INSTRUCTION TYPE AND STUDENT MAJOR AS THEY RELATE TO STUDENT SUCCESS IN COLLEGE LEVEL DEVELOPMENTAL MATHEMATICS CLASSES

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INSTRUCTION TYPE AND STUDENT MAJOR AS THEY RELATE TO STUDENT SUCCESS IN COLLEGE LEVEL DEVELOPMENTAL MATHEMATICS CLASSES

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ABSTRACT

The low success rate of developmental (or remedial) mathematics courses is a hot topic at the higher education level. In this research, student success is considered in terms of final grade, D/F percentage, and withdrawal percentage. The author is interested in looking at student success at a Midwestern university as it relates to instructional delivery type (online vs traditional) and student major (arts and humanities, STEM, and undeclared). It was found that final grade and D/F percentage were statistically significant while withdrawal percentage was not when the data were analyzed with a two-way analysis of variance.
The faculty listed below, appointed by the Dean of the School of Graduate Studies, have examined a dissertation titled “Instruction Type and Student Major as they Relate to Student Success in College Level Developmental Mathematics Classes,” presented by Jean Coltharp, candidate for the Doctor of Philosophy degree, and certify that in their opinion it is worthy of acceptance.

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Across the nation, one of the common themes that two-year colleges and four-year universities alike have been concerned with is student success. High dropout rates continue to be a problem, which has been attributed to the fact that many students are underprepared for college (Bettinger, Boatman, & Long, 2013; Bettinger & Long, 2009; Boylan, 1999; Fong, Melguizo, & Prather, 2015; Cafarella, 2016). The area of study in which this is most apparent is mathematics with higher enrollment numbers in developmental mathematics courses (usually Beginning Algebra and Intermediate Algebra) when compared to developmental English and developmental reading. This high enrollment in developmental classes is attributed to inadequate preparation for college from the high school level. It has been estimated (Bettinger, Boatman, & Long, 2013; Bettinger & Long, 2009; Boylan, 1999a; Cafarella, 2016; Fong, Melguizo, & Prather, 2015) that 30% of all incoming freshman will need developmental education in two or more classes. Out of the 12 million first-year college students, this would amount to 3.6 million students enrolled in developmental classes.

These developmental education courses are designed to help students who are underprepared gain the content knowledge and skills to be prepared for general education college classes. Students that enroll in a developmental mathematics class, have more classes required to pass before they can receive college credit for a mathematics class, and hence, fulfill their general education mathematics requirement. This extended process can discourage students and contribute to a decision to drop out. Students that are enrolled in remedial mathematics courses already struggle with the content and are having to take more
mathematics classes than a prepared peer, which is often a daunting task. The cost of these developmental classes is also a factor (for the student, and the university) with some estimates of $1-2 billion across the country for colleges and universities each year. A discussion about the wide range of costs will be addressed in Chapter 2 (Bettinger, Boatman & Long, 2013; Bettinger & Long, 2009; Fong, Melguiz, & Prather, 2015).

The picture that has been painted at the national level is no different from what occurs at the state level. The need for developmental education is still increasing. According to the Missouri Department of Higher Education (MDHE, 2016) in 2015 in Missouri, only 44% of high school seniors who took the ACT were deemed ready for college mathematics. However, the state has actually seen a decrease in enrollment in developmental mathematics classes. Enrollment in these classes was 35.7% in 2013 down to 28.2% in 2015. This drop could be attributed to any number of things but it should be noted that in the last five years, the number of students who are attending college (mainly community colleges) has decreased by 3.6%, which definitely contributes to the lower enrollment in developmental classes (MDHE, 2016).

A growing trend in higher education, including the university being studied, is online learning. Some schools choose to offer their remedial education online. Online classes are designed to allow students to balance their education and a busy personal schedule. But online classes are not a perfect solution. In general, developmental mathematics classes may be structured in a traditional, hybrid, or online setting. Though hybrid will be discussed when reviewing the literature, this study will not have a hybrid component because the university at which this study takes place does not offer hybrid courses. Research that has been
conducted on the differences between these delivery types can be conflicting. Ashby, Sadera, & McNary (2011) found the delivery with the highest percentage of pass rates for students was the online delivery model with an 85% pass rate (compared to the traditional lecture model with a 63% pass rate, and the hybrid model with 69%). When looking strictly at completion rates (rather than pass rates) more students in the traditional classes completed the class (93%, hybrid 70%, online 76%). While online students passed the class more often than students in classes with different delivery methods, the online sections had fewer of the original students by the end of the class. This is a classic example of how mixed data in this field of study can be.

Along these same lines, no research has been conducted, on students’ majors and how they relate to retention rates in developmental mathematics classes. Though tangentially related, Battalio (2009) looked at the connection of student major with learning styles. He found that reflective learners (students who thought about work rather than interacting with others) did consistently better than learners who preferred to work with other students. However, learning this is not enough. Looking at a student’s major could give instructors a way to improve student success in developmental education classes if something was discovered about how certain majors succeed in different types of classes. For example, in a certain major, if a majority of the students may score better in online developmental mathematics classes, the university could use this information to better advise future students.

Research has shown that for every developmental class that a student takes, the chance of that student graduating from college drops by 50% (MDHE, 2016). Students who
take two developmental classes are 75% less likely to graduate than students who were not required to take any developmental classes. To fix this problem and improve success rates in developmental mathematics classes allowing students to persevere to graduation, instructors need to understand what causes them to fail. This is the first step of many in helping students graduate.

**Definition of Terms**

**Arts/Humanities**: Majors at the university that will fall into this category are art*, communication*, criminal justice, English*, French*, general business*, general education degrees (physical education, special education and elementary education), history*, human resource management, international business, international studies, management, marketing, music*, political science, psychology, sociology, Spanish*, theatre*. Any of the programs (denoted with a star) that are in the school of education, and the student plans to teach the subject at the middle or high school level also fall in this category. Education majors are considered Arts/Humanities because they take the same number of courses in their content as pure content majors (MSSU, 2016).

**Developmental classes**: Courses for which students pay tuition but do not receive college credit. Also called ‘remedial classes’ (MDHE, 2016).

**First-generation college student**: A student who is the first in their familial line to attend college.

**Hybrid classes**: Classes that have an online component. This is typically seen as half online. The remaining part is a traditional classroom setting.
**Online classes**: Classes that are taught more than 50% online and are asynchronous in nature.

**STEM (Science/Technology/Engineering/Mathematics)**: Majors at the university that will fall into this category are accounting, biochemistry, biology*, chemistry*, computer forensics, computer science, computer technology, economics, environmental health, finance, health science, industrial engineering technology, information systems, information technology, logistics, health promotion & wellness, mathematics*, medical technology, nursing, physics*. Any of the programs (denoted with a star) that are in the school of education and the student plans to teach the subject at the middle or high school level also fall in this category. Education majors are considered STEM because they take the same number of courses in their content as pure content majors (MSSU, 2016).

