EFFECTIVENESS OF SUPPLEMENTAL INSTRUCTION PROGRAM ON IMPROVING RETENTION RATE, SUCCESS RATE AND GPA OF DEVELOPMENTAL MATH STUDENTS

by

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ABSTRACT

Developmental courses and services are created to provide academic tools and skills for students who are unprepared for higher education curriculum (Gordanier, Hauk & Sankaran, 2019, p. 24). Developmental education has grown into an essential part of higher education institutions with over 98% of community colleges providing developmental courses in 2000 (Williams & Siwatu, 2017, p. 24). Approximately 58% of students enrolling at community colleges are placed in developmental education, but only 44% complete the developmental English sequence compared to 31% for developmental math (Quarles & Davis, 2017, para. 4). The purpose of this quantitative comparative ex post facto study was to assess the effectiveness of an academic assistance program – Supplemental Instruction (SI) - on retention, success and GPA of developmental math students. Sample population for this study included 9,301 SI students and 14,597 Non-SI students enrolling in a total of 625 developmental math courses from summer 2013 to spring 2018. Aggregate data pertaining to the mean values of retention rates, success rates and GPAs of SI and Non-SI students enrolling in developmental math courses were used for comparative analysis. A one-way ANOVA and independent two-sample t-test with significance value p of less than 0.05 displayed a statistical significant difference between the retention rates, success rates and GPAs of SI and Non-SI students. Results from this research study call for continual supports and curriculum reforms to enhance learning outcome and success of developmental math students. Academic assistance programs are fundamental in helping students improve their retention and success.

DEDICATION

I would like to dedicate this work to my mother. You worked tirelessly your entire life to support us and never once asked for anything in return. Your patience and love never went unnoticed and till this day years after you had passed on, I tell my children of that love of their grandmother. To my dad, for someone who had only an elementary education and yet somehow could instill in me the love for learning and to never stop learning. I miss you both dearly.

To my sister Hieu, when I think of kindness, selflessness and what our parents' definition of a good person was, you are the first one that comes to mind. To my son Brody, you are my first love, my forever love and I am grateful that I get to be your mother. To my son Parker, you are a blessed addition to our family. I loved you the moment I saw you and will love you for always. To my wife Quynh, you are the love of my life. Thank you for loving me and taking care of me the way you do. I don't say it enough but you are the pillar of our family and we are better because of you.

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Community colleges, faculty, administrators and students – you are the core foundation of higher education and I am humbled to have been in your company for almost two decades. You have my utmost admiration.

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Chapter 1

Introduction

Enrollment in postsecondary institutions continues to grow steadily. The National Center for Education Statistics projected a 15% growth rate in American higher education from 2014 to 2025 (Hussar & Bailey, 2017, p. 23). The Great Recession of 2008 has made many young adults rethink college, especially as employment opportunities plunged and people lost their jobs. Postsecondary enrollment rose from 48.7% to 50.8% between 2007 and 2010 for ages 18-19, 30.5% to 32.6% for ages 20-24, and 6.7% to 8.5% for ages 25-30 (Barr & Turner, 2013, p. 168-169). Community colleges rose in popularity across the country during this time. These are learning institutions for working adults to advance their skills and for the younger population of academically at-risk students to review basic knowledge (Castillo, 2013, p. 35-36). Community colleges appeal to students because they are a less-expensive alternative to the typical four-year universities (Nutting, 2014, p. 614). Many students look to community colleges to fulfill general education requirements, and at the same time, to stay closer to home (Carter, Coyle & Leslie, 2011, p. 11).

A large number of students entering community colleges are referred to developmental math, English, or both as the result of their placement exams. About 92% of community colleges have some forms of standardized placement exams that place students in developmental courses (Bettinger, Boatman & Bridget, 2013, p. 96). Placement exams assess students' academic competency, both present and potential, then place them in the proper class accordingly to their academic strengths. As many as 80% of newcomers to community colleges enroll in developmental education (Saxon & Morante, 2014, p. 24). It is not uncommon to find students that are academically unprepared for college courses. Aside from having convenient location and low-cost tuition, community colleges also offer an open-admissions policy (Teranishi, Suarez-Orozco & Suarez-Orozco, 2011, p. 153). Unlike four-year universities that use high school transcripts and SAT scores to estimate students' college academic work (Roseanu & Drugas, 2011, p. 9), open-admissions policies admit everyone without any cutoff line. This form of admission may get students enrolled, but it does not necessarily allow them to take college-level courses upon acceptance to the college (Pratt, 2017, p. 2). Students with little or no formal basic knowledge are placed into developmental courses as refresher courses. The intention for this learning experience is to afford students with the needed review in basic and elementary skills that will increase their chances for academic success (Valentine, Konstantopoulos & Soldrick-Rab, 2017, p. 806-807).

Background of the Problem

Over 80% of students enrolling at community colleges in California are referred to developmental math, which amounts to nearly 20% of all community college students in the U.S. (Ngo & Melguizo, 2016, p. 171). Traditionally developmental math education comes in a sequence of several courses that students must take sequentially (Xu & Dadgar, 2017, p. 63). Developmental math proficiency, according to California State University (CSU), includes 3 years minimum of high school Algebra 1, 2 and geometry, or a comparable integrated math sequence (California State University, 2014, p. 2). Developmental courses are as costly and time-consuming as other college courses, but they do not have any college credit value toward a degree (Hanford, 2016, para. 7). Students who cannot pass all the math courses in the developmental sequence typically end up not transferring to a university or leaving the college altogether without any degrees (Bahr, 2013, p. 171). Long developmental math sequences with low success rates suggest that students need help and changes should be made. The focus can begin with placement exams' accuracy, course content materials and how they are delivered, and then ultimately reevaluating students' success rates (Melguizo, Kosiewicz, Prather & Bos, 2014, p. 2).

Developmental math courses have become the gatekeeper for many students to achieve their college goals and to have a successful career. Only 30% of developmental math students can complete the entire sequence successfully (Cafarella, 2016, p. 55). If the sequence of developmental math courses is not completed successfully, students are not qualified for certain majors or allowed to proceed to graduation (Rech & Harrington, 2000, p. 63). Students with the least math preparation are required to complete a minimum of 3 semesters of developmental math, and only 20% of these students continue on to be successful in college-level math (Xu & Dadgar, 2017, p. 63).

Academic and student support programs like tutoring and counseling can help enhance student performance and perseverance (Marcus, 2017, para. 29). An academic assistance program – Supplemental Instruction (SI) with an embedded tutor – examined in this study may help improve the retention rate, success rate and GPA of students enrolling in developmental math courses through motivation and participation. Students' active participation in academic work has a positive relationship to their achievement (Tincani & Twyman, 2016, p. 2). The goal of SI program is to provide assistance in comprehension of the learning materials and to improve students' overall grades. Students attend weekly peer-facilitated study sessions held at the college's tutoring or math center. These sessions are facilitated by SI tutors who act as liaisons between students and the course instructors by attending class, taking notes and tutoring.

Statement of the Problem

Success in the American education in the 21st century relies heavily on the effectiveness of Science, Technology, Engineering and Math (STEM) education as society becomes more technologically dependent (K-12 STEM, 2011, p. 33). Creativity in STEM-focused education allows students the opportunity to grow and develop academically by exposing them to different subjects and learning methodologies. Curriculum instructions in STEM or STEM related subjects emphasize collaborative learning, building connections between similar concepts, and inquiring scientifically and systematically throughout tasks (Tawfik & Trueman, 2015, p. 7). When compared to students in other countries, American students do not perform as well in math or other STEM-related subjects. Students in the United States often trail behind their Asian counterparts in exams like PISA (Program for International Student Assessment) or TIMSS (Trends in International Mathematics and Science Study) (Gasser, 2011, p. 108). In 2015, students of age 15 around the world took PISA and the average scores from both Korea and Finland were higher than the United States (National Center for Education Statistics, 2018).

In 2001, the No Child Left Behind Act (NCLB) overhauled the American educational system. The main goal of NCBA was to lessen the disparity in academic performance between students of affluent backgrounds and those that are at risk for failure (Lagana-Riordan, 2009, p. 135). It was not a popular Act because it only substantiated poor academic achievement and left many at-risk students for failure. By June 2010, Common Core State Standards (CCSS) was passed with the support of more than 45 states (Sewall, 2014, p. 339). The role of CCSS was to outline the subject content and student competency for each grade level. Widespread implementation of CCSS prompted many higher education institutions to study and conduct research on Common Core in order to better support students that are college bound (Sewall, 2014, p. 339).

High percentage of students enrolling in developmental education at community colleges is in contrast to a low success rate. When compared to college-level-course peers, students taking developmental courses accrue less college credits within 3 years from initial enrollment and are unlikely to obtain a degree in 6 years (Bremer et al., 2013, p. 157). According to Venezia and Jaeger (2013), students entering college from high school do not possess the basic study skills, content information, or determination required to prosper in a higher learning institution (p. 117). Not being prepared for college academically can be challenging for students trying to acclimate to new learning environments. Students with low GPAs from high school or SAT and ACT scores are considered unprepared for college and often assigned to developmental education (Cholewa & Ramaswami, 2015, p. 205). Cholewa and Ramaswami (2015) stated that developmental students have a higher risk of failing courses or dropping out of school (p. 205). The specific problem is that there have been few studies to determine the effectiveness, if any, that SI program has on the retention rate, success rate and GPA of students enrolling in developmental math courses. Supplemental Instruction program addresses issues related with academically underprepared students and helps them transition to and be successful in college (Price, Lumpkin, Seemann & Bell, 2012, p. 9). The program follows the structure and content of the course to teach life-long study skills, as well as identifies what type of learner a student is and what learning methods are most effective for each student.

