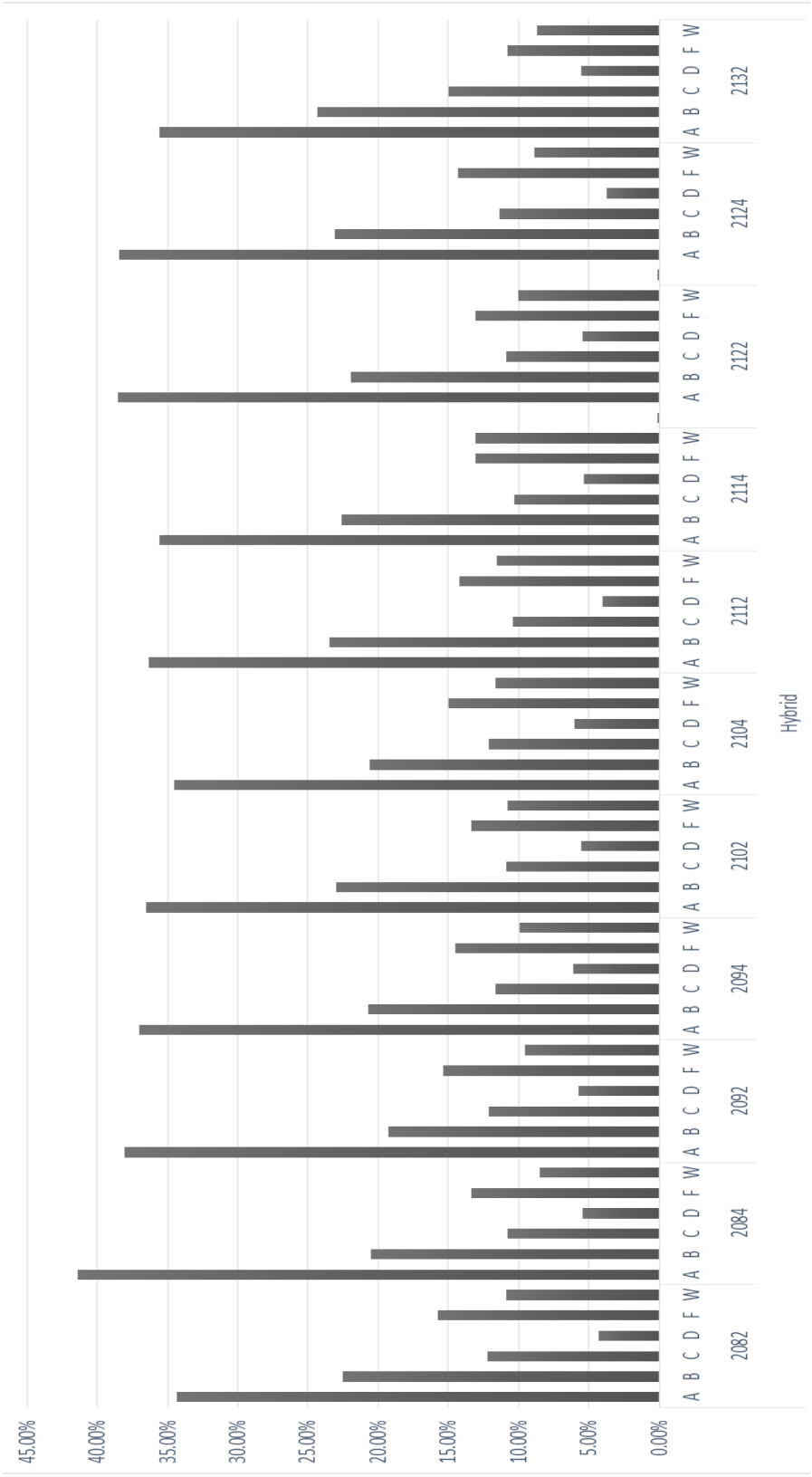

Figure 4-23. Grade distributions in hybrid courses, by semester (in percent).