**Student success**: For the sake of this study, student success (or lack thereof) will be considered in terms of the final grade (converted from letter grade to corresponding 4.0 GPA number), the percentage of D and F grades a class has, and the withdrawal percentage for each class. From hereafter, “student success” will be used to refer to the three dependent variables (final grade, D/F percentage, and withdrawal percentage).

**Traditional class**: A class that is taught in a face-to-face environment. The class can be taught by lecture or can be hands-on, or activity/problem solving based.

**Purpose Statement**

The purpose of this study is to compare student success (in terms of final grade for the class, the average percentage of D/F grades a class has, and the average withdrawal percentage for each class) in developmental mathematics classes at a small, Midwestern
university over the last ten years. Groups to be looked at are determined by delivery method (traditional vs. online) and student major (STEM vs. arts/humanities vs. undeclared).

**Research Questions**

1. Is there a difference in the means of instructional delivery type (online vs. traditional) when considering student success?

2. Is there a difference in the means of student major (arts/humanities vs. STEM vs. undeclared) when considering student success?

**Hypotheses**

**Final Grade**

$H_0$: There is no difference between the means of the delivery type in regards to final grade in the developmental mathematics classes.

$H_1$: There is a difference between the means of the delivery type in regards to final grade in the developmental mathematics classes.

$H_0$: There is no difference between the means of the student major in regards to final grade in the developmental mathematics classes.

$H_1$: There is a difference between the means of the student major in regards to final grade in the developmental mathematics classes.

**D/F Percentage**

$H_0$: There is no difference between the means of the delivery type in regards to D/F percentage in the developmental mathematics classes.

$H_1$: There is a difference between the means of the delivery type in regards to D/F percentage in the developmental mathematics classes.
\( H_0: \) There is no difference between the means of the student major in regards to D/F percentage in the developmental mathematics classes.

\( H_1: \) There is a difference between the means of the student major in regards to D/F percentage in the developmental mathematics classes.

Withdrawal Percentage

\( H_0: \) There is no difference between the means of the delivery type in regards to withdrawal percentage in the developmental mathematics classes.

\( H_1: \) There is a difference between the means of the delivery type in regards to withdrawal percentage in the developmental mathematics classes.

\( H_0: \) There is no difference between the means of the student major in regards to withdrawal percentage in the developmental mathematics classes.

\( H_1: \) There is a difference between the means of the student major in regards to withdrawal percentage in the developmental mathematics classes.

**Framework**

Research has been done on many factors commonly discussed as contributing to the lack of success in developmental mathematics classes. The biggest factor that has been cited is lack of preparation by high schools for college (MDHE, 2016; Boylan, 1999a; Bettinger & Long, 2009; Bettinger, Boatman, & Long, 2013). Other factors include part time vs. full time students, gender, race, and age. Fong, Melguizo, & Prather (2015) reported that students in developmental classes are more often part-time students who also have family and/or work obligations. In terms of demographics, White, young, full-time female students are the most successful. This is compared to male, older, part-time, African American students who are,
statistically, the least successful. The type of college from where a student takes his/her developmental classes also has been determined to have an effect on the student’s success. Students tend to do better at smaller institutions, institutions that had a higher percentage of Euro American students, and institutions with higher tuition. With regards to age, as students get older, the odds of them taking a developmental class decreases but, if they do attempt it, they are more likely to be successful (Fong, Melguizo, & Prather, 2015).

Additional factors relating to success in developmental mathematics were attendance and engagement in class. Students who were successful in passing a developmental mathematics class were found to take, on average, more credit hours per semester (Smith, O’Hear, Baden, Hayden, Gorham, Ahuja, & Jacobsen, 1996). This coincides with what was already discovered about full-time students’ success rates when compared to part-time students. While all of these factors are important, with extensive research being done on how they affect student success in developmental mathematics, they are not the focus of this study. The research is still developing in terms of how instructional delivery type and student major affect student success in developmental mathematics classes. This study intends to add to the literature in both areas.

**Significance**

This study will specifically help mathematics instructors with enrollment at the small, Midwestern university from which the data are collected. It will allow better advising of students in the future as to which instructional delivery type is best for them. In addition, it can serve as a starting point for other universities across the nation, and add to the literature on the comparison between online and traditional developmental mathematics classes, which
is lacking. Trenholm (2009) suggested looking at a wide sample of online students in developmental mathematics classes, which this study intends to do. It will also start the literature with comparisons between how students in different majors, especially undeclared students, succeed in developmental mathematics classes, which is nonexistant.
CHAPTER 2
LITERATURE REVIEW

This look at the current literature starts by addressing the topic of developmental education—mathematics in particular. This will be done by examining the current state of developmental mathematics education at the national level and then narrowing the focus to the state of Missouri (the state in which this study takes place). After considering the current state of developmental mathematics education, an examination of strategies that some universities are utilizing to address the problems associated with this topic, will be recounted. Lastly, literature from online vs traditional vs hybrid delivery systems will be detailed. Unfortunately, due to the lack of studies that fall into these categories in developmental mathematics (and none that combine all of them), expanding to a similar study in another field (like Biology) is required since no literature exists that encompasses everything that this study does.

The Problem

A number of factors can contribute to student success or lack thereof in college, and even more specifically, in developmental courses. An example of one factor is the age of the student; non-traditional, older students who are juggling the demands of work/family/school have more on their plate than just schoolwork and this can have a negative impact on these grades (Ashby, Sadera, & McNary, 2011). Overwhelmingly, the reasons given for enrolling in an online section of a class are family obligations (young children to take care of) or financial reasons (not being able to afford to drive to campus) (Fong, Melguizo, & Prather, 2015). Additionally, a combination of these two reasons is also reported—the inability to drive
to school because of the time commitment due to work or family (Hill, 2013). Another factor influencing the success of developmental education students is the fact that a majority of these students are first-generation college students and are unfamiliar with the language and expectations they will encounter in higher education (Boylan, 1999b).

When students enter college underprepared, they are required to take remedial or developmental classes to catch up. Nationally, over two-thirds of entering freshmen test into developmental classes with only a third of those passing on their first try (Trenholm, 2009). Failing a class in a subject they are already behind in can cause students extra stress and eventually lead to their dropping out (Fong, Melguizo, & Prather, 2001). If these students are able to persist through the developmental mathematics sequence (only about 21% of students are), they are just as successful as students who were not placed into remedial classes (Bonham & Boylan, 2011). Even though the problem may start with students coming in underprepared and needing remedial classes, once they are admitted to college, the focus should be on getting them through the mathematics sequence they need. Thirty percent of students who were referred to developmental education did not enroll in these classes—opting instead, for enrolling in a credit bearing class for which they were not prepared. Of the 70% that did enroll in a developmental course, less than half of them completed the sequence (Fong, Melguizo, & Prather, 2015). Though not the focus of this study, this raises questions as to why students did not enroll in classes that were recommended for their skill level and what can be done to encourage them to take the best route.