Purpose of the Study

The purpose of this quantitative study is to compare the retention rate, success rate and GPA of students enrolling in developmental math courses integrated with SI program to those without SI program. The intention of developmental math courses is to enhance learning skills of academically underprepared students. Only 49% of students at community colleges are able to finish all developmental courses that they attempt (National Center for Education Statistics, 2016, p. v). Academically underprepared students must complete these developmental, zero-credit bearing courses before moving to college-level, credit-bearing courses. According to Melguizo, Hagedorn and Cypers (2008), the average completion time for community college students is 5 years, with half of that spent on taking developmental courses, and yet only accumulate one year's worth of full-time transferrable credits (p. 417). Despite the fact that many students have developmental courses as prerequisites, many of them are deterred to enroll, and some do not complete the recommended sequence that they are assessed into (Crisp & Delgado, 2014, p. 100).

Findings from this will help alleviate the study problem that there is not enough research existed on the general, non-specific academic assistance programs to help students that are taking developmental math. Benefits of this study may also provide educators and administrators with the necessary information for future curriculum design and teaching strategies that associate with poor study skills, math anxiety and test-taking techniques.

This quantitative comparative ex post facto study examines the effect of an academic assistance program targeting developmental math students. Three assessed variables include the retention rates, success rates and GPAs of students enrolling in developmental math courses integrated with and without SI program. A quantitative research method is appropriate for this study because it focuses on classifying, measuring and constructing statistical analysis to explain what is being studied (McCusker & Gunaydin, 2015, p. 538). Ex post facto is a well-suited design because the study looks at an after-the-fact intervention for a dependent outcome (Lord, 1973, p. 5). It is a good explanatory instrument for gaining insights into the correlations between variables that cannot be controlled by the researchers (Lacruz & Cunha, 2018, p. 219). This study is bound by aggregate and archival data provided by the participating college's Annual Supplemental Instruction Report from the 2013 to 2018 academic years. Based on an SI prototype established by the University of Missouri – Kansas City, Supplemental Instruction program at the participating college is available for students enrolling in targeted courses.

Community college students struggle to complete developmental math requirements. Being academically underprepared in math can negatively impact students' college progression and timely graduation (Hodara, 2013, p. 2). In this study, Supplemental Instruction program provides academic assistance to developmental math students with a concentration on improving their retention, academic success and GPA.

Significance of the Study

One objective of developmental education is getting students ready for postsecondary academic work. Readiness in higher education is defined as having a high school diploma and being able to complete first year of college successfully by passing all college-level courses without any developmental education (Woods, Park, Hu & Jones, 2018, p. 179). Many students entering postsecondary education are academically unprepared for college-level instruction. Reasons for this can be peer influences, disparities in expectation between high school and college curriculum, family backgrounds, and environments that support academic success (Venezia & Jaeger, 2013, p. 117). Though developmental education is meant to assist unprepared students with study skills and basic knowledge, Park, Woods, Hu, Jones and Tandberg (2017) reported that developmental students, especially in math, are less likely to transfer or obtain a degree (p. 318).

The significance of this study is to present a broader informational platform for faculty and administrators on curriculum development, instructional plan, study skills alongside with learning supports to improve academic success and increase retention of developmental math students. Community colleges are equipped with various programs and services that promote academic success – like tutoring, counseling and mentoring. Academic advising is an important component of students' college experiences (p. 292). The need for an academic assistance and support is essential in the transition to college for students (Farenga, 2015, p. 70). Supplemental Instruction program provides students with long-term study skills to become independent thinkers and life-long learning strategies needed to reach their educational goals.

Nature of the Study

Concern about retention and success of developmental math students is the motivation for this quantitative comparative ex post facto study. Referral and enrollment are especially high for developmental education at community colleges and despite concerted effort both in money and time, success rate remains low (Xu & Dadgar, 2017, p. 63). Students that are assessed as having needing developmental math prerequisites before enrolling in non-developmental courses are less likely to succeed, whether it be as graduating or transferring (Logue, Watanabe-Rose & Douglas, 2017, para. 2).

The study population includes students enrolled in developmental math courses with and without SI program integration at a community college in Southern California. Supplemental Instruction program at the participating college seeks to improve students' academic achievement and retention by establishing an interactive and dynamic learning environment that is welcoming for all individuals from different backgrounds and identities. Students enrolling at community colleges are less successful in developmental math, with just about 50% of them are able to complete the sequential courses, compared to 63% for developmental English/reading courses (National Center for Education Statistics, 2016, p. 23). An academic assistance program is needed to provide learning support to developmental math students in terms of enhancing their retention rate and outcome success.

University of Missouri – Kansas City has been providing SI training in over 29 countries to more than 1,500 higher education institutions since the program was created in 1973 (Stone & Jacobs, 2008, p. vii). The International Center for Supplemental Instruction from University of Missouri – Kansas City describes SI program as “a non-remedial approach to learning that supports students toward academic success by integrating ‘what to learn’ with ‘how to learn’” (International Center for Supplemental Instruction, 2018). Gasiewki, Eagan, Garcia, Hurtado and Chang (2011) noted that students are more likely to collaborate with other students and engage when they feel comfortable in the class, go to tutoring or attend SI sessions (p. 229). Unlike SI program design established by the University of Missouri – Kansas City which is attached to high-risk courses, SI program in this study is designed to provide academic assistance for developmental math courses through SI tutors and SI study sessions. The objective of SI program in this study is to insert SI tutors in the classrooms as the liaison between students and instructor, and to increase existing individual tutoring services. Tutors in the SI program are referred by either faculty or current tutors from the tutoring or math center who were asked about any current or past students that exhibit good interpersonal skills and academic excellence. Once hired, SI tutors undergo a training process before employment. Supplemental Instruction study sessions are study groups organized by SI tutors to work with students on learning strategy, reviewing lecture notes, developing study aids and preparing for exams.

For this study, the retention rate, success rate and GPA of students enrolling in developmental math courses integrated with SI program (referred to hereafter as "SI students") are compared with the retention rate, success rate and GPA of students enrolling in developmental math courses that are not integrated with SI program (referred to hereafter as "Non-SI students"). Data collection treats Non-SI students as the baseline group and SI students as the experimental group. Supplemental Instruction program assumes the role of independent variable in this study, whereas the dependent variables consist of retention rate, success rate and GPA. Retention is one of the main components that correlates student achievement during the first year experience to graduation from the same institution (Bingham & Solverson, 2016, p. 51). The retention rate of a course is the ratio set up between enrollment headcount of students who remained in the course (i.e. numerator) with end-of-semester letter grade of "A," "B," "C," "D," "F," "P (Pass)," or "NP (No Pass)" and enrollment headcount of students who initially registered in the course (i.e. denominator) with end-of-semester letter grade of "A," "B," "C," "D," "F," "P (Pass)," "NP (No Pass)", or "W (Withdraw), then multiplied by 100 to make a percentage. The success rate of a course is the ratio set up between enrollment headcount of students who passed the course (i.e. numerator) with end-of-semester letter grade of "A," "B," "C," or "P (Pass) and enrollment headcount of registered students in the course (i.e. denominator) with end-of-semester letter grade of "A," "B," "C," "D," "F," "P (Pass)," "NP (No Pass)," or "W (Withdraw)", then multiplied by 100 to make a percentage. The scale for GPA is from 0.0 to 4.0, computed by dividing the sum of all converted decimal grades (numerator) by the number of classes taken (denominator). It is used to assess an individual's goal specificity, achievement encouragement and self-efficacy (Dickinson & Adelson, 2016, p. 8). Students'

GPA is one of the main requirements for college admission because it is made up of grades from all the courses that students have taken.

A quantitative comparative ex post facto method design is used in this study to examine the effectiveness of SI program on developmental math students. Ex post facto evalutes the relationships between variables and assesses the outcomes. The comparative aspect of the design is to determine the correlations between variables both dependent and independent after an intervention or action has taken place (Salkind, 2010, p. 125). The purpose is to examine whether the independent variable - SI program - affects the outcomes, or dependent variables – retention rate, success rate and GPA. Data for this study is numerical, calculable, and assessable, defining the characteristics of a quantitative approach more than qualitative. Qualitative method dominates the market research and social studies (Gelo, Braakmann & Benetka, 2008, p. 270). This method stresses the need for the ability to interview and use skills to interpret findings and recommendation (Bailey, 2014, p. 168). Quantitative approach is a more suitable choice for this study as there is no interview or observation involved. Data analysis of students' retention rates, success rates and GPAs in this study signifies the impact that an academic assistance program – Supplemental Instruction - has on student retention and academic achievement.

Research Questions/Hypotheses

Research Questions

Based on archival data, three research questions are established for this quantitative comparative ex post facto study addressing the differences between the retention rates, success rates and GPAs of SI and Non-SI students. The questions are as follows:

RQ 1: What is the difference between the retention rates, if any, of students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program?

RQ 2: What is the difference between the success rates, if any, of students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program?

RQ 3: What is the difference between the GPAs, if any, of students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program?

Hypotheses

Hypotheses provide the groundwork for predicting the final destination of the research study. The precursor to the hypotheses is the outline of the study, and that elaboration allows for a better consideration of the statistical method (Toledo, Flikkema & Toledo-Pereyra, 2011, p. 191). For this study, the hypotheses are structured on the premises of past studies and archival data where the null hypotheses remain the default and the alternative hypotheses show significant changes so that the null hypotheses can be rejected. Based on the established research questions, three hypotheses are explored:

$H1_0$ Retention rates are not significantly different between students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program.