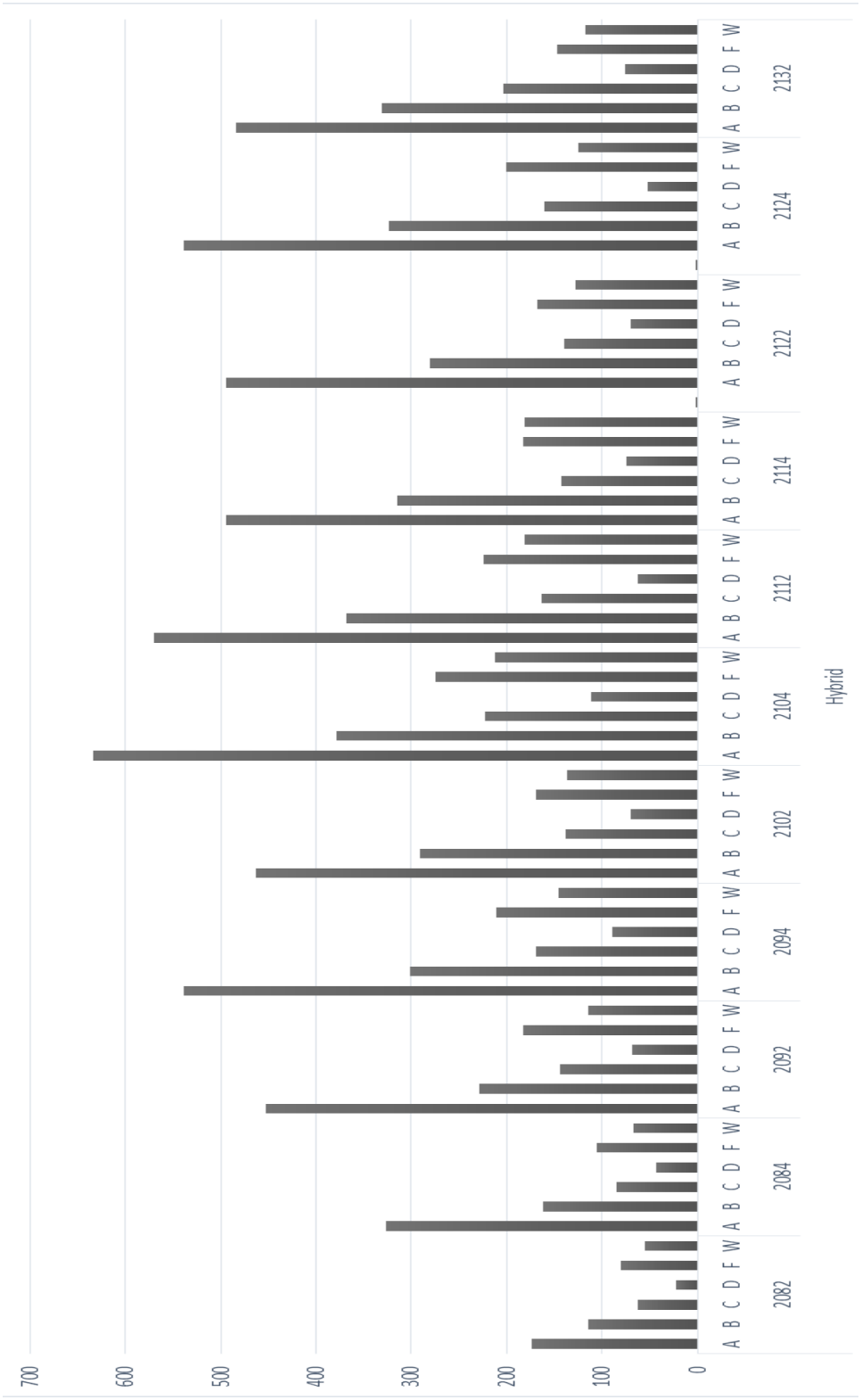

Figure 4-24. Grade distributions in hybrid courses, by semester (by number of students).

Summary of Changes over Time

The grade distributions over the time period analyzed (Spring 2008 to Spring 2013) have remained primarily consistent. However, the percentage of A's earned peaked for both hybrid and virtual sections of courses in the Fall 2008 semester. The number of students enrolled in virtual courses has increased steadily over this time period, although the number of students enrolled in hybrid sections peaked in the Fall 2010 semester and has declined since.