When looking specifically at community colleges, only 22% of students who enter earn an Associate’s degree. The results are slightly higher for students who are enrolled in
developmental education; 24% will receive their degree (Boylan, 1999a). However, these low numbers might not be as bad as they initially seem—some of the students who don’t earn an Associate’s degree could have earned certificates or even transferred to a four-year institute. Looking at the developmental mathematics classes in particular, Basic (or Beginning) Algebra has the highest failing and withdrawal rates of any other course across the nation (Bonham & Boylan, 2011). Success rates in developmental mathematics can be as low as 24% in some colleges (Spradlin & Ackerman, 2010). Gerlaugh, Thompson, Boylan & Davis (2007) examined data from 116 colleges to try to identify trends in developmental education. Mathematics classes saw an average withdrawal rate of 20%. Out of the 80% that stayed in the class, only 68% of those students passed (54% of the original students who enrolled). This is of course higher than the 24% previously mentioned that would receive their degree because this study is only taking into account passing developmental mathematics courses.

Despite the recognized need for remediation, an argument against developmental education is the cost. Saxon & Boylan (2001) point out that some argue that tax money should not go to a person taking a class twice—once at the high school level and then again at the college level. They set out to find how much remedial education costs and found that in California, 11% of the state’s education budget went to remedial education alone. This is compared to 1.2% in Maryland. A number of things may contribute to the difference between these two states—one justification may be the fact that different researchers and states count different things when it comes to developmental education. For example, some of the data are self-reported, and some are figuring only the cost of delivery for the classes. Some even
count English as a Second Language classes and continuing education as a part of remedial education. When looking at how much this translates to in dollar amounts, the estimates range wildly still: anywhere from $260 million (Saxon & Boylan, 2001) to $1 billion annually (Saxon & Boylan, 2001). Though the costs are high, many schools (Saxon & Boylan, 2001) believe that whatever amount they are spending, comes back to them. Onondaga Community College in New York estimated that they spend $1 million on remedial education but this generated $1.3 million in revenue. Expanding our view to these students after college, even if only 30% of these remedial students graduate with a Bachelor’s degree, they will contribute $87 billion to society (from higher level jobs due to a higher degree). This is compared to the only $43 billion they would contribute if they were not successful in completing a 4-year degree (Saxon & Boylan, 2001).

Examining the data a little closer to home, 50.6% of working-age Missourians have a postsecondary degree or certificate. The Missouri Legislature’s goal was to have this percentage up to 60% by 2018. However, this will be an increasingly difficult task because in the last five years, enrollment in colleges and universities in Missouri has dropped by 3.6%. The Missouri State Department believes the problem starts in high school. Only 44% of incoming freshmen are at the level they should be in order to enter into college mathematics. Again, just because it is suggested that students enroll in a remedial course does not mean they take this advice. Overall, about 27% of high school graduates in 2015 were enrolled in a remedial class in college. This, however, is a decrease. In just two years, the number of first year students enrolled in remedial education went down by 7.5% (MDHE, 2016).
Student Support Models

There are a number of things being done to try to improve success rates in developmental education. Of the students who come in underprepared, only 10% will successfully earn a Bachelor’s degree without any support. With help, this goes up to 40% (Spradlin & Ackerman, 2010). Help that can occur comes in the form of acceleration models, contextualized learning models, and supplemental support models. Though student support models are not the focus of this research, it is important to have the background of what some universities believe help struggling students. These models are being used in a variety of courses but are especially useful in developmental classes like remedial mathematics.

Acceleration Models

As previously mentioned, the long sequence of mathematics courses remedial students are required to take can lead to failure. This fact is the inspiration for the acceleration model. Acceleration models increase the pace of the developmental class. Like with other literature in this area, research on acceleration models is mixed. Students are able to work at their own pace and only move on when they understand the material. Of course students believing they understand the material and actually understanding the material can be two different things. However, success has been shown (Rutschow & Schneider, 2011) by higher pass rates reported in accelerated developmental classes along with higher persistence noted in later classes. Conversely, some schools are finding drawn out, year-long developmental classes to be more beneficial (Rutschow & Schneider, 2011, Jaggars, Hodara, Cho, & Xu, 2014).
Contextualized Learning Models

These learning models incorporate the content from the developmental class into the world of the student’s major or interest area. Not enough research exists to definitively say whether these are successful or not. However, results are promising (Rutschow & Schneider, 2011) despite the fact that no long-term effects have been found. While the contextualized learning model is in effect, students show growth, but this does not persist after the class ends. The problem arises when trying to create contextualized learning models for all majors. This leads to a giant hurdle of funding issues at the college or university. It is not practical to have, for example, a Beginning Algebra class for each major so that only students in that major can enroll in that class (Rutschow & Schneider, 2011, Johnny, 2008).

Alternatively, a support class that meets for struggling students is also considered a contextualized learning model. These support classes can have voluntary attendance and meet outside of the regular scheduled class time. The support class can be lead by a graduate student, a professor (including the instructor for the class), or by a student who has previously passed the class. These classes review concepts discussed in lecture and also give students time to work on problems and ask questions in a more relaxed environment (Rutschow & Schneider, 2011, Johnny, 2008).

Supplemental Support Models

Tutoring is the most popular example of this model. Some form of tutoring is offered at every college or university either in the form of instructor, peer, or online help (Boylan, 1999b). Despite the fact that there is a lot of research on supplemental support (Martin & Arendale, 1994; Skoglund, Wall, & Kiene, 2018; Adrian, & Moore, 2018) there is not a lot of
research as it relates to the topic of this study, and what there is, has to be taken with a grain of salt. A majority of the time, a student decides for him/herself whether to enroll in tutoring. Most of the time, the students who take advantage of tutoring are older, and they skew the average age higher when comparing the data to the average college student (Rutschow & Schneider, 2011, National Center for Academic Transformation, 2008).

Supplemental instruction is another example of this model. This strategy is often used in a class that has a high risk of failure. It is proactive (as opposed to reactive) and is peer taught (sometimes by students who have been through the class already). Phelps & Evans (2006) reported that many studies have found supplemental instruction to be extremely helpful when paired with developmental education classes. For example, Wright, Wright & Lamb (2002) found that students who attended supplemental instruction, had a higher grade on the final in their developmental mathematics class, had a higher overall GPA and had higher retention rates up to a year later. As expected, the number of times a student attended supplemental instruction was positively correlated with these improvements as well.

Rutschow & Schneider (2011) admit that the literature in the area of student supports in developmental education is still developing. Despite the popularity, this is even true in the area of how technology programs like MyMathLab and ALEKS influence student success. Both of these programs are online aid and assessment programs which will be discussed next.

**Online**

Because the topic of online education is still relatively new (with online, developmental education—and even online, developmental mathematics classes—being even newer) the literature is still growing. The data are at odds as to whether online is better than
traditional classes or not. In this section, the studies are organized with the ones that are positive towards online classes first, then research that shows traditional classes are better follows, and finally, the research that has mixed results is reported.

According to a study done in 2010 by the Sloan Consortium, during the fall of 2009, 29% of college students took an online class across the country. There has been more than a 19% increase in enrollment in online classes every year for five years since (Xu & Jaggers, 2011). Research has found that when comparing online and traditional classes, there is a 10-20% increase in attrition rate for online classes (Ashby, Sadera, & McNary, 2011). The amount that this differs from previously mentioned data is due to Ashby, Sadera, & McNary conducting a nationwide study as opposed to one at a specific school like others.