$H1_A$ Retention rates are significantly different between students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program.

$H2_0$ Success rates are not significantly different between students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program.

$H2_A$ Success rates are significantly different between students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program.

$H3_0$ GPAs are not significantly different between students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program.

$H3_A$ GPAs are significantly different between students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program.

Theoretical Framework

Several learning theories are explored in an attempt to further understand student motivation, development and how higher education institutions affect academic success, as related to the likelihood of student retention and achievement. The theoretical framework for this study is grounded, both socially and cognitively, in the learning theory of Tinto's Model of Student Retention. The assumption is if students engage more socially and academically in the college life, then it will enhance their retention and success rates (Stuart, Rio-Aguilar & Deil-Amen, 2014, p. 328).

Social Cognitive Theory. Social cognitive theory is related to self-adjustment and self-reflection under the influences of social structures (Bandura, 2001, p. 266). It is human nature to gain understanding through interactions and to develop knowledge based on the information derived from experiences (Bandura, 2001, p. 267). Holland's theory of person-environment fit demonstrates the knowledge and perception of the differences in students' educational accomplishment, satisfaction and stability (Feldman, Smart & Ethington, 1999, p. 643). Academic planning related to self-efficacy and self-regulation can be assessed using social cognitive theory to help students have a successful college experience (Erlich, Russ-Eft, 2011, p. 5).

Self-efficacy is the confidence that drives people to engage in activities that benefit their goals, whereas self-regulation refers to being responsible for their learning (Erlich, Russ-Eft, 2011, p. 5). Learning theorists advocate that this is a form of discovery learning where students develop knowledge based on their own individual experience (Hushman & Marley, 2015, p. 371). Piaget's theory of development is the mainstream pathway for cognitive learning about human growth and development (Bormanaki & Khoshhal, 2017, p. 996). Understanding these theories can provide insights into a person's early development and societal influences.

Constructivism: Constructivism is a learning theory related to how people actively construct their own knowledge from built-on experience and reflection (Walker & Shore, 2015, p. 2). In a classroom, a constructivist form of learning can include assorted practices of teaching, usually encouraging students to apply active techniques to enhance their comprehension, reflect and assess how their knowledge is changing. According to Walker and Shore (2015), inquiry-based learning in a classroom that involves questioning out of interest and curiosity contributes to a person's motivation and understanding (p. 3). Lonergan's model of understanding suggests that an act of knowing is not a single process but an integrated, dynamic one with three cognitive operations: experience, understanding, and judgment (Roscoe, 2004, p. 542). Constructivism triggers a person's innate curiosity, and he or she will attempt to understand, engage, and ultimately draw conclusions based on his or her own findings.

Student Involvement Theory. Student involvement theory relates to the energy both physically and psychologically dedicated to academic experience (Astin, 1999, p. 518). Getting involved enables students to develop the feeling of belonging and eases the transitioning process to college. Astin (1999) stated that learning development in any academic activities varies directly with students' participation both in quantity and quality (p. 519). Academic success has always been linked with active participation in the classroom, and other forms of engagement in college. Students' level of responsibility is either enhanced or lessened, depending on how well they integrate themselves in college. Tinto's interactionalist theory suggests that students and their learning institution consistently interact socially and educationally, and persistence rests upon the extent to which students interact in this environment (Chaves, 2006, p. 142). Integration is critical to the process of persistence as students going through three phases: disengagement, transition, and embodiment (Milem & Berger, 1997, p. 388). Disengagement occurs when students somewhat cut ties from the familiarity of their past. Transition happens after separation, when students have not yet adapted to the new environment. Embodiment takes place once students have adapted to and adopted their learning community. Successful embodiment does not guarantee persistence, as Tinto suggested that students must trust that they are an integral component of the system, both academically and socially (Milem & Berger, 1997, p. 389).

Tinto's Model of Student Retention. When students involve themselves academically and socially in the learning environment, they have a higher tendency to persevere and excel (Stuart, Rio-Aguilar & Deil-Amen, 2014, p. 328). Initially, student retention was believed to be the reflection of students' motivation, skills and characteristics – students fail when they are less enthusiastic, less able and less inclined, not due to the institution (Tinto, 2006, p. 2). The decision to quit college comes from a combination of students' academic/social integration with their learning environment and their own characteristics (Connolly, 2016, para. 1). Tinto's model of student retention individualizes learning behaviors, as there are many different reasons for which an individual may decide to, or be forced to quit college. Institutions must look into issues of self-efficacy, curriculum and sense of belonging from students' perception in order to enhance the likelihood of more individuals are aspired to persist (Tinto, 2015, p. 259).

Definitions of Terms

Key terms relevant to community colleges, developmental education and academic assistance programs are used all through this study. The following definitions have distinct meanings suitable for the context of this research study:

American College Test (ACT): This is an entrance exam used for college admission in the United States consisted of subject areas in math, reading, writing and science (ACT, 2018). Each section of the exam is graded on a scale from 1 to 36, for the average of four sections of the entire exam (The Princeton Review, 2018, para. 10).

College-Level Courses: Refers to courses both in lower and upper division that provide general and degree-specific education for associate and bachelor's degrees (Pritchard & Lee, 2011, p. 2). Students earn college credits for every college-level course that is completed successfully and these credits are counted toward their degree programs and graduation.

Common Core State Standards (CCSS): These are guidelines for math and English language arts/literacy that summarize what needs to be taught and what students' competency level should be per grade (Common Core State Standards Initiative, 2018, para. 2). Academic guidelines for students in California from kindergarten to high school are set by the State Board of Education (California Department of Education, 2018, para. 2).

Community College: Community colleges are often seen as a better alternative to obtaining a bachelor's degree in terms of cost than universities (Anonymous, 2014, p. 8). Also referred to as junior or two-year college, community college offers an associate's degree for different majors, continuing education for adult learners, certificate programs for those in the work force and general education for students who have the intention of transferring to a university.

Developmental Course: This is a remedial course. Upon enrollment at community colleges, students are given a skills assessment in math, English or both. From the results of the assessment, students are either enrolled directly in college-level courses or referred to developmental/remedial courses to prepare for future non-developmental courses (Bailey & Cho, 2010, p. 1).

General Education Development (GED): This is a certificate equivalency of a high school diploma. It is a test-based credential consisted of reading, writing, math, social studies, and science that are comparable to those of high school graduates (Zajacova & Everett, 2014, p. 222).

Grade Point Average (GPA): This is a number that demonstrates how well a student performs in their courses on average. It is used as an early warning sign of students' academic success or failure (Gershenfeld, Hood & Zhan, 2015, p. 470). In the United States, GPA has a scale from 0.0 to 4.0, designated to letter grades of A, B, C, D and F, respectively.

High-Risk Courses: Courses that require a significant amount of readings from difficult textbooks or reference works, infrequent exams, and a large class with little to no interaction with the professor (Dawson, van der Meer, Skailicky & Cowley, 2014, p. 610). Common high-risks courses are STEM related subjects such as science, technology, engineering or math.

No Child Left Behind Act (NCLB): This is a test-driven accountability law imposed on public schools beginning of January 2002 (Duncombe, Lukemeyer & Yinger, 2008, p. 382). It is an apogee of a standard-based reform directed at low-achieving students with the effort to improve low-performing schools.

Program for International Student Assessment (PISA): This is a reading, math and science examination administered once in 3 years around the world among students 15 years of age by the Organization for Economic Co-operation and Development (OECD) (Schneider, 2009, p. 2).

Scholastic Aptitude Test (SAT): This is a uniform, college entrance exam in the United States with the highest possible score of 1600. The Scholastic Aptitude Test is a multiple-choice test created by the College Board, which assesses high school students' college preparedness in writing, reading and math (The Princeton Review, 2018, para. 1).

Science, Technology, Engineering and Mathematics (STEM): A form of program instruction that focuses on four distinguished disciplines – science, technology, engineering and mathematics.

Assumptions

Aggregate data from the participating college is publicly available online, it is reasonable to assume that validity, rigor and reliability of the collected data have already been established. Another assumption is that students enrolling in developmental math courses with SI integrated program attend the weekly SI study sessions and other open-session workshops at the participating college's math center or tutoring center. It is assumed that student learning outcomes and curriculum instruction are comparable in all developmental math courses, both with SI program and without SI program. Another assumption is that faculty and administrators at the participating college are concerned with students' retention, academic performance and success.

Scope

The largest community college system is in the state of California with 112 colleges catering to more than 2 million students (Buckley & Piland, 2012, p. 29). While at one point it was ranked as one of the top states in the country known for high school and college graduation rates, California now is in the bottom ten (Douglass, 2011, p. 27). The scope of this study is the effectiveness of SI program on retention rate, success rate and GPA of students enrolling in developmental math courses. The scope is applicable to faculty and administrators of community colleges. Findings of this research study may support the important contribution of an academic assistance program – Supplemental Instruction - to positively impact students' learning outcomes and success. Faculty and administrators may use the research as an informational base for curriculum development and instructional planning that align with different types of learners and what teaching/learning methods are most effective for students. Higher education leaders may use the research to extend academic assistance programs to other non-developmental and high-risk-for-failure courses or subjects. Specific topics consist of the correlations between retention rates, success rates, and GPA of SI students and Non-SI students of developmental math courses.

Limitations

According to Rahman (2017), one of the weaknesses of quantitative approach is that one cannot account for how people interpret their behaviors or how reality is shaped (p. 106). For this study, random assignment into control (Non-SI students) and experimental (SI students) groups is not possible. Integration of SI program into the curriculum of developmental math courses at the participating college depends on several factors such as funding, availability of SI tutors and the consent of the course instructors.