CHAPTER 5

Discussion

Summary of Findings

In order to make sense of the findings within this study, it may prove useful to summarize the findings in a table format (see *Table 5-1*). In the developmental math courses MTH 3 and MTH 4, the students in face-to-face sections achieved at higher levels with regard to final grades than students in the hybrid sections. The results were statistically significant in two of the 5 instructor-level cases analyzed. Even when the results were not significant, small to medium effect sizes were found, in each case the face-to-face students outperformed hybrid students. In the case of instructor M4 teaching MTH 3, the effect size (Cramer's V) was 0.371, the greatest effect size found in this study. This number indicates that there was a markedly higher success rate for earning higher grades among face-to-face students when compared to hybrid students. In the case of instructor M3 teaching MTH 4, the effect size was 0.185, a small to medium effect. When the data for all students and instructors is combined for MTH 3, again students enrolled in face-to-face sections earned significantly higher final grades than students enrolled in hybrid sections, although the effect size was smaller (0.167) than it was at the instructor level.

These findings are interesting in the fact that the community college made the decision, effective in the Spring 2013 semester, to cease offering the developmental math courses in the face-to-face format entirely. From that point on,

all developmental math courses have been offered solely in the hybrid course format. Perhaps a data analysis such as the one contained in this paper would have

Table 5-1

Summary of Overall Study Findings and Measures of Statistical Significance

Course-Section	Instructor	Grading Scale	Comparison Groups	Group(s) with Highest Grades	*n*	Chi-square statistic	p-value	Cramer's V
MTH 3	M1	RSU	F, H	F	77	6.880	0.076	0.299
MTH 3	M2	RSU	F, H	F	116	5.243	0.155	0.213
MTH 3	M3	RSU	F, H	F	207	4.732	0.193	0.151
MTH 3	M4	RSU	F, H	F	152	20.967	0.0001*	0.371
MTH 3	All	RSU	F,H	F	2466	68.866	0.00001*	0.167
MTH 4	M3	RSU	F, H	F	244	8.403	0.038*	0.185
ENF 3	E1	RSU	F, H	F	37	1.340	0.511	0.190
ENG 111	E2	ABCDF	F, H, V	H	518	12.768	0.047*	0.111
ENG 111	E3	ABCDF	F, H, V	F, H	459	8.930	0.178	0.098
ACC 212	A1	ABCDF	F, H, V	H	379	21.607	0.001*	0.239
VET 100	V1	ABCDF	F, V	V	238	1.640	0.650	0.083
VET 230	V2	ABCDF	H, V	V	292	11.389	0.001*	0.197
MTH 3-F	M4	RSU	Females, Males	Males	113	2.506	0.474	0.095
MTH 3-F	All	RSU	Females, males	Females	795	8.131	0.043*	0.101
ACC 212- F	A1	ABCDF	Females, Males	Males	260	2.722	0.437	0.102

Note. F = face-to-face, H = hybrid, V = virtual. Both the RSU and ABCDF grading scales also utilize grades of W, removed from table to eliminate clutter.

*Statistically significant at $p < 0.05$ threshold.

helped to inform that decision and to even have altered it. Because students taking developmental math courses tend to struggle in math, it is possible they benefit more from guided practice from an instructor rather than independent practice on a computer. Indeed, some of the feedback from math faculty at the community college, which will be discussed later in this chapter, appears to verify this.

The only statistically significant finding in English courses was for students enrolled in ENG 111 with instructor E2. In this case, students in the hybrid sections earned higher grades than students in either the face-to-face or virtual sections, although the effect size was small (Cramer's V = 0.111). Likewise, statistically significant results were found with the accounting course ACC 212 with instructor A1, although the effect size was medium to large (Cramer's V = 0.239, 2 df). As was the case with ENG 111, students in the hybrid sections outperformed students in the virtual and face-to-face sections. The findings were also statistically significant for students in the veterinary studies course VET 230 with instructor V2. In this instance, students enrolled in the virtual sections earned higher final grades than students in the hybrid sections, with an effect size of 0.197.