Many mathematics classes have an online homework component despite being a traditional class in other ways. Jacobson (2006) studied how online homework vs. traditional homework helped test scores in a Beginning Algebra course. The study took place in the western United States on a four-year campus with an enrollment of about 11,000. On average, the students who did not use the computer for their homework scored better on the exam than the students whose homework was online. The amount of online homework that a student finished (less than one third, between one third and two thirds, and greater than two thirds) and their grades on the test were also analyzed. The students that completed the homework in the traditional way finished more of it and did better on it and the exam than students with the online homework. However, a majority of the students who interacted with the online program rated it very highly in terms of ease of use and helpfulness, which are
important factors when studying online delivery. They do not, however, address learning or success in the content.

Moving to a study that looked at Beginning Algebra and Intermediate Algebra classes taught online, traditionally, and in a computer lab across one academic year, the results were surprising. When studying the percentage of students who passed the class (C or better), the online section had the highest percentage followed by the traditional lecture class and then the lecture that was in a computer lab (Beginning Algebra: 61.5%, 39.4%, and 37% respectively; Intermediate Algebra: 42.1%, 37.1%, and 35.1% respectively). This was true for both courses separately as well as the combination. Interestingly, the online classes also had the lowest withdrawal percentage of the three groups. Previous studies analyzed have shown that online classes tend to have higher withdrawal percentage when compared to traditional and hybrid courses. In the online classes, the average student was older, the average grade on the final was higher, and the average grade earned in the class was higher. It is worth mentioning that in the online class, only the final exam was proctored unlike all tests being proctored in the other two classes. This could be used as an argument for why cheating might be a factor on all other assignments but, as already stated, the online students averaged higher on the proctored final as well (Trenholm, 2009).

Not all studies paint online classes in such a positive light. In an introductory Biology class in southern Missouri, students were enrolled in an online, face-to-face, or hybrid class. There were more passing grades (A, B or C) in the traditional class than hybrid or online (with hybrid classes having higher grades than online ones). When looking at withdrawal rates, the online section had the highest (with 26%) and hybrid had the lowest with 6% of
students withdrawing. Traditional classes were in the middle with a 10% withdrawal rate. This study was unique by being mixed methods and having a survey component. Only one student from the face-to-face class said they would be willing to take the Biology class in a hybrid or online format, but, more than two-thirds of the online or hybrid students said they would recommend the delivery type that they had taken (Hill, 2013). This is a good example of how different delivery modes may be preferred by different students.

Shifting focus back to developmental mathematics, Weems (2002) looked at Beginning Algebra classes that were taught online and face-to-face. It is important to point out that this study had a very low $n$ with only 48 students enrolled. As with most developmental education, the students self placed into either the online or traditional class. Students in the traditional class had a higher mean score on two out of three exams. It was found that performance declined significantly in the online class as the semester progressed, while in the face-to-face class it remained relatively consistent throughout.

Zavarella & Ignash (2009) also looked at a Beginning Algebra classes offered in online, hybrid, and traditional methods. The study took place in southern Florida on two of the five campuses (since those are the only campuses that offered all three methods), which saw just under 200 participants. However, they looked at withdrawal percentages in particular. They found that the traditional lecture class had the fewest withdrawals, and the hybrid class had the highest percentage. So while online classes did not have the highest withdrawal percentage, it was still found that classes that involved a computer had a higher percentage of students withdrawing than the traditional lecture classes.
Not every study is as cut and dried as the previous ones. Some research is split within even the same study as to whether online or traditional is better. In a study by Spradlin & Ackerman (2010) that takes place in a public, eastern university with enrollment of about 11,000 students, Intermediate Algebra classes had three different types of delivery type: traditional, hybrid, and online. The students who were in the hybrid classes had a higher post-test score than the face-to-face class but the strictly online students had the lowest scores. The students in each class were also asked their opinion on using a computer for education purposes. The students in the online classes responded favorably 97% of the time compared to 71% for the traditional class and 59% for the hybrid students.

In his research, Kinney (2001) took the idea a step further and looked at a traditional lecture and computer-mediated lecture in a Beginning Algebra and Intermediate Algebra classes. There are about 900 students who enroll in these classes each year at the school in which the study takes place. No significant difference was found in final grades between the two types of instructional delivery. However, more students withdrew from the computer-mediated class than the traditional class. Students who persisted were also given a survey about their thoughts on the class, and students in both Beginning and Intermediate Algebra reported being more satisfied with the computer-mediated class than the lecture class. It is a common theme that students who enroll in an online class enjoy being in one.

Finally, a study conducted at Mid-Atlantic Community College looked at only Intermediate Algebra classes. There were three types of classes to choose from: traditional, online, and hybrid. Of the students in the online class, 76% of the students completed the class compared to 93% completing the face-to-face class. When it came to passing grades,
65% of the online students passed (49% of those that originally enrolled) compared to 59% of face-to-face students (55% of those that originally enrolled). (Ashby, Sadera, & McNary, 2011).

**Conclusion**

Ashby, Sadera, & McNary (2011) admit that there is limited literature on student success in developmental education. Usually, the smaller the sample size, the more likely it is that the researchers will find online classes more beneficial (Xu & Jaggars, 2014). As was seen, the literature that is available regarding the success of online vs. traditional lecture in developmental mathematics (or even developmental education in general) is very mixed. In the current age of technology, for students who are busy with their personal lives, online classes are increasing in popularity. From an administrator’s point of view, online classes cost less than traditional lecture classes, which is another argument to keep online classes around (Mgutshini, 2013). Because online classes seem to be here to stay, the next goal that needs to be addressed is how to improve student success in these classes. Students might already be succeeding in these classes (more than traditional classes) but perhaps is not empirically suggested because of insufficient literature.

After an extensive search through many peer-reviewed journals (e.g. Journal of Developmental Education, Research in High Education, Journal for Research in Mathematics Education; a complete list can be found in the Appendix), it may be confidently stated that there is no research on how student major affects success in developmental mathematics. This can even be broadened to developmental education and higher education in general. It raises the question as to why there is such a gap in the research in this area. Researchers may
think that it is obvious that STEM majors will do better in STEM classes. However, a layman’s argument can be made that students who are worried about the class are more conscientious students as compared to students who think the class will be easy. This can lead to the data telling a different story than what was originally thought. As was seen with the research with online classes, the literature is mixed. If extensive research is done, and results support the original hypothesis, then the relationship between student major and student success in a certain content area will be known for sure as opposed to just hypothesizing. Looking at student major in reference to developmental mathematics (or any class) can help faculty help students succeed. No study reviewed had all the same aspects as the one that will be conducted here, further illuminating the gap in the research that this study is intended to fill.
CHAPTER 3

METHODS

This research was quantitative in nature and examined factors that impacted student success in developmental mathematics classes. The study took place at a small, Midwestern university with data examined from the last ten years. At the university, there were two mathematics classes that are considered developmental: Beginning Algebra and Intermediate Algebra. Students are placed into their mathematics course by ACT score or a placement test (if the student doesn’t have an ACT score or the student believes they are better suited for a higher course). For the sake of this study, the data were not separated by class. The data that were utilized were from traditional and online developmental mathematics classes. The data were also broken down by student major. The independent variables considered were delivery type (online, traditional) and student major type (STEM, arts/humanities, undeclared) and how they affected the dependent variables of final grade, D/F percentage, and withdrawal percentage. Data for STEM majors were averaged for online and traditional classes separately and compared. This was then done for Arts and Humanities majors and Undeclared majors. The data that were examined were final grade, D/F percentage, and withdrawal percentage. They were analyzed to see if a specific major consistently did better with a certain instructional delivery method.