Although SI program extends to non-developmental math courses and other subjects, the population for this study only covers developmental math courses. This research study is confined to one community college in Southern California. Since the research takes place at one community college, findings may be pertinent to only that student population or other general populations with similar settings such as cultural backgrounds, perspectives, socioeconomic levels, and abilities. The population for this study consists of developmental math students participating in a voluntary academic assistance program outside the classroom. Data includes aggregate, archival information for only 5 consecutive years and is limited to students enrolling in developmental math courses with and without SI program integration.

Delimitations

The focus of this study is on students enrolling in developmental math courses integrated with SI program at a community college. Non-developmental math and other subject courses integrated with SI program are excluded. Findings for this study may be befitting only to the participating institution. Weekly attendance for SI study sessions at the math center or tutoring center is an essential component of this academic assistance program. Outside-the-classroom SI study sessions have several gains for students and the instructors. First, there are no time constraints for these sessions at the math center or tutoring center as there are for lecture-style classroom environment. Second, students attending weekly SI study sessions can be considered as being self-motivated and having the desire to succeed because this is a voluntary program requiring additional time from students aside from coming to class for lecture.

Summary

In 2017, the National Assessment of Education Progress (NAEP) revealed that about 25% of 12th graders are at or above the proficiency level in math and 37% in reading (The Nation's Report Card, 2017). In the field of developmental education, students are taking courses that have no credit value toward their degrees because they are not academically proficient to take college-level courses. Every year, a large number of students have to sign up for developmental education at community colleges to help with math, reading, and/or writing (Bahr, 2012, p. 661). Chapter 1 provides underlying information aiding the belief that students enrolling in developmental courses are in need of academic assistance and guidance. A theoretical framework provides the foundational base for this study. Supplemental Instruction is a support program that focuses on improving success of developmental math courses, and students will gain life-long learning skills to become independent learners. Academic assistance programs for developmental math students may have significant impact on students' motivation, retention, college-readiness and transferring to a four-year university.

Chapter 2 reviews literature relevant to both past and current developmental math education and academic assistance programs. Chapter 2 is divided into sections that covers the synopsis of the problem, current view on academic assistance programs, and published research studies addressing concerns relevant to the problem.

Chapter 2

Review of the Literature

Developmental education became known in the late 1960’s for accommodating students who were unprepared for postsecondary education instruction (Dotzler, 2003, p. 121). Unprepared newcomers to college have a higher risk of dropping out (Cholewa & Ramaswami, 2015, p. 204). Approximately 75% of students are taking a minimum of one developmental math course upon enrollment at all community colleges (Cafarella, 2016, p. 55). A developmental system dedicated to give students a better chance at succeeding in college turns out to be not as helpful as planned. Nearly 70% of community college students successfully complete a minimum of one developmental course within 6 years from the initial enrollment, but only 20% go on to take college-level math (Xu & Dadgar, 2017, p. 63). This is important when considering the appropriate intervention to assist students enrolling in developmental math. Interventions that may help decrease attrition and increase retention by focusing more on students’ academic skills and traits (Chloewa & Ramaswami, 2015, p. 205).

Many higher education institutions provide services and programs aiding students in their transitional process to college life (Morisano, Hirsh, Peterson, Pihl & Shore, 2010, p. 256). Students who are well adapted to college life tend to be more devoted to their educational goals (Grant-Vallone, Reid, Umali & Pohlert, 2004, p. 255). The purpose of this quantitative comparative ex post facto study is to compare academic success in terms of retention rate, success rate and GPA, of students enrolling in developmental math courses integrated with an academic assistance program to those without assistance program. When students immerse themselves in the learning environment, both socially and academically, there is a higher probability that they will persist and succeed in college. Student support programs on campus such as mentoring, tutoring, learning skills instruction, and counseling, among others, are believed to be indispensable in helping students adapt to the college life and commit to success (Grant-Vallone, Reid, Umali & Pohlert, 2004, p. 259).

The purpose of the study, described in Chapter 1, is to compare the retention rate, success rate and GPA of students enrolling in developmental math courses integrated with SI program to those without SI program at a community college in Southern California. Background information included an overview of the traditional developmental math education. Many community college students are taking developmental math, but few can finish the required sequence, which results in them existing the college without a degree or transferring (Bahr, 2013, p. 195). Also presented were limitations due to the study not being extended to other subjects aside from developmental math and the scope of the study is confined to only one community college.

Chapter 2 includes details of title and author search processes and the organization of the search. The review of the literature is conducted in line with the problem statement and purpose statement of this study. Searches were focused primarily on seven fundamental topics, including (a) community college, (b) higher education policies, (c) open-admission policies, (d) assessment and placement exams, (e) college readiness, (f) developmental math education, and (g) academic assistance programs and learning theories. The underlying goal for the literature review is to establish a blueprint that presents the layout of ex post facto comparative research design. Specific goals are to explore the essential learning theories and assumptions with respect to community college students as inferences to the impact of curriculum instruction of developmental math, learning skills and behaviors of academically unprepared students. Academically unprepared students have characteristics associated with family background, personal commitment to goals, and some with precollege education meshed with the institution's mission to attrition and retention (Grimes & David, 1999, p. 75). Chapter 2 concludes with information about existing gaps in the literature associated with the significance of SI program and academic success of developmental math.

Title Searches

Terms, phrases and keywords related to the seven fundamental topics are roles of community colleges, student populations, placement exams, developmental math curriculum/instruction, retention rates, success rates, learning theories, study skills, and students' intervention/assistance programs. Information searches come from many sources including University of Phoenix Dissertations and Theses, peer-viewed journals from the University of Phoenix Library, specifically from JSTOR, ProQuest, EBSCOhost and SAGE Knowledge. Peer-reviewed journals provide an informational base in connection with the significant contribution of developmental math education, success and fail rates of developmental math students, and the need for an academic assistance program to provide help for these students so that they can be ready for college-level instruction. Additional sources inquired for this research include data and reports published by the California Community College Chancellor's Office, National Center for Education Statistics, U.S. Department of Education, and the American Association of Community Colleges.

Table 1

Summary of Reviewed Literature Sources

Topic	Books	Peer Reviewed Journal Articles	Dissertations	Total
Community College	0	15	0	15
Higher Education Policies	0	8	0	8
Open-Admission Policies	0	5	0	5
Assessment/Placement Exams	0	11	0	0
College Readiness	0	10	0	10
Developmental Education/ Developmental Math Education	0	22	0	22
Total	0	99	1	100

Roles of Community College

There are 1,462 community colleges across the country; of these, more than two-thirds are public institutions (U.S. Department of Education, 2017). Community colleges have an impactful role on postsecondary education system. They are home to approximately 43% of all higher education enrollments (Kalleberg & Dunn, 2015, p. 225). Community colleges experienced a significant growth after World War II with the first institution established in early 20th century, and in the next century, over 1,000 more followed suit (Crookston & Hooks, 2012, p. 350). According to the American Association of Community Colleges, nearly 12.1 million students were registered in credit and non-credit courses for the 2016-17 academic year (American Association of Community Colleges, 2018, p. 1). Students are depending more and more on community colleges to reach their goal of acquiring a bachelor's degree. The priority of community colleges is to be accessible and affordable to anyone who wish to pursue higher education (Stanley, 2007, p. 11). It is a practical choice in pursuing high education especially for low-income students, underrepresented minority, first-in-the-family college goers, and those who do not have the means or are unqualified for a four-year university. For the 2015-16 academic year, tuition, fees, room and board are about $10,432 for community colleges, compared to $26,120 for four-year unversities (National Center for Education Statistics, 2018).

In 2015, President Obama unveiled an initiative known as America's College Promise Act that would offer free tuition for community colleges, saving students an average of $3,800 per year (Goldrick-Rab, 2016, para. 6). Within 6 months of its introduction, Tennessee launched the Tennessee Promise program, providing free tuition for community or technical colleges to nearly 16,000 high school graduates (Whissemore, 2015, p. 4). Oregon and Minnesota also followed the Act with their own statewide programs called the Oregon Promise and the Minnesota's College Tuition Relief Bill (Whissemore, 2015, p. 4). Denning (2017) did a quasi-experimental study on the impact of tuition on enrollment in the Texas community college system (p. 155). The conceptual framework of the research was built on the economic theory predicting that college enrollment will increase as the result of lowering tuition cost (Denning, 2017, p. 157). America's College Promise initiative for this study would suggest an increase of 29% in community college enrollment from recent high school graduates, an additional of about 102,000 students (Denning, 2017, p. 185). When tuition cost is high, it is a financial burden for students and an eventual reason for them to drop out because they do not want to accumulate more debt (Dwyer, McCloud & Hodson, 2012, para. 20). Institutions can increase degree production either by offering more resources or by lowering the degree-production cost (Jenkins & Rodriguez, 2013, p. 196). America's College Promise and the Tennessee Promise represent a significant change in government funding within higher education system that affects enrollment, persistence and degree completion. The success of federal and state policies for educational funding depends on how well the institutions perform and whether it aligns with the goals and missions that they are designed to inspire (Jenkins & Rodriguez, 2013, p. 202).

Higher Education Policies

The first focus of Federal legislation on higher education was the Morrill Acts of 1862, signed into law by President Lincoln (Billings, 2012, p. 729). The Act provided land grants to new western states so that they could build colleges, thus making higher education accessible to working-class people and farmers. In addition to establishing higher education institutions, the Act also provided programs that trained citizens in agriculture and other technical skills they would need for the working world (Palmadessa, 2016, p. 54). The Act changed the face of higher education because the government became involved in higher education directly for the first time and this started a trend for the type of government aids that state colleges and universities are currently receiving across the country.