Although gender differences were observed in some of the statistically significant findings within this study, the gender differences themselves were not found to be statistically significant in two of three cases when tested. When all instructors and students were pooled together in MTH 3 face-to-face courses, females earned significantly higher grades when compared to males, although the effect size was small (0.101). In fact, with very few exceptions, females at this community college tend to have higher grade distributions across all sections

offered in all subject areas examined. Grade distributions have remained fairly constant over the time period examined (Spring 2008 to Spring 2013) for both hybrid and virtual sections, although the number of A's earned for both modalities peaked in Fall 2008. The number of students enrolled in hybrid sections of courses increased until the Fall 2010, when it began a slow declining trend. The number of students enrolled in virtual sections of courses steadily increased over the timeframe in this study.

Interpretation of the Findings

In an effort to uncover some of the reasons behind the statistically significant results contained in this study, an effort was made to collect the thoughts and opinions from the leadership of the various academic disciplines at the community college (Math, Accounting, English, and Veterinary Studies). The significant results found in this study were sent via email to the department lead instructors and chairs along with the request to identify possible factors that may have contributed to them. In several cases, feedback was received. The head instructors in the math department provided three bullet points of possible reasons that students enrolled in face-to-face sections of MTH 3 and MTH 4 earned significantly higher grades than students enrolled in hybrid sections:

- Students self-elected which format they wanted to take. Math-avoidant students may have been more prone to elect to take a hybrid because it met less often, yet they may be the most ill-prepared to succeed.

- The face-to-face met 5 hours a week and the hybrid met 3 hours a week. Hybrid students may not have budgeted their time well to get their work done outside of class.

- Developmental math students doing work outside of class don't have as much access to instructor support leaving ample opportunity for the student to stop progressing.

The first bullet point is interesting in the fact that it lends credence to one of the limitations set forth in this study: selection bias for those who might be math avoidant. Those students who would like to avoid math class as much as possible might choose the hybrid modality, since it meets for a shorter duration. Some of the differences in achievement might be due to this bias, because those students who are prone to avoid math when possible might have lower readiness levels than those students who are less prone to avoidance.

The second bullet point above alludes to difficulties surrounding the budgeting of time amongst students choosing the hybrid option for either MTH 3 or MTH 4. In a hybrid class section (and even more so in a virtual class section), students need to budget their time independent of the structure provided by a face-to-face class. There may have been instances where students did not budget in the extra 2 hours necessary to equal the amount of time spent on the face-to-face section class work. As noted in the literature review section of this paper, Allen & Seaman (2014) finds that students need more discipline to succeed in an online course.

The third bullet point suggests that students do not have as much opportunity for access to instructor support in a hybrid section of math class. For students who need synchronous feedback to develop in a meaningfully quick manner, the asynchronous feedback commonly associated with hybrid and virtual courses may provide an obstacle difficult to overcome. This is entirely plausible and fits with the research. As noted in the literature review, one of the primary complaints of Canadian K-12 online students' was the asynchronous nature of their courses (Barbour, McLaren, & Zhang, 2012).

The department chair for math also sent feedback as to why students in face-to-face sections may have earned significantly higher grades than those in hybrid sections:

- Human contact. Developmental students are reluctant to ask questions. While sitting at home in front of a computer, it is easy to sidestep those questions. And, if the student is lucky enough to get the right answer, they can walk away from that question without really understanding the objective. In addition to good luck, the student also has "computer helps" which allow him to view step one in an example, then do step one in the assigned problem; then view step 2 in the example, followed by doing step 2 in the assigned problem. By continuing this step by step method, the student is able to arrive at a correct answer without internalizing the total process. Hopefully, in a face to face situation, the instructor works the entire example and then allows the student to tackle an in class problem only after seeing the entire process for the problem. The student has an overall picture of the objective rather than the piecemeal picture for the online student.

- Procrastination is easier online. Developmental students tend to wait until the last minute to complete assignments. This means they have to rush through the material allowing less time for the brain to absorb the information. Retention is jeopardized as a result.

The math chair believes it is easier for students to procrastinate online and more difficult for developmental math students to learn online. Rather than seeing entire examples worked through for them by a live professor, they can view one step at a time and then complete that same step on a nearly identical homework problem. This could lead to a fragmented view of solving the problems, rather than students being able to internalize the entire concept and process in a holistic manner. This is yet another advantage that face-to-face learners of developmental math have over their hybrid counterparts, according to instructors at the community college.