The school at which the study took place has approximately 5500 students. Currently, about 20 developmental mathematics classes are offered each semester. Over the ten-year window encompassed in the study, roughly 12,500 students were enrolled in developmental mathematics classes. The breakdown for the $n$ of each category was as follows:
Table 1

*Sample Size*

<table>
<thead>
<tr>
<th></th>
<th>Arts/Humanities</th>
<th>STEM</th>
<th>Undeclared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Online</td>
<td>1663</td>
<td>1070</td>
<td>910</td>
</tr>
<tr>
<td>Traditional</td>
<td>3796</td>
<td>3055</td>
<td>1991</td>
</tr>
</tbody>
</table>

Students’ majors were considered at the time of enrollment in the course, not the degree they ended up graduating with (if they graduated). Though other remedial courses are offered at the university in other content areas, they are not the focus of this study. Specifically, Beginning Algebra and Intermediate Algebra fall under the umbrella of developmental mathematics. They are two classes and one class, respectively, below College Algebra. Approximately one-third of the classes are offered online with the others representing traditional lecture delivery. Online classes have discussion boards due weekly on Blackboard (a learning management system). Quizzes, homework, and tests are administered through Pearson’s MyMathLab. Even in the traditional style class, at the very least, homework is through MyMathLab too. No assessments are common among instructors. For the online classes, the students are required to have a midterm and final (at least 50% of their grade) proctored. Proctoring can be done off campus with an approved proctor (through Distance Learning), on campus with the instructor at a designated time, or by appointment in the Distance Learning office.

For the independent variables, there are student major and instructional delivery type. Data were coded using SPSS®. Undeclared majors were coded 0, arts and humanities majors were coded 1, and STEM majors were coded 2. Traditional classes were coded as 0 and online classes were coded 1. There were three dependent variables that were considered. The
first is the final grade. This is the grade that the student earned in the developmental mathematics class. This variable is on the traditional 4.0 scale. The next variable is withdrawal percentage. Students were considered ‘withdrawn’ if they withdrew three weeks into the semester (two weeks in an 8-week summer class) or more—as designated with a W on their transcript. Students were able to withdraw from a class up until a week before finals. If a student withdrew from the class, they were coded as a 1; if they did not withdraw, they were coded with a 0. Finally, the D/F percentage was figured. It was coded similarly. If a student received a D or an F for the class, they were coded as a 1; if they received an A, B, or C, they were coded as a 0. Seeing which classes have a higher percentage of D/Fs could suggest the number of students struggling with the class.

**Analysis**

To see if there is a significant difference in the means of grades for class type and student major, a two (class type) by three (major) way analysis of variance was run. Final grade, the dependent variable, was converted from a standard A-F grade to the corresponding number on the 4.0 GPA scale (A: 4, B: 3, C: 2, D: 1, F: 0). Class type was divided into two categories: traditional and online. Student major had three categories: arts/humanities, STEM, and undeclared.

For each class, the number of students who received a D or an F were added up (no distinction was made between the two grades). The percentage of the class that these students accounted for was then calculated. These percentages were then computed across all classes in each category (class type or student major). This same process was used to calculate the withdrawal percentage.
CHAPTER 4
RESULTS

This study examined the connection between instructional delivery type and student major and how they affected student success in developmental mathematics classes. The measures of student success were final grade, D/F percentage, and withdrawal percentage; instructional delivery type was divided between online and traditional classes. Student major was split into three categories for the purpose of this study: STEM, Arts and Humanities, and Undeclared. The SPSS® output for each dependent variable is given after the table summary the corresponding variable.

For the following data analysis, a 0.05 confidence level was assumed. This means that when the null hypothesis is rejected, it is with a low probability (less than 5%) of this being a false rejection. Data were broken down by each of the student success outcomes with each table below showing the difference between online and traditional classes in each major for that particular student success outcome. Illustration 1 (p. 30) summarizes the information found in Table 2.

The first hypothesis examined was whether there is a difference in the means of final grades with respect to the instructional delivery type (online vs. traditional). Each grade was converted from a letter grade to a number on a standard 4.0 scale (using a traditional search and replace program). The average was then determined individually for all STEM majors in online classes across the 10-year window. This was then repeated for each of the other two classifications of majors. Final grades of D and F were included in this calculation.
represented as 1 and 0 respectively. After SPSS® found the overall average, a two-way 
ANOVA was run to find the p-values.

The analysis indicated that STEM majors in traditional classes had the highest final 
grade average, whereas Undeclared majors, enrolled in online classes had the lowest. In 
terms of letter grades, each group (STEM online students, Arts and Humanities online and 
traditional students, and Undeclared online and traditional students) averaged a D, no matter 
the instructional delivery method, except for STEM students in traditional sections who 
earned a C average. All of the p-values were less than 0.05, meaning that the null hypothesis 
(that there is no difference between the means) can be rejected with a low probability (5%) of 
this being a false rejection.

Table 2

*Online vs Traditional Delivery and Student Major in terms of Final Grade for*

    *Developmental Mathematics Classes*

<table>
<thead>
<tr>
<th></th>
<th>STEM</th>
<th>Arts/Humanities</th>
<th>Undeclared</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average</td>
<td>Standard</td>
<td>Average</td>
</tr>
<tr>
<td></td>
<td>Deviation</td>
<td>Deviation</td>
<td>Deviation</td>
</tr>
<tr>
<td>Online</td>
<td>1.647</td>
<td>0.882</td>
<td>1.603</td>
</tr>
<tr>
<td>Traditional</td>
<td>2.074</td>
<td>0.781</td>
<td>1.913</td>
</tr>
<tr>
<td>$p &lt; 0.000$</td>
<td>$p &lt; 0.000$</td>
<td>$p = 0.001$</td>
<td></td>
</tr>
</tbody>
</table>
Table 3

SPSS Output for Tests of Between-Subjects Effects for Final Grade for Developmental Mathematics Classes