Higher Education for Democracy of 1947 from the Truman Commission suggested that community colleges to be made accessible to the American people (Fonte, 2009, p. 45). Democracy alone is not self-sustainable but with education, the people can be informed, responsible citizens (Fonte, 2009, p. 45). Even in 1947, the cost for attending college was a hurdle for many students and higher education was limited to only those of higher economic status (Gilbert & Heller, 2013, p. 418). The Commission suggested that it is time for the Federal government to be the major financial contributor for higher education so that higher education is for everyone regardless of race, gender, religion, or nationality (Gilbert & Heller, 2013, p. 418). As the result of the Commission, many initiatives, acts and policies have been passed by the government addressing issues regarding enrollment, financial aid and accessibility in postsecondary education.

Another measure of regulation, the Government Issue (G.I.) Bill of Rights is one of the most extensive and inclusive Bill the federal government has ever offered to service members.

The Bill catered to returning veterans of World War II by extending many social welfares, including postsecondary education and vocational programs (Mettler, 2002, p. 351). Between 1940 and 1955, nearly 70% of all service members who turned 21 received free college tuition along with a sizable living stipend (Stanley, 2003, p. 671). Just 10 years after World War II, over 2 million veterans had enrolled in college and almost 6 million started vocational education, all subsidized under the G.I. Bill (Mettler, 2002, p. 351).

At any level, policies are established in relation to how an institution operates, to whom it serves and performance accountability because these are the focus of how resources and incentives are granted. The Higher Education Act (HEA) was made into law by President Lyndon B. Johnson in 1965 to establish federal aid program that makes higher education accessible to all (Capt, 2013, p. 1). The Act appropriates funds directly to the institutions based on student headcounts at the same time providing financial assistance through grants and subsidized loan to low-income and middle class students (Cofer & Somers, 2001, p. 58).

There is a consensus that community colleges have been the champion for working class people since the Truman Commission demanding equity and accessibility in higher education (Fonte, 2009, p. 45). They are the driving force of economic development for the local community and surrounding businesses. Community colleges have a crucial role in educating people for tomorrow's jobs and providing training to the local workforce (Sygielski, 2011, p. 6). They are structured in a unique way that can respond and cater to the demands of the local community and surrounding industry (Sygielski, 2011, p. 6). By introducing students to an array of career possibilities through internship with the local business, private sectors and government can bring about a student's self-awareness and community growth. When students complete the education that prepares them for the workforce, it is a success story for the local economy and the community by creating and keeping jobs in the area (Sygielski, 2011, para. 6). American Recovery and Reinvestment Act (ARRA) was created in 2009 to encourage community colleges to partner with businesses and companies that want to expand their operations or retrain their existing workforce (Nickoli, 2013, p. 69). The "stimulus" or ARRA was signed by President Obama with the intention of creating new jobs and saving current ones due to the Great Recession of 2008 (Taylor & Cantwell, 2016, p. 199). Stimulus funds from ARRA lend a hand to higher education institutions so that they can maintain their operations with little or no interruptions from the statewide budget deficit (Taylor & Cantwell, 2016, 202).

Open-Admission Policy

Community colleges are rooted in general education, vocational certificates/programs and transfer curriculum to a four-year university (Friedel, 2010, p. 207). The core operation of community colleges lies within their open-admission policy that allows for everyone the opportunity to move up on the social ladder benefited from educational experience (Ingram & Morrissey, 2009, p. 32). Deficiency in academic preparation and learning skills do not limit students from college access under open-admission policy (Mulvey, 2009, p. 30). Approximately 95% of community colleges admit students based on an open-admission policy (Bragg & Durham, 2012, p. 108). Students with or without a high school diploma or a GED and regardless of GPA or any standardized test scores fall within the policies of open admission. This policy particularly supports the American dream of nontraditional, underrepresented or underserved students (Bragg & Durham, 2012, p. 108). Demographic characteristics of these students are more often immigrant, first-in-the family, indigent, racial and ethnic minorities (Bragg & Durham, 2012, p. 108). Data from the American Association of Community Colleges (2018) show that there are 36% of first-generation to attend college, 24% of Hispanic, 13% of

African Americans and less than 10% for both Asian/Pacific Islanders and Native Americans currently enrolling in community colleges across the country.

Assessment and Placement Policies

Assessment and placement policies play an important role in assigning first-year college students into particular courses. While each state has its own approach on placement policies, most typically implement standardized assessments for entry into college-level courses (Collins, 2008, p. 16). These assessments determine the appropriate courses based on students' assessed knowledge and skills (Kingston & Anderson, 2013, p. 3). Once the placement test result is available, students are assigned to the course level that will fit them best. Eligibility requirements for community colleges are based on ASSET (Assessment of Skill for Successful Entry and Transfer) with minimum scores of 39 and 46 for College English I and College Algebra, respectively (Kinston & Anderson, 2013, p. 4).

A study conducted by Scott-Clayton, Crosta and Belfield (2014) explored various aspects of the screening process that mis-place, under-place and over-place students into developmental courses (p. 371). Developmental assessment and placement are dominated by 2 standardized tests: ACT's COMPASS and College Board's ACCUPLACER (Kenner, 2016, p. 274). At least 42% of all community colleges use COMPASS and 31% use ACCUPLACER for developmental math assessment of elementary and college algebra (Fields & Parsad, 2012, p. 11). Sample data for the study included high school transcripts, developmental exam scores, and grades from college courses of students from over 50 community colleges that belong to large urban community college system (LUCS) and state-wide community college system (SWCCS) (Scott-Clayton et al., 2014, p. 373). The study applied rich predictive model using students' college grades to examine the screening and placement policy under alternative policy simulations

(Scott-Clayton et al., 2014, p. 377). Under-placement is more common than over-placement in developmental assessment (Scott-Clayton et al., 2014, p. 388). Scott-Clayton et al. (2014) suggested that using students' high school information can help reduce inaccurate placement especially for racial/ethnic and gender subgroups (p. 388).

In California, if the assessment standards of CSU (California State University) system applied to community colleges, then nearly 8 out of 10 students would need to enroll in a minimum of one developmental course (Melguizo, Kosiewicz, Prather & Bos, 2014, p. 691). Research by Melguizo et al. (2014) provides details of A & P (Assessment & Placement) policies of the Los Angeles Community College District regarding developmental math placement (p. 693). Policies of A & P vary widely from state to state but institutions have some level of autonomy of their own. Uniform standards for A & P (1) provide better preparation for college-level coursework; (2) enhance A & P accuracy; (3) establish a homogenous criterion for college readiness; (4) enable students to transfer between institutions without retesting; (5) contribute to institutional assessment of performance and effectiveness of programs (Melguizo et al., 2014, p. 695). This case study employed qualitative and quantitative designs to analyze data that was collected online in addition to documents and transcripts provided by the districts (Melguizo et al., p. 700). As stated by Melguizo et al. (2014), A & P policies are more effective with the contribution of faculty and staff who determine the design and how students are assessed (p. 697). In 2011, Assembly Bill 743 was passed in California requiring the state to develop a uniform assessment to ascertain students' level of readiness for college math and English (Melguizo et al., 2014, p. 716). The authors intended the Bill to align higher education institutions' A & P policies with standards for college readiness from Common Core for high school students (Melguizo et al., 2014, p. 716).

While curriculum and instruction of developmental education are mandated in some states, community colleges in California and few other states have the autonomy to decide on how developmental courses should be taught (Kosiewicz, Ngo & Fong, 2016, p. 205). In California, only 19% of students placed in the third level down from college standards – continue on to take college-level English, compared to 6% in math (California Community College Chancellor's Office, 2013). Funded by the state Chancellor's Office, the California Acceleration Project (CAP) partners with statewide community colleges to work on redesigning the curricula of developmental education (Hern & Snell, 2014, p. 27). In accordance with Section 55003 of Title 5 of the California Code of Regulations, prerequisite courses are not required unless students are at risk to fail college-level courses without them (California Community College, 2018, para. 3). Prerequisites provide students the opportunities to review necessary skills and information to succeed in college (Chancellor's Office, California Community Colleges, 2012, p. 3). In practice, this policy is not followed because it does not have enough information for community colleges to apply different measures of assessment to avoid over-placing students into developmental courses. In October 2017, the Governor passed Assembly Bill (AB) 705 clarifying the existing law associated with assessment and placement (California Legislative Information, 2018, para. 3). Community colleges are required to maximize students' probability of taking and completing transfer-level courses within the span of one year. Developmental math courses in particular are considered a hindrance to student success (Quarles & Davis, 2017, p. 33). Under AB 705, assessment instruments now include high school records of coursework, grades and GPA so that students are not assigned to developmental courses that can possibly incur a setback or prevent them from reaching their goals (California Legislative Information, 2018, para. 3).