Given the advantages for students taking developmental math courses in face-to-face sections and keeping the likely procrastination and selection bias issues in mind, a good hypothesis can be made as to why face-to-face students earn higher grades than their hybrid counterparts. For instructor M4 teaching MTH 3, however, the effect size was notably larger (by more than double) than the pooled effect size. How can this happen? Could this instructor just be so skilled at teaching in person that the difference between students' achievement in face-to-face and hybrid sections is primarily due to the 2 hours difference students get to be with the instructor? It is impossible to know without knowing the identity of the instructor and something about their instruction. The community college administration would have access to the identity of this instructor, and could use this information for the good of the college. For example, they could ask the instructor to share some

instructional ideas, resources, or lesson plans. They could observe a few classes to see what the instructor might do differently to achieve such positive results with face-to-face students.

This list of possible contributing factors to the significant results provided by the various math faculty at the community college were helpful in explaining why students enrolled in face-to-face sections of MTH 3 and MTH 4 may have outperformed students enrolled in hybrid sections, but why did students enrolled hybrid sections of ENG 111 (for instructor E2) achieve at higher levels than students enrolled in the same instructors' virtual and face-to-face sections? The chair of the English department offered this response to that question:

> We do not offer Eng 111 in a hybrid format very often. My memory from looking at your data, is that it only included one class, one summer. Often a small class working closely together like that will all come through with higher than average grades. Or perhaps, that one teacher was less demanding than others are. I doubt if it is a significant anomaly given that it is not usually offered in that format, and there was little data to compare.

The instructor offering this feedback suggests that since hybrid courses are not offered very frequently for ENG 111, that the results may be an anomaly given that individual classes sometimes can work closely with one another and help each other achieve higher grades. Looking at the data itself, there were 28 students in the hybrid comparison groups, representing two classes in the Summer 2008 and Summer 2009 semesters. The feedback from this member of the community college faculty could be correct. Perhaps the two small summer classes bonded together in such a manner as to help to raise everyone's grades. The effect size was small (0.111) and could easily be explained by this sort of phenomenon. The faculty

member's second point about the possibility of this particular teacher being less demanding, however, does not likely help to explain the result. This is because the instructor's hybrid sections were compared to the same instructor's virtual and face-to-face sections, lowering the likelihood that there were inconsistencies in how demanding the instructor may have been.

Why did students enrolled in hybrid sections of ACC 212 with instructor A1 earn significantly higher grades than students in the face-to-face or virtual sections? The sample size of the hybrid students taking this course was 67. This represents 5 classes from 2008 to 2011. Also, the effect size of 0.239 is substantial and is considered a medium effect size (with 2 degrees of freedom). Therefore, it is not likely to be a situation similar to ENG 111 where one or two classes just come together and achieve in an exceptional way. Without the requested feedback or knowing about the specifics involved in the instruction of ACC 212 at this community college during this timeframe, one can only base conjecture on previous studies.

Therefore, one possible rationale for hybrid students achieving at significantly higher levels is the time spent on task. As noted above in the literature review, Means, et al. (2009) suggests that some hybrid courses have comparatively higher achievement profiles because enrolled students may be involved in an equal amount of face-to-face instruction *in addition to* spending extra time engaged with online course material. Although not necessarily so, the benefit per hour of instruction could be the same between a hybrid and a face-to-face course. Even so,

it appears that some hybrid courses offer the benefit of engaging the student in the course material for longer amounts of time (Means et al., 2009).

In the veterinary studies courses, students in the virtual sections of *Veterinary Hospital Management*, or VET 230, earned significantly higher grades than students in the hybrid sections of the course taught by the same instructor. The research coordinator at the community college indicated that many of the students enrolled in virtual sections are already working at a veterinary office or hospital. The practical experience of working in the veterinary business while simultaneously learning about the business in the classroom undoubtedly aids in making the material more concrete and easier to retain for students. This would help to explain why students enrolled in virtual sections have higher rates of success with regards to final grades than students enrolled in hybrid sections.