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td>8.179</td>
<td>1</td>
<td>8.179</td>
<td>17.325</td>
<td>0.000</td>
</tr>
<tr>
<td>Intercept</td>
<td>1051.842</td>
<td>1</td>
<td>1051.842</td>
<td>2228.081</td>
<td>0.000</td>
</tr>
<tr>
<td>OT</td>
<td>8.179</td>
<td>1</td>
<td>8.179</td>
<td>17.325</td>
<td>0.000</td>
</tr>
<tr>
<td>Error</td>
<td>196.387</td>
<td>416</td>
<td>0.472</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1595.787</td>
<td>418</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>204.566</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td>15.194</td>
<td>1</td>
<td>15.194</td>
<td>23.127</td>
<td>0.000</td>
</tr>
<tr>
<td>Intercept</td>
<td>1157.014</td>
<td>1</td>
<td>1157.014</td>
<td>1761.096</td>
<td>0.000</td>
</tr>
<tr>
<td>OT</td>
<td>15.194</td>
<td>1</td>
<td>15.194</td>
<td>23.127</td>
<td>0.000</td>
</tr>
<tr>
<td>Error</td>
<td>271.335</td>
<td>413</td>
<td>0.657</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1871.656</td>
<td>415</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>286.529</td>
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<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td>7.860</td>
<td>1</td>
<td>7.860</td>
<td>10.427</td>
<td>0.001</td>
</tr>
<tr>
<td>Intercept</td>
<td>955.455</td>
<td>1</td>
<td>955.455</td>
<td>1267.431</td>
<td>0.000</td>
</tr>
<tr>
<td>OT</td>
<td>7.860</td>
<td>1</td>
<td>7.860</td>
<td>10.427</td>
<td>0.001</td>
</tr>
<tr>
<td>Error</td>
<td>312.095</td>
<td>414</td>
<td>0.754</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1589.578</td>
<td>416</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>319.955</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

From the SPSS® output, the row of interest is OT for the interaction between online and traditional classes for each of the respective dependent variables. The significance value is in Table 2 as the p-value. The standard deviation is an indicator of how much the average grades differ from each other i.e. the larger the standard deviation, the more dispersed the data are. Table 2 indicates that STEM majors, in online classes, vary the most (standard deviation of 0.882) from each other in terms of their final grade with undeclared majors in
traditional classes not far behind. The least variation occurred in the data from the Arts and Humanities majors in online classes (standard deviation of 0.656). However, the differences between these two extreme standard deviations (and all of the standard deviations for that matter) did not vary drastically from each other. Regardless of the three different student majors, the fact remains that the students had lower grades in the online sections. As expected, the STEM majors had the highest scores in both delivery modes (1.647 and 2.073 for online and traditional respectively). All of these $p$-values were less than 0.05 so the data are statistically significant. This suggests the null hypothesis should be rejected, or, there is a significant difference in the means of the final grades for delivery type and student major.

As previously noted, Illustration 1 provides a visual representation of the averages found in Table 2. Student major is represented by the horizontal axis, and the final grade, converted to a 4.0 scale, is found on the vertical axis. From the graph, it is evident that students in the traditional classes, despite their major, had higher grades than those in the online classes. It can also be seen that STEM majors, in traditional classes, received the highest grades (2.074, C) on average while Undeclared majors in online classes received the lowest (1.529, D).
The second hypothesis addressed was the percentage of D/F grades. Recall that the researcher wished to determine if the means of instructional delivery type of D/F percentages were equal, and then whether the means of a student’s major of D/F percentage were equal. The number of STEM students in an online class who received a D or F in a class was determined, and the total was divided by how many students were in that particular class to obtain a percentage. These percentages were then averaged across all online classes with STEM majors. This was then repeated with the remaining student majors and traditional classes to find an overall percentage for each of the groups. SPSS® was utilized to find all of these averages and the p-values from a two-way ANOVA. As can be seen in Table 4, Arts and Humanities majors, in online classes had the highest D/F percentages while Undeclared majors, in traditional classes, had the lowest percentage. Again, none of the p-values were
greater than 0.05, which means the null hypothesis—no difference in means delivery type or student major when considering D/F percentage—should be rejected, or, D/F percentage and delivery type and D/F percentage and student major have different means.

Table 4

*Online vs Traditional Delivery and Student Major in terms of D/F Percentage for Developmental Mathematics Classes*

<table>
<thead>
<tr>
<th></th>
<th>STEM</th>
<th>Arts/Humanities</th>
<th>Undeclared</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average</td>
<td>Standard Deviation</td>
<td>Average</td>
</tr>
<tr>
<td>Online</td>
<td>12.238%</td>
<td>8.394</td>
<td>19.647%</td>
</tr>
<tr>
<td></td>
<td>p = 0.041</td>
<td></td>
<td>p &lt; 0.000</td>
</tr>
<tr>
<td>Traditional</td>
<td>10.471%</td>
<td>7.901</td>
<td>13.355%</td>
</tr>
</tbody>
</table>

*p* = 0.041, *p* < 0.000, *p* = 0.003
Table 5

*SPSS Output for Tests of Between-Subjects Effects for D/F Percentage for Developmental Mathematics Classes*

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td>3433.409</td>
<td>1</td>
<td>3433.409</td>
<td>42.230</td>
<td>0.000</td>
</tr>
<tr>
<td>Intercept</td>
<td>94463.077</td>
<td>1</td>
<td>94463.077</td>
<td>1161.857</td>
<td>0.000</td>
</tr>
<tr>
<td>OT</td>
<td>3433.409</td>
<td>1</td>
<td>3433.409</td>
<td>42.230</td>
<td>0.000</td>
</tr>
<tr>
<td>Error</td>
<td>34147.494</td>
<td>420</td>
<td>81.304</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>134750.250</td>
<td>422</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>37580.903</td>
<td>421</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td>270.986</td>
<td>1</td>
<td>270.986</td>
<td>4.185</td>
<td>0.041</td>
</tr>
<tr>
<td>Intercept</td>
<td>44726.117</td>
<td>1</td>
<td>44726.117</td>
<td>690.804</td>
<td>0.000</td>
</tr>
<tr>
<td>OT</td>
<td>270.986</td>
<td>1</td>
<td>270.986</td>
<td>4.185</td>
<td>0.041</td>
</tr>
<tr>
<td>Error</td>
<td>27192.920</td>
<td>420</td>
<td>64.745</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>78355.803</td>
<td>422</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>27463.907</td>
<td>421</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td>519.507</td>
<td>1</td>
<td>519.507</td>
<td>8.873</td>
<td>0.003</td>
</tr>
<tr>
<td>Intercept</td>
<td>33207.749</td>
<td>1</td>
<td>33207.749</td>
<td>567.149</td>
<td>0.000</td>
</tr>
<tr>
<td>OT</td>
<td>519.507</td>
<td>1</td>
<td>519.507</td>
<td>8.873</td>
<td>0.003</td>
</tr>
<tr>
<td>Error</td>
<td>24591.888</td>
<td>420</td>
<td>58.552</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>61356.194</td>
<td>422</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>25111.394</td>
<td>421</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

From the SPSS® output, the row of interest is OT for the interaction between online and traditional classes for each of the respective dependent variables. The significance value is in Table 4 as the p-value. The standard deviations for D/F percentages are all much higher than those seen in the analysis of final grades; however, this could be due to of the type of data. Final grades are limited to a scale from 0-4, while D/F percentages can range from 0-100%. Therefore, it makes sense that the D/F percentage standard deviations would be
greater. As with final grades, the online sections for all majors had the higher D/F percentage when compared to the traditional sections. However, this time, the Undeclared majors had the lowest percentage of D/F grades (11.008% and 8.560% for online and traditional respectively); whereas, the Arts and Humanities majors had the highest (19.647% and 13.355% for online and traditional respectively). All of these $p$-values were less than 0.05, so, again, the data are statistically significant.