Another option, the Advancement Placement (AP) exam score is a distinct implication of a student's academic ability (Smith, Hurwitz & Avery, 2017, p. 68). The exam is a combination of multiple-choice and free-response graded on 5-point scale, where 5 is the highest possible score (College Board, 2018). The scores of 1 to 5 are compatible with college-level studies where 5 means the student is extremely well qualified and his/her academic level is comparable to the letter grades A or A+ of college-level courses. Students can benefit significantly from performing above the threshold with a score of 3 or more, including a higher chance of college admission, college credit or placement without developmental education (Smith et al., 2017, p. 69). Smith et al. (2017) did an empirical study on whether AP exam score promotes higher educational attainment (p. 77). Sample data for this study were examinees from the 2004-9 graduating high school students provided by the College Board (CB) and National Student Clearinghouse (NSC) (Smith et al., 2017, p. 72). The authors identified strong correlations between AP exam scores and the probability of students being on the right path to obtain a bachelor's degree (Smith et al., 2017, p. 123). If high school juniors score above the threshold of the AP exam, they are more likely to participate and succeed on the AP exam in their senior year (Smith et al., 2017, p. 122). Findings of this study have positive implications that granting AP credit or placement to students with high AP exam scores can free them from developmental or introductory courses in college (Smith et al., 2017, p. 122). One limitation noted by the authors includes inconclusive reporting on the effect of taking AP courses in high school on bachelor's degree completion rate (Smith et al., 2017, p. 123).

There exists a gap between college expectation and high schools' perspective of their graduating students. About 89% of college professors believe first-time college goers are unprepared for college courses while less than 30% of high school teachers concur (Almeida, 2015, p. 312-313). The main reason for this dissent is the untimely and insufficient information provided to high school students regarding college preparation (Almeida, 2015, p. 303). In 2004, California State University (CSU) system created Early Assessment Program (EAP) in conjunction with the State Board of Education (SBE) and the California Department of Education (Venezia & Voloch, 2012, p. 72). The purpose of EAP is to increase the chance for incoming college freshmen to take college-level math and English (Venezia & Voloch, 2012, p. 72). To help identify at-risk students for developmental education upon enrollment to college, EAP assesses the level of readiness in college math and English among high school juniors (Knudson, Zitzer-Comfort, Quirk & Alexander, 2008, p. 228). The assessment encourages students to take the initiative to better their knowledge and skill levels during last year of high school. Three elements of EAP include assessment, curricular opportunities and professional development (Venezia & Voloch, 2012, p. 72). The mathematical portion of EAP has an extra 15 questions attached at the end of the California Standards Test (CST) (Houser & An, 2015, p. 939). The EAP scores consist of 4 categories pertaining to college-level courses: (1) Exempt – ready for college-level courses, (2) Nonexempt – not ready, more preparation recommended in senior year, (3) Incomplete – not ready because essay or multiple-choice portions were incomplete, and (4) Conditionally Exempt (math only) – ready but recommended to maintain math study during senior year (Venezia & Voloch, 2012, p. 72).

Almeida (2015) used a qualitative exploratory method to assess the perspective of low-income, mainly Latino students regarding EAP and their behaviors in relation to EAP (p. 318). Sample participants in this study were 24 students from an outreach program, with 2 African Americans, 3 Asians and 19 Latinos (Almeida, 2015, p. 318). The data collection method was audio-taped focus groups asking students about their experiences with EAP. Interviews were transcribed verbatim and analyzed with both deductive and inductive techniques. Students believed that high schools should put more emphasis on college preparation after knowing more about the specifics of EAP (Almeida, 2015, p. 323). The author addressed the essentials of collaboration between higher education institutions and K-12 system to improve readiness among high school students and college completion rates (Almeida, 2015, p. 330). A larger sample size was not feasible for this study due to the constraints of time and budget (Almeida, 2015, p. 330).

College Readiness

College readiness means that students can successfully pass college-level courses in the first year of attendance without developmental education (Woods, Park, Hu & Betrand Jones, 2018, p. 179). Many college-bound students do not have the basic academic skills, mentality and behaviors that are requisite for college success (Lane, Morgan & Lopez, 2017, p. 3). There exists a disassociation in expectations between high school students and academic standards of higher education. Over 83% of high school students intend to pursue higher education, but not many participate in curriculum or educational programs that would improve their success in college (McCarthy & Kuh, 2006, p. 665). As discussed by Lane, Morgan and Lopez (2017), high school students spend less than 3 hours per week on studying in contrast to the minimum average of 13 hours for first-year college students (p. 3). These students are not aware that they lack of remedial skills and knowledge to succeed in college until they arrive at college underprepared. In addition to not spending enough time studying, high school students are not self-motivated and not persisting through tasks in order to maximize their academic experiences (Lane et al., 2017, p. 4). There are numerous factors contributing to students' motivation and performance (Basila, 2014, p. 45). Study skills and time management are instrumental for attending college. Effective study skills and persistence among high school students especially underserved population are not taught unless they are a part of a special program (Lane et al., 2017, p. 4). Research by Lane et al. (2017) indicated that support programs, networking, mentoring, and advisory are essential in fostering academic readiness (p. 4). The study examined how the Comprehensive STEM Program (CSP) helps underrepresented students of color with their college readiness (Lane et al., 2017, p. 2). Observations, interviews, questionnaires and focus groups were methods chosen for this study (Lane et al., 2017, p. 6). Sample participants were only 50 students, which was the allowed capacity of CSP (Lane et al., 2017, p. 6). Students of CSP believed that the program increased their foundational learning experiences for future acquisition and integration of new knowledge (Lane et al., 2017, p. 21).

Approximately 42% of students admitted to community colleges are unprepared for college-level curriculum (Travers, 2016, p. 51). Students' academic shortcoming can result in a negative effect on attrition, retention and learning success. Completion rate for certificates and degrees is lower at community colleges than four-year universities, with only 20% can finish a program of study within the span of 6 years (Travers, 2016, p. 51). When access to higher education is without restriction, enrollment in developmental courses will increase (Mulvey, 2009, p. 30). The trend is ongoing given the fact that 30% of newcomers to postsecondary institutions need some form of developmental education (Chung, 2005, p. 2). According to Hunter Boylan, - Director of the National Center for Developmental Education, developmental education is described as "the integration of academic courses and support services guided by the principles of adult learning and development" (Special Feature, 2017, p. 28). The curriculum of developmental courses integrates various interventions to help students get ready for collegiatelevel coursework. Interventions consist of tutoring, advisory, counseling, study skills instruction, and learning assistance center (Boylan, 1999, p. 2).

Another student population of community college is adult learners. Over 50% of students attending community colleges are of traditional-aged 25 years or older (Frey, 2011, p. 21). Recent economic changes have compelled many working adults to return to college for a new trade or skills needed for re-employment (Bettinger, Boatman & Bridget, 2013, p. 95). Community colleges are affordable and convenient for working adults to earn a degree or certificate (Frey, 2011, p. 21). Many adult learners are GED holders but may not be academically ready for college-level courses (Kallison, 2017, p. 303). Certain learning skills need to be rebuilt when high school graduation was years ago (Attawell, Lavin, Domina & Levey, 2006, p. 887). Subjects germane to college preparation include math, reading and writing because these are the foundations for all other disciplines (Kallison, 2017, p. 304). Bettinger et al. (2013) describe adult learners as focused and ready for the opportunity to refresh and catch up in developmental courses (p. 98). When educational leaders can identify the population of students that can benefit most from developmental education then they can develop curriculum and programs that will help improve student learning outcomes (Bettinger et al., 2013, p. 99).

Developmental Education

Developmental education in the U.S. is available at both community colleges and universities (Clotfelter, Ladd, Muschkin & Vigdor, 2015, p. 356). In some states, community colleges are the only higher education institutions that offer developmental courses in order to reduce cost (Clotfelter et al., 2015, p. 356). Students enrolling in developmental education are both traditional and nontraditional who are in need of basic skills review. Higher education institutions provide developmental education through learning assistance programs such as counseling, advising and tutoring in support of underprepared students' academic and personal growth (Arendale, 2011, p. 58). Educational leaders are facing numerous dilemmas when it comes to developmental education. After passing state tests, many high school students believe that they are academically proficient to graduate only to be assessed by a college as academically underprepared for college-level courses (Williams, Tompkins & Rogers, 2018, p. 2). Placement rate of developmental education is relatively high at community colleges (Xu & Dadgar, 2017, p. 63). As many as 60% of all newcomers to community colleges are assigned to developmental education and about 33% are taking a minimum of one developmental course (Pretlow & Wathington, 2011, p. 2). Thousands of new students are assessed every academic year as not meeting college standard for reading, writing and basic algebra (Brothen & Wambach, 2012, p. 34).

Higher education institutions are spending more time and money to adjust to this new wave of students by offering help and support, or risking them dropping out altogether. Within the community college system, developmental education is costly with a price tag of over $2 billion annually (Collins, 2010, p. 2). According to the U.S. Department of Education (2017), fewer than 23% of students who had a minimum of one developmental course obtained an associate degree in 6 years from their initial enrollment and only 4% graduated with a bachelor's degree in academic year 2003-04 (p. 8). Poor outcomes at great costs have made researchers question the effectiveness of developmental education in helping students succeed in college (Collins, 2010, p. 2).

Developmental education consists of reading, writing and math at basic levels that bear no college credit values (Goldstein & Perin, 2008, p. 90). When students enter college academically underprepared, the college offer a range of developmental courses in an effort of bridging the skill gap. A study by Boatman and Long (2017) explored the impact of developmental courses on students with different levels of academic preparedness (p. 29). Sample data was from two- and four-year public postsecondary education institutions in Tennessee where some students were assigned to one developmental course and others who need several courses (Boatman & Long, 2017, p. 30). This study was confined to students 21 years of age or younger and over 85% of these students have taken the ACT exam at time of enrollment (Boatman & Long, 2017, p. 37). Outcome measures were based on students' accumulated credits, college-level courses' success rate and enrollment outcomes both short and long terms (Boatman & Long, 2017, p. 38). Regression discontinuity (RD) was the design model used to determine the causal effects in this empirical study (Boatman & Long, 2017, p. 40). Boatman and Long (2017) contended that developmental math students have lower probability of earning a college degree either associate or bachelor's in a period of eight years since the initial enrollment (p. 49). In California, many students are placed two levels below college math standards, which equates to two or more extra semesters, prolonging students' time for transferring or earning a degree (Fong, Melguizo & Prather, 2015, p. 720). The load of developmental courses students are assigned to correlates to the greater probability of dropping out (Fong el al., 2015, p. 720).