Although the research coordinator's guess seems logical, there is no data to confirm or deny the assertion that more students in virtual sections work in the field while taking the course than students in hybrid sections. Without receiving feedback from the community college's staff who actually teach VET 230 as to why students in virtual sections earn significantly higher grades, it is an exercise in conjecture to pose reasons why this is the case. Given this caveat, some possible reasons could that the virtual sections may offer better materials or repeated practice in anatomy lesson such as dissections. In order to learn about the anatomy of an animal, face-to-face courses in veterinary studies might include dissections as part of their course work. Virtual sections of the same course could provide endless opportunities for virtual practice with dissection and thus the teaching of anatomy

lessons. It might be impractical to learn anatomy from dissection of each type of animal a veterinarian or a veterinarian tech might encounter in his or her future vocation. However, virtual courses could offer opportunities to learn the anatomies of a myriad of different animals without ever leaving the computer.

Another possible reason that students enrolled in virtual sections of veterinary studies courses such as VET 230 may have done better might stem from instructors' personal passion for online teaching and from the online instructors emphasizing approaches to increase student engagement, as Meyer (2014) suggests, as noted in the literature review. If an instructor loves and prefers to teach online courses, and if he or she is proficient at increasing student engagement online, then it stands to reason that students enrolled in their virtual sections might achieve at higher levels than those in their hybrid sections. Conversely, an instructor could be a poor lecturer, and really thrive by contrast in online sections.

Implications and Future Directions

Consistent with the literature, the findings of this study underscore the point that no one teaching modality is superior to all others in every instance. In some cases, students taking a course virtually earned significantly higher grades than students in other sections of the same class, as was the case with the VET 230 course. In the accounting course ACC 212, the students in the hybrid sections significantly outperformed students in other sections. In the developmental math courses contained within this study, students taking the course in the face-to-face

format achieved at higher levels than students in the hybrid sections, sometimes significantly so.

As educators, it behooves us to examine which modalities of teaching are best for our students' achievement on a case by case, course by course, section by section, and instructor by instructor basis. Utilizing data analysis analogous to, if not equivalent to, the type employed in this study, educators both at the administrative levels and teaching levels can better make informed decisions in order to maximize student learning in the future. For example, if one instructor at a community college is found to have significantly higher success rates than other instructors with students in virtual sections of his or her course, perhaps other instructors would want to see how this highly successful virtual course is designed and incorporate any lessons learned into their own virtual course designs.

Armed with pertinent information wrought from rigorous analysis, the future of virtual and hybrid course designs and implementations can only get better. It might also be the case that virtual and hybrid courses are not a good fit for a given subject matter. Perhaps an auto mechanic course in high school, for example, should always be hands-on, and therefore offered only in the face-to-face modality. Maybe the nearly instantaneous graphing capabilities of the computer suggest that virtual courses are the preferred delivery method for courses in geometry or engineering. Without the statistical data and findings to support them, decisions as to which modality to offer courses in for the future are just stabs in the dark-guesses at best. Let us hope that educational decision makers are not merely

guessing, but are using data (such as the data contained in this study) to make informed decisions.

Limitations

In addition to the limitations set forth in Chapter 3 of this paper, this study has other limitations which may mute its generalizability and implications. To begin with, the data contained for each student taking a course at this community college was limited to one data point- the student's final grade earned. Although this is useful data in many regards, it is still merely a single point of data. It does not inform as to whether the knowledge gained for that student was stored for the long-term. It does not tell us whether a particular student scored a high B such as an 89%, or a low B such as an 80%. It does not help to determine the student's future academic trajectory. It does not help to identify how the student would have done in another section of the given course. In short, there is an infinite number of bits of information it does not provide. The data in this study only tells the student's final grade- nothing more and nothing less.

Another limitation that went unmentioned in Chapter 3 of this paper is so obvious that it almost goes without saying. The results of this study are specific to this community college during this timeframe. Furthermore, this study focused on a small number of instructors at the community college. As noted in the literature review, educational technology is in a constant state of change. Course management software such as *Moodle* and social networking tools such as Facebook have helped to connect virtual learners in ways unimaginable even a decade ago. The findings in

this study hold true for the specific times and places in which they occurred. Game-changing technology in education is not only possible, but is rather likely in the coming decades. Just because students in face-to-face sections of developmental math courses in this study outperformed students in hybrid sections, it does not necessarily follow that all future developmental math courses at all community colleges (or even at this community college, for that matter) should be offered face-to-face. Perhaps a new technology will present itself in the coming years that will make hybrid or virtual courses in developmental math the better choice.