The graph in Illustration 2 shows a visual interpretation of the data from Table 4. It is similar to Illustration 1. Since D/F percentages are being considered, it would be more educationally sound if these percentages were low. Online classes for all 3 majors had higher D/F percentages than the traditional classes.

![Illustration 2. Online vs Traditional Delivery and Student Major in terms of D/F Percentage for Developmental Mathematics Classes](image-url)
Withdrawal percentage was the last variable. Recall, the researcher was interested in whether or not the means of delivery type and then student major were equal in regards to withdrawal percentage. From the data, the number of STEM students who withdrew in each individual class was divided by the total number of students in that class to determine the withdrawal percentage. This process was repeated for all STEM majors in traditional classes and so on with the other majors. Again, the statistical software package, SPSS®, was utilized to find the averages across all classes and majors, and the researcher further analyzed the data using a two-way ANOVA, for which the p-value was calculated. This was the first instance that resulted in a p-value greater than 0.05. The results would indicate that these data are not statistically significant so the null hypothesis should not be rejected. This means that we fail to reject the null hypothesis that there is no difference between the means of the delivery type and of the means of the student major in regards to withdrawal percentage.

Table 6

*Online vs Traditional Delivery and Student Major in terms of Withdrawal Percentage for Developmental Mathematics Classes*

<table>
<thead>
<tr>
<th></th>
<th>STEM</th>
<th>Arts/Humanities</th>
<th>Undeclared</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average</td>
<td>Standard Deviation</td>
<td>Average</td>
</tr>
<tr>
<td>Online</td>
<td>3.183%</td>
<td>3.832</td>
<td>4.653%</td>
</tr>
<tr>
<td>Traditional</td>
<td>3.022%</td>
<td>3.756</td>
<td>4.430%</td>
</tr>
<tr>
<td><em>p = 0.693</em></td>
<td><em>p = 0.650</em></td>
<td></td>
<td><em>p = 0.770</em></td>
</tr>
</tbody>
</table>
From the SPSS® output, the row of interest is OT for the interaction between online and traditional classes for each of the respective dependent variables. The significance value is in Table 6 as the p-value. Comparing these standard deviations to the ones from the D/F percentages, it can be seen that these are smaller despite being on the same scale (0-100%). However, the averages of the withdrawal percentages are smaller than the D/F percentages, so these data not being as spread out makes sense.
Again, because the variable of withdrawal percentages represents a negative, it would be better if this percentage were low. In the graph representing this variable, it can be seen that there was not a big difference between the online and traditional sections, but online sections still had a higher withdrawal percentage. Once again, Arts and Humanities majors had the highest withdrawal percentages in both delivery types (4.653% and 4.430% for online and traditional respectively) and Undeclared had the lowest (3.114% and 2.991% for online and traditional respectively).

Illustration 3. *Online vs Traditional Delivery and Student Major in terms of Withdrawal Percentage for Developmental Mathematics Classes*

The interest was in whether the means of the delivery type and student major were equal in terms of final grade, D/F percentage, and withdrawal percentage. Since a confidence
level of 0.05 was assumed, the null hypothesis was rejected and the alternate hypothesis was accepted in the case of final grades and D/F percentage. In summary:

$H_1$: There is a difference between the means of the delivery type in regards to D/F percentage in the developmental mathematics classes.

$H_1$: There is a difference between the means of the student major in regards to D/F percentage in the developmental mathematics classes.

$H_1$: There is a difference between the means of the delivery type in regards to final grade in the developmental mathematics classes.

$H_1$: There is a difference between the means of the student major in regards to final grade in the developmental mathematics classes.

This shows that there is a difference between the means in these cases. The p-values for withdrawal percentages were above 0.05, so the null hypotheses were not rejected:

$H_0$: There is no difference between the means of the delivery type in regards to withdrawal percentage in the developmental mathematics classes.

$H_0$: There is no difference between the means of the student major in regards to withdrawal percentage in the developmental mathematics classes.

It can be seen that when considering delivery style, students earned higher grades and fewer students earned a D or F in the traditional classes. Students in traditional classes withdrew at a lower rate than online students, but it wasn’t as large a difference as the D/F percentage. In reference to student major and success, STEM majors had the highest GPAs but not the lowest withdrawal or D/F percentage. Conversely, Undeclared majors had the lowest GPAs but also the lowest withdrawal and D/F percentage. Arts and Humanity majors
were in between on GPA but had the highest percentage of withdrawals and failing grades. A
discussion and the author’s thoughts regarding these findings can be found in Chapter 5
along with ideas for future research.
CHAPTER 5
DISCUSSION

The goal of this research was to determine if student major or instructional delivery type affected how students performed in developmental mathematics classes at a small Midwestern university. Student success was broken down into three categories: final grade, D/F percentage, and withdrawal percentage.

At the 0.05 confidence level, it was shown that the withdrawal percentage in each group (delivery type and student major) are not statistically significant. This means that the null hypothesis cannot be rejected. In this case, that means that there was no difference in the means of the delivery type and there was no difference in the means of withdrawal percentage when comparing student major. In other words, neither the method of delivery (online or traditional) nor the student major (STEM, Arts/Humanities, or Undeclared) make any difference in whether or not students withdraw from developmental mathematics classes. It is interesting that final grade and D/F percentage are statistically significant when withdrawal percentage is not. It raises questions about why withdrawal percentage is not affected by delivery type or student major but D/F percentage and final grade are. The withdrawal percentages found in this study were around 3-4% whereas in literature, it is found to be 5-10% and some even has high as 20% (refer to Chapter 2 for specific examples).

Strictly looking at the means, it is not a surprise that the STEM majors received higher grades than the arts/humanities and undeclared majors (and the arts/humanities received higher grades than undeclared). One would assume that STEM majors are better at mathematics courses since the courses are more closely related to their major and the fact
that the M in STEM stands for mathematics. However, when looking at the percentages, it’s not as cut and dried as the STEM majors doing the best in a mathematics course in all categories. Undeclared majors received fewer D/F grades (11.00% and 8.56% compared to 19.65% and 13.36% for Arts and Humanities majors and 12.24% and 10.47% for STEM majors in online and traditional classes respectively) and withdrew from classes at a lower rate than their STEM and Arts and Humanities counterparts (3.11% and 2.99% compared to 4.65% and 4.43% for Arts and Humanities majors and 3.18% and 3.02% for STEM majors in online and traditional delivery types respectively). This is very surprising and is tough to unpack. One would think that the group of students that received the highest grades in the class would also be the ones that would be least likely to receive a grade of D/F and/or withdraw from the class, not the group of students who received the lowest average grades in the class. One would also assume that STEM majors should have the fewest D/F grades and the lowest withdrawal rates since their majors use mathematics more.