There is not one nationally-accepted guideline implemented to measure the effectiveness of developmental education (Goldwasser, Martin & Harris, 2017, p. 10). Higher education institutions all have different ways to evaluate the quality and outcome of their programs. A research by Goldwasser et al. (2017) explored some of the best practices associated with operational cost, placement process and program structure of developmental education (p. 10). The most prevalent area of concern for higher education institutions is the cost of providing developmental education (Goldwasser et al., 2017, p. 11). The framework for the six best practices regarding to operational cost of developmental education includes (1) keeping expenses within 3% of total institutional budget, (2) maintaining budget to be less than those of college-level courses, (3) comparing cost with other regional institutions, (4) suspending operation when expenditures exceed revenues, (5) integrating computer-based programs to reduce costs, and (6) seeking educational grants or funds from the U.S. Department of Education (Goldwasser et al., 2017, p. 12). Suggested practices that are best for program structure in developmental education consist of (1) commitment to student success, (2) centralized services and support, (3) collaboration and open communication between faculty, staff and program personnel, (4) shared goals and mission with non-developmental programs, (5) ongoing program evaluation, (6) seeking adjuncts' input for program design and operation, (7) professional development and education for faculty and administrators, (8) academic advising and counseling, and (9) accelerated options to complete developmental courses (Goldwasser et al., 2017, p. 13). Five recommended best practices for placement approach comprise of (1) multiple assessments available for placement, (2) more comprehensive and thorough exam preparation materials, (3) mandated valuation for placement, (4) alignment between placement assessment and general curricula, and (5) supplemental learning support services and co-requisite courses for students whose placement scores are at the threshold (Goldwasser et al., 2017, p. 15-16). Consistency in program evaluation and student learning outcome assessments are key factors in providing students the best education an institution can offer (Goldwasser et al., 2017, p. 17).

Developmental Math Education

About two-thirds of community college freshmen across the nation require developmental math assistance (Bahr, 2013, p. 171). Developmental math education was created in response to students seeking admission to college but without the efficiency in basic skill level math. Developmental math courses are designated courses below college-level math by individual college and generally have course number less than 100, i.e., Math 096 (Cafarella, 2014, p. 36). They are structured in a sequence of arithmetic/algebra courses starting with basic to elementary then intermediate (Ariovich & Walker, 2014, p. 46). These are non-transferrable and non-degree-applicable credits contingent upon students' placement results. For some students it may take 3 to 4 semesters to complete their developmental sequence before reaching college-level math (Ariovich & Walker, 2014, p. 46). Many students end up failing, withdrawing or dropping out altogether before completing the sequence. Only 30% of developmental math students finish the sequence and even less make it to college-level math at community colleges (Ariovich & Walker, 2014, p. 46). Developmental math education has an important role in students' college success and timely graduation. Higher education institutions have employed best practices of instruction and applied changes in curriculum to improve the success rate, but not limited to, student learning outcomes and degree completion (Ariovich & Walker, 2014, p. 45).

Research by Quarles and Davis (2017) examined the correlation between learning Intermediate Algebra (IA) - conceptually and procedurally with student progress (p. 37). Student progress was assessed based on grade, accumulated credits, retention rate, and degree or certificate earned whereas learning includes gained knowledge and skill sets regardless of course or degree completion (Quarles & Davis, 2017, p. 35). This research was carried out at a community college in Washington State that had just redesigned its developmental program (Quarles & Davis, 2017, p. 37). Sample population for the study were students enrolling in one of the three IA courses offered for 2 academic quarters - winter and spring of 2012 (Quarles &

Davis, 2017, p. 38). Pre- and post-scores of an algebra skill test were analyzed in correlation to students' grades and progression (Quarles & Davis, 2017, p. 37). Assessment was divided into 2 sections containing conceptual skills with modeling exponential relationship whereas procedural skills were solving and simplifying equation/inequality (Quarles & Davis, 2017, p. 40). Analysis of data included logistic regression, linear regression, and descriptive statistics (Quarles & Davis, 2017, p. 40). Quarles and Davis (2017) addressed the one hurdle of this study regarding learning and progress is the different types of learning that define mathematical proficiency – conceptual, procedural, strategic, adaptive reasoning or productive disposition (p. 36). Findings of this study revealed that degree progression could be affected by the type of mathematics that students learn (Quarles & Davis, 2017, p. 47). The authors concluded that intermediate algebra was learned mainly by procedures and better procedural algebra skills offer almost no help to pre-calculus students in getting better grades (Quarles & Davis, 2017, p. 45). Conceptual knowledge serves as a foundation for subject areas that have not yet been comprehended. A new domain of mathematics can be supported by a conceptually congruous information from prior knowledge (Sidney & Alibali, 2015, p. 160).

A mixed method study conducted by Goeller (2013) looked into student perception of the placement assessments that require them to take developmental math (p. 22). A lack of basic mathematical skills is problematic for many students entering postsecondary education with many struggle to get pass the developmental sequence or progress on to college-level math (Wan, Sun & Wickersham, 2017, p. 428). The focus of this research was on how satisfied students were with their placement and the instructional pace of the course that they were assigned to (Goeller, 2013, p. 24). Participants were students from a southwestern community college enrolling in basic mathematics from one summer course and three fall courses (Goeller, 2013, p. 25). Qualitative portion of the study explored student viewpoints of their placement whereas quantitative component was data collected from a survey along with students' placement test scores (Goeller, 2013, p. 25). Approximately 72% of the participants agreed with their placement (Goeller, 2013, p. 28). Though placement does not reinforce academic achievement, success in developmental courses has a critical impact on students' persistence. Students at community colleges are more likely persist, graduate or continue on to a four-year university if they pass a minimum of one developmental course (Attewell, Lavin, Domina & Levey, 2006, p. 891).

There are many best practices in curriculum and instruction of developmental math education. It is necessary that faculty, administrators and program coordinators not only understand the practice, but also have the right knowledge to evaluate the program (Wheeler & Bray, 2017, p. 10). Poor results in assessments and outcomes have been the focus of developmental math reform by researchers and policy makers (Corbishley & Truxaw, 2010, p. 72). A study conducted by Wheeler and Bray (2017) examined the correlation between demographic factors and academic success of developmental math students at one community college (p. 10). Study sample consisted of 10,003 students enrolling in the first college-level-math-course (Math 100) over a period of 11 years. Participants were divided into two groups: students who did not have any developmental math before taking Math 100 and students who did (Wheeler & Bray, 2017, p. 11). The study assessed the pass/fail status of Math 100 along with the interactions within the 2 groups based on race and gender factors (Wheeler & Bray, 2017, p. 11). Logistic regression was the technique used to examine whether race and gender were the predictors of the course's pass/fail status and students' overall graduation goal (Wheeler & Bray, 2017, p. 12). According to Wheeler and Bray (2017), statistical significance existed between race/gender and students' odds to successfully finish the first college-level math course (Wheeler & Bray, 2017, p. 11). Despite negative connotations associated with developmental education, researchers of this study stated that developmental courses have an essential role in assisting students with their learning and substantially increasing their chance of graduating (Wheeler & Bray, 2017, p. 14). Regardless of the outcome, colleges still offer developmental courses because students are still in need of developmental skills (Wheeler & Bray, 2017, p. 11).

There are many hurdles facing college students starting with high school graduation requirements being not in sync with postsecondary expectations. Only two-thirds of college goers stated that they are adequately prepared for higher education (Abraham, Slate, Saxon & Barnes, 2014, p. 8). Experts and researchers of developmental math have reported of different successful pathways in the discipline. A study by Cafarella (2016) addressed the issues of student success along with some successful practices in developmental math courses (p. 56). The author emphasized on cooperative learning and group activities to help students ease the tension and reduce the feeling of math anxiety (Cafarella, 2016, p. 56). Good note-taking in class also produces positive outcomes on exams because students are actively engaging in the lecture (Isaacs, 1994, para. 17). There are still many unsuccessful students in developmental math courses despite different best practices. Poor attendance is one of the key factors affecting learning outcomes because it creates a large gap in content comprehension (Cafarella, 2016, p. 57). Success rates are also impeded by negative attitude and low motivation where students stop trying altogether (Cafarella, 2016, p. 57). There has been a surge in developmental math programs focusing on acceleration and compression with the intention of pushing students through the sequence quicker (Cafarella, 2016, p. 58). With so many students requiring developmental assistance, especially in math, the focus should be on practices that reach a large and heterogeneous student population (Cafarella, 2016, p. 63). Curriculum instruction matters to students enrolling in developmental courses especially when it is versatile and of quality. It all begins with support services and institutional commitment that developmental education is a part of the institution's duty and goal (Boylan, 2008, p. 16).