The quality of assessments utilized in a course can also be a limitation of this study. If the assessments are poorly aligned to the curriculum, then a student's grade might be inaccurately describe what they have learned. If the assessments are more or less difficult to take online versus on paper, this could factor in to any differences observed in students' final grades in different sections of the same course. For example, in mathematics, it can sometimes help to be able to write directly on the figures given on paper tests. When the test is online, students often have to first transpose part of the problem from the computer screen to paper before they can begin solving the problem. Transposing material in this manner can lead to increased errors and test fatigue. These are some of the many ways the quality of assessments can be a limitation of this study.

Conclusions

While there are undoubtedly more limitations to this study than presented here and in Chapter 3, this does not negate the fact that there are lessons to be

learned. The use of virtual courses is on an ever-increasing and upward trend at all levels of education- K-12, community college, and at the undergraduate and graduate levels of higher education. Studies such as this one that examine their efficacy are paramount for the future of education. Only by making the most informed decisions possible may educators forge the best path forward and ensure the greatest chance of success for the future students of virtual education. Online education has the ability to distribute knowledge to greater numbers of learners in more corners of the world than was ever thought possible in the past. Informed decisions as to when and how best to utilize virtual learning, based on rigorous data analysis of virtual learning's efficacy in particular places and times, literally has the power to transform the landscape of education, and thus the world itself.

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APPENDIX

Count of Grade			
COURSE	Section	Grade	Total
ACC 211	F	A	18.75%
		B	43.75%
		C	18.75%
		F	9.38%
		W	9.38%
	F Total		50.79%
	H	A	32.26%
		B	12.90%
		C	16.13%
		D	12.90%
		F	9.68%
		W	16.13%
	H Total		49.21%
ACC 211 Total			100.00%
Grand Total			100.00%

Figure A-1. Screenshot of data sorted by course (ACC 211), Section, and Grade.

Count of Grade		
Section	Grade	Total
F	A	34.78%
	B	27.49%
	C	15.55%
	D	4.87%
	F	9.17%
	I	0.01%
	R	0.20%
	S	1.17%
	U	0.50%
	W	6.22%
	X	0.04%
F Total		61.93%
H	A	24.30%
	B	16.62%
	C	10.24%
	D	3.82%
	F	7.38%
	P	0.20%
	S	22.69%
	U	8.79%
	W	5.92%
	X	0.05%
H Total		16.63%
V	A	34.94%
	B	22.98%
	C	12.62%
	D	4.79%
	F	14.96%
	W	9.70%
V Total		21.43%
Grand Total		100.00%

Figure A-2. Screenshot of data sorted by Section and grade- all courses.

Count of Grade			
Subject	Section	Grade	Total
ACC	F	A	24.78%
		B	42.48%
		C	12.39%
		D	3.54%
		F	8.85%
		W	7.96%
	F Total		60.43%
	H	A	32.26%
		B	12.90%
		C	16.13%
		D	12.90%
		F	9.68%
		W	16.13%
	H Total		16.58%
	V	A	32.56%
		B	27.91%
		C	9.30%
		D	2.33%
		F	25.58%
		W	2.33%
	V Total		22.99%
ACC Total			100.00%
Grand Total			100.00%

Figure A-3. Screenshot of data sorted by Subject (ACC), Section, and Grade.

Row Labels	Count of Grade
MTH 3	**552**
M1	**77**
Face-to-fac	47
R	4
S	36
U	1
W	4
Hybrid	30
R	6
S	21
U	3
M2	**116**
Face-to-fac	73
R	31
S	27
U	14
W	1
Hybrid	43
R	12
S	14
U	16
W	1
M3	**207**
Face-to-fac	34
R	4
S	15
U	15
Hybrid	173
R	18
S	49
U	98
W	7
X	1
M4	**152**
Face-to-fac	113
R	18
S	47
U	37
W	10
X	1
Hybrid	39
R	12
S	2
U	23
W	2
Grand Total	**552**

Figure A-4. Screenshot of MTH 3 by instructor Excel Pivot Table.