Through this analysis, it can be seen just how difficult developmental mathematics classes are for students. Low average final grades regardless of delivery type or student major (1.65 and 2.07 for STEM majors, 1.60 and 1.91 for Arts/Humanities, and 1.53 and 1.83 for undeclared in online and traditional classes respectively) support what the literature has said about the low success rate in these classes across the country. The national pass rate (a grade of C or better) for developmental mathematics classes is 49.45% (Twigg, 2011) compared to 53.99% at the institution being studied.
Limitations

As previously mentioned, there are a number of factors that can lead to student success in developmental mathematics college classes. This study was limited to considering student major and class delivery type. Findings may not be generalizable to other universities or classes besides developmental mathematics classes. The state of Missouri is currently in the process of reworking the developmental mathematics course sequence since pass rates are so low. A co-requisite model is being proposed. Students would enroll in a credit-bearing general education mathematics class and if they required remediation, they would be enrolled in a remediation class at the same time (similar to a contextualized learning model mentioned in Chapter 2). The data from this study will still be beneficial but the specific sequence looked at here may not be in effect at a later date. The location of the school may be a factor in other ways. The university is liberal arts, commuter school. STEM majors at a university like this may mean something different than a STEM major at an engineering school. Because the university is in a rural area, slow Internet speeds may be a factor in enrollment in online classes. Along the lines of student major, as mentioned in Chapter 3, the students’ major was their declared major at the time of their enrollment in the class. A student could have declared a major of mathematics, for example, and then realized after doing poorly in developmental mathematics courses, that they needed to change their major. This change could even occur during the semester that the student is enrolled in developmental mathematics. The major that a freshman chooses initially may change a number of times, which could lead to inconsistencies in the data.
At the university in which the research takes place, there are two mathematics classes that are considered developmental. For the sake of this study, these two classes were combined to look at developmental mathematics classes as a whole rather than broken apart. It is important to look at the big picture first but, because of this, data about each class could be lost. Also, the researcher is an instructor at the university where the data was collected. Some of the classes included in the data were ones the instructor taught as well. However, data were not traceable to specific students, classes, or instructors, so the researcher’s position should not be a factor. One important point to make relates to the size of n in this research. Because this study used data from 10 years, 12,500 students were considered. Lastly, because of the span of the study, a number of factors could affect the success of online classes over this time period. Students and instructors are more familiar in an online environment than they were 10 years ago.

Implications

This research has many implications for the future. Regarding student major, it did show something surprising. As mentioned previously, one would assume that STEM majors would perform better in mathematics classes, even developmental ones, but this study found that not to be true. This indicates that there is more research to be done in this area.

The data from this research can be used to help enrollment of students at the university in which the study took place. Many times when enrolling a student, they don’t know whether they would prefer an online class or a traditional class. Based on the data found in this research, faculty can advise these students which delivery method students in their major excel at. This can be the basis of similar studies done at other universities to help
their students with enrollment as well. At the university in which this study took place, the data showed that success rates in developmental mathematics courses are no different than at the national level, which means something needs to change to help the students succeed. Student learning models (touched upon in Chapter 2) should be considered at the institution of study. Since it was found that traditional classes were more successful than online classes as was expected (Hill, 2013; Weems, 2002; Zavarella & Ignash, 2009), a rework of the online classes is needed. Online classes are becoming more prevalent (Xu & Jaggers, 2011) and colleges and universities need to work on bringing them up to the level of success of traditional classes. There should not be a difference from a learning outcome point of view in whether a student decides to take a class online or in a classroom.

**Future Research**

There are several big extensions that should be examined to further this research. The first suggestion for further research would be to add a mixed methods component. Surveying students could lead to helpful insight that the numbers alone can’t show. Questions might include why students dropped the class, what could have been done to help them pass/stay in the class, and what they thought was working in the class already (none of the current literature has this component either). This could also lead to some helpful insight to what student support models will work. The research has been started on ways to help these students but more focus should be on how to improve success rates across the nation.

Additionally, separating the data by class may bring some information to light that was hidden by grouping Beginning Algebra and Intermediate Algebra together. The only reason the data were not broken apart by class was because the author was interested in the
big picture of developmental mathematics. However, looking at the classes separately may indicate that one class is far more significantly worse off or better off than the other and needs a redesign to target it first. Trenholm (2009) found no difference when separating the two courses though. Related, comparing students who were placed directly into Intermediate Algebra with students who enrolled in it after passing Beginning Algebra could lead to some interesting results. An extension of this would be comparing the success of students who were placed directly into a credit bearing college mathematics course (such as College Algebra) to students who eventually enrolled in this course after starting in Beginning or Intermediate Algebra.

**Conclusion**

The goal of this study was to determine student success in developmental mathematics classes based on student major and instructional delivery type. The literature was mixed on whether online or traditional students were more successful in remedial mathematics courses (Xu & Jaggers, 2011; Hill, 2013; Spradlin & Ackerman, 2010). Among the data in this study, students in online classes performed worse than their traditional counterparts. As was stated in Chapter 2, no research had been done on whether student major had an impact on student success. Most would assume that STEM majors would perform the best in mathematics courses because of the close connection to their own major. However, this study showed that this wasn’t always the case. In fact, undeclared majors sometimes out performed STEM majors. More research needs to be done to determine *why* this is happening.
Taking a step back from this study raises the question about what is causing this problem in the first place. It is worth looking at why students are coming to college so unprepared, and what can be done to change this. It is clear that the success rates of developmental mathematics classes at the university in which this study took place are in line with what is happening across the nation. Analyzing data for the last 10 years gives one a lot to think about as to what can be done to help students be more successful. It is clear that there are plenty of good student support options (from Chapter 2: acceleration, contextualized learning, and supplemental support models) that need to be explored by this university (and others across the nation) to improve the success rates of students in developmental mathematics classes.
APPENDIX

Journals searched for student major as it pertains to student success

- American Journal of Distance Education
- American Mathematical Association of Two-Year Colleges Educator
- American Mathematical Association of Two-Year Colleges Review
- Comparative Education Review
- Educational Technology Research and Development
- Higher Education Research and Development
- Journal for Research in Mathematics Education
- Journal of College Student Development
- Journal of Developmental Education
- Journal of Online Learning and Teaching
- Journal of Research on Technology in Education
- Quarterly Review of Distance Learning
- Research and Teaching in Developmental Education
- Research in Developmental Education
- Research in Higher Education
- Review of Research in Education
- Studies in Higher Education
- Teaching in Higher Education
- The Chronicle of Higher Education
- The Internet and Higher Education
- The Journal of Higher Education
- The Review of Higher Education
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VITA

Jean Louise Coltharp was born on June 3, 1992 in Olathe, Kansas. Her family soon moved to Asbury, Missouri where she attended Carl Junction schools graduating in 2010. She then attended Pittsburg State University where she graduated summa cum laude with a bachelors of science in education in 2013. This degree was then followed by a masters of science in mathematics in 2014.

Upon graduation, she accepted a position teaching mathematics at Missouri Southern State University. At this time, she also began working on her PhD in Curriculum and Instruction and Mathematics at University of Missouri-Kansas City.