Academic Assistance Programs and Interventions

Arco-Tirado, Fernandez-Martin and Fernandez-Balboa (2011) examined the potential gains for first-year college students from a peer tutoring program (PTP) in terms of lessening course failure and dropout (p. 773). Data for this study included 141 students from the University of Granada in Spain of which were 100 freshmen and 41 tutors (Arco-Tirado et al., 2011, p. 776). Peer tutoring employs peers to provide instruction, repetition and concept review. The program also used counseling approach to emphasize the significance of time management, quality effort and active participation in learning (Arco-Tirado et al., 2011, p. 775). Peer tutoring has positive effects on students because tutors and tutees have constant and immediate feedback with plenty of opportunities to respond and time to collaborate (Bowman-Perrott et al., 2013, p. 39). Findings of this study determined that performance rate, success rate and GPA of first-year students were not significantly affected by PTP (Arco-Tirado et al., 2011, p. 780). Arco-Tirado et al. (2011) contended that PTP enhances student autonomy and a statistically significant difference was detected between the cognitive and metacognitive learning strategies and students' usage of study materials (p. 780).

Interventions enhance college readiness by making different services available to students, from academic supports and preparation, to psychological and behavioral counseling, to organizational skills and persistence (Venezia & Jaeger, 2013, p. 117). A qualitative, retrospective study by Sweeney and Villarejo (2013) explored the aspect of educational experiences from an intervention program that focused on persistence and performance of minority students (p. 534). Minorities continue to be underrepresented with common assumptions that they lack of motivation and preparation (Hurtado, Cabrera, Lin, Arellano & Espinosa, 2009, p. 191). Compared to their counterpart, minority students experience additional challenges such as lack of confidence, financial hardship and lower self-esteem (Sweeney & Villarejo, 2013, p. 534). Data collection consisted of a survey gathering information on students' experiences with the program and how it affected their career choice during and post college (Sweeney & Villarejo, 2013, p. 536). Sample participants included 106 program alumni with 68% female, 58% Hispanic, 20% Asian, 18% African American, 4% Native American, and 1% White (Sweeney & Villarejo, 2013, p. 536). Majority of the study participants acknowledged that advisory and mentorship were supportive and encouraging, allowed them to carry through difficult courses and made the right choices for their future (Sweeney & Villarejo, 2013, p. 538). Academic support services and counseling play a major part in helping students create directions for their life-affirming goals (Lapan, Poynton, Marcotte, Marland & Milam, 2017, p. 85).

Tutoring has a special effect on developmental students' academic success, retention and graduation (Defeo, Bonin & Ossiander-Gobeille, 2017, p. 15). A study by Butcher and Visher (2013) investigated the impact of an intervention program known as Beacon Program where a college personnel scheduled visits to math classes to inform students of different services offered at the college (p. 298). Beacon Program was implemented and evaluated at Pecan College, which is one of five campuses of South Texas College (STC) where student population is 94% Hispanic (Butcher & Visher, 2013, p. 300). Pecan College trained their employees to deliver information several times per semester about existing services such as counseling, tutoring and encouraged students to utilize these services (Butcher & Visher, 2013, p. 298-299). Samples included 83 math classes divided into two groups: treatment group had a visitor delivering information to students and control group had no visitors (Butcher & Visher, 2013, p. 304). A randomized-controlled design was used in this study to assign the 83 math classes to either treatment group or control group (Butcher & Visher, 2013, p. 304). The collected data included records of all class visits for each semester and card-swipe entry logs of students visiting the tutoring center (Butcher & Visher, 2013, p. 303). There is an estimate of 89.3% of tutoring services available for developmental education programs at community colleges (Defeo, Bonin & Ossiander-Gobeille, 2017, p. 14). Students who come to tutoring center have more time to practice their skills and it is a better learning environment for them to focus on tasks (Fullmer, 2012, p. 77). The treatment group of the study had a 30% more tutoring center visits compared to the control group (Butcher & Visher, 2013, p. 314-315). It is important to convey campus information directly to the classrooms instead waiting for students to search for it (Butcher & Visher, 2013, p. 315).

English (2016) conducted a quantitative ex post facto study that examined the impact of the Emporium Model of instruction on academic success of developmental math students at a community college in North Carolina (p. 3). Emporium Model is a redesigned developmental math through student engagement (English, 2016, p. 7). English (2016) employed a causal-comparative research design that relies on inferential statistics and descriptive statistics to compare the traditional model of instruction to the Emporium Model (p. 12). Many best practices were used in the Emporium Model which include collaborative learning, frequent assessments, structured lessons and computerized instructions (English, 2016, p. 49). Sample data for the study included cohorts of academically underprepared students and newcomers to the college enrolling in a developmental math course from 2008 to 2013 (English, 2016, p. 66).

English (2016) concluded that outcome success for students who enrolled in developmental courses integrated with the Emporium Model is better than those that were in the traditional model (p. 113).

Academic readiness can have a significant impingement on students' success in the classroom and overall retention rates. A study by Hesser and Gregory (2016) explored the effect of embedded support and extended instructional time on students who were assessed below college math standards but enrolling in a college-level chemistry course (p. 22). Many higher education institutions offer developmental math, reading, and writing and some also offers developmental chemistry. Students are placed in developmental chemistry in accordance to their math SAT scores (Hesser & Gregory, 2016, p. 22). Sample population for this quantitative, quasi-experimental study included 92 students from a single semester that were identified as needing developmental support (Hesser & Gregory, 2016, p. 23). These students would be assisted with algebra for the calculation-based components of their chemistry course. Data collection process included surveys given on the first day of class, records of students' math placement scores, SAT scores, and questions developed as part of the course exams and final exam (Hesser & Gregory, 2016, p. 24). Nearly 75% of the participants persisted with final exam score equivalent to or higher than their college-ready peers (Hesser & Gregory, 2016, p. 26). High school completion of chemistry course was not taken into consideration on students who were assessed as underprepared in math (Hesser & Gregory, 2016, p. 26).

Learning Theories

Kreysa (2007) conducted a study on students' persistence rate in developmental and non-developmental courses based on their personal backgrounds and learning experiences from both high school and college (p. 251). The theoretical framework of this study built on Vincent

Tinto's model of individual student departure (Kreysa, 2007, p. 253). Participation in both academic programs and social events are crucial to the process of persistence. The process includes separating from past communities, transitioning to the routines of the new environment, and adopting the prevailing patterns of the college (Milem & Berger, 1997, p. 388-389). Population sample included 438 college freshmen and among these, 217 registered in a minimum of one developmental course (Kreysa, 2007, p. 257). Demographic of the cohort consisted of 54.6% white, 23.3% Asian, 10.7% Hispanic, 8% African American and 0.5% Native American (Kreysa, 2007, p. 257). Logistic Regression was the method chosen to predict college graduation based on three variables: demographic, high school experience, and college experience (Kreysa, 2007, p. 259). Findings of the study indicated a positive connection between GPA and persistence (Kreysa, 2007, p. 262). Improvements in academic outcomes are linked to academic integrations such as peer sessions, faculty-student meetings and campus activities (Kreysa, 2007, p. 262).

A study by Homlund and Silva (2014) described an intervention program that focused on enhancing noncognitive skills of underachieving students – as a way to improve attendance and cognitive behaviors (p. 126). Noncognitive skills are attributes such as life skills, study habits, motivation, discipline, self-esteem, confidence, and they are as important as students' cognitive academic achievements (Homlund & Silva, 2014, p. 127). The intervention is a remedial educational program called xl club program concentrating on underachieving students who are 14 years old and attending English secondary schools (Homlund & Silva, 2014, p. 127). Program effectiveness was evaluated beginning in 2004 on a group of students aged 14 that finished their compulsory education exams two years later (Homlund & Silva, 2014, p. 133). Data collection process of the study consisted of students' achievement records and characteristics, which were provided by the Department of Education (Homlund & Silva, 2014, p. 133). The study used empirical approach and descriptive statistics with the adoption of logit specification to present its findings on students' propensity scores (Homlund & Silva, 2014, p. 141). Homlund and Silva (2014) noted an increase in maturity, self-esteem, motivation and students are more confident in their future educational goals (p. 155).

Learning communities at community colleges have the potential of improving students' learning outcomes through common interest. Students are integrated into shared academic and social systems that will help enhance their level of commitment to academy (Weiss, Visher & Weissman, 2015, p. 521). A study by Weiss et al. (2015) assessed the effectiveness of learning communities on students enrolling in developmental education (p. 520). The study consisted of cohorts of students taking two or more of the same courses and the curricula of these courses are structured based on similar theme (Weiss, et al., 2015, p. 521). Sample participants included 7,000 students from six different community colleges, all of which were divided into 174 learning communities (Weiss, et al., 2015, p. 526). Data from six colleges was gathered through interviews, observations plus some other approaches (Weiss, et al., 2015, p. 529). The main analysis relied on the intent-to-treat concept, which provided an approximation for the effect of learning communities in a school-based setting that resembles the real world, regardless of compliance (Weiss, et al., 2015, p. 523-524). Weiss et al. (2015) stated that learning communities and students' credit accumulation are positively correlated, especially in targeted subjects like math and English (p. 529). By sharing the same learning environment from co-enrollment, students have better opportunities to grow and build a meaningful college experience (Rocconi, 2011, p. 178).

Deil-Amen (2011) conducted a qualitative study on the dynamics of persistence among community college students using Tinto's Theory of Student Departure (p. 54). Tinto correlates the inadequacy of academic and social involvement with students' lack of responsibility to their educational goals and withdrawal (Deil-Amen, 2011, p.55). Surveys, interviews and observations were the methods of choice for this study. Study sample included interviews of 238 students, faculty and staff from 14 two-year public and private community colleges (Deil-Amen, 2011, p. 60). Interviews of students' experiences with social and academic integration within their institutions context were recorded and transcribed (Deil-Amen, 2011, p. 60). Findings of the study indicated a positive impact on students' integration process from the help of faculty and staff that