Row Labels	Count of Grade
MTH 3	**2466**
Face-to-face	**796**
R	150
S	328
U	260
W	57
X	1
Hybrid	**1670**
R	294
S	469
U	825
W	81
X	1
Grand Total	**2466**

Figure A-5. Screenshot of Excel Pivot Table for all MTH 3 in Aggregate.

Row Labels	Count of Grade
MTH 4	**244**
M3	**244**
Face-to-face	62
R	6
S	28
U	25
W	2
X	1
Hybrid	182
R	34
S	48
U	88
W	12
Grand Total	**244**

Figure A-6. Screenshot of Excel Pivot Table for MTH 4 with instructor M3.

Row Labels	Count of Grade
ENF 3	**37**
E1	**37**
Face-to-face	19
S	14
U	3
W	2
Hybrid	18
S	10
U	5
W	3
Grand Total	**37**

Figure A-7. Screenshot of Excel Pivot Table for ENF 3 with instructor E1.

Row Labels	Count of Grade
ENG 111	977
E2	518
Face-to-fac	367
A	107
B	122
C	53
D	14
F	56
W	15
Hybrid	28
A	9
B	10
C	5
D	1
F	3
Virtual	123
A	22
B	40
C	24
D	4
F	20
W	13
E3	459
Face-to-fac	335
A	151
B	63
C	40
D	14
F	64
W	37
Hybrid	16
A	5
B	5
F	6
Virtual	48
A	11
B	10
C	3
D	3
F	15
W	6
Grand Total	977

Figure A-8. Screenshot of Excel Pivot Table for ENG 111 with instructors E2 and E3.

Row Labels	Count of Grade
ACC 212	379
A1	379
Face-to-face	260
A	54
B	106
C	56
D	16
F	24
W	4
Hybrid	67
A	21
B	26
C	9
D	2
F	5
W	4
Virtual	52
A	6
B	18
C	9
D	3
F	13
W	3
Grand Total	379

Figure A-9. Screenshot of Excel Pivot Table for ACC 212 with instructor A1.

Row Labels	Count of Grade
VET 100	**238**
V1	**238**
Face-to-face	208
A	53
B	86
C	51
F	10
W	6
X	2
Virtual	30
A	5
B	17
C	7
W	1
Grand Total	**238**

Figure A-10. Screenshot of Excel Pivot Table for VET 100 with instructor V1.

Row Labels	Count of Grade
VET 230	**301**
V2	**301**
Hybrid	177
A	130
B	39
C	2
F	4
W	1
X	1
Virtual	124
A	113
B	10
C	1
Grand Total	**301**

Figure A-11. Screenshot of Excel Pivot Table for VET 230 with instructor V2.

MTH 3	**152**
M4	**152**
Face-to-face	113
Female	**60**
R	10
S	22
U	20
W	7
X	1
Male	**53**
R	8
S	25
U	17
W	3
Hybrid	39
Female	**20**
R	8
S	1
U	11
Male	**19**
R	4
S	1
U	12
W	2
Grand Total	**152**

Figure A-12. Screenshot of Excel Pivot Table for MTH 3 with instructor M4 by gender.

MTH 3	2465
Face-to-face	**795**
Female	503
R	105
S	214
U	148
W	35
X	1
Male	292
R	45
S	113
U	112
W	22
Hybrid	**1670**
Female	917
R	176
S	308
U	401
W	32
Male	753
R	118
S	161
U	424
W	49
X	1
Grand Total	**2465**

Figure A-13. Screenshot of Excel Pivot Table for all MTH 3 by gender

Row Labels	Count of Grad
ACC 212	**379**
A1	**379**
Face-to-fac	260
Female	**101**
A	24
B	35
C	20
D	10
F	9
W	3
Male	**159**
A	30
B	71
C	36
D	6
F	15
W	1
Hybrid	67
Female	**33**
A	14
B	12
C	3
D	1
F	2
W	1
Male	**34**
A	7
B	14
C	6
D	1
F	3
W	3
Virtual	52
Female	**34**
A	5
B	12
C	5
D	2
F	8
W	2
Male	**18**
A	1
B	6
C	4
D	1
F	5
W	1
Grand Total	**379**

Figure A-14. Screenshot of Excel Pivot Table for all ACC 212 with instructor A1 by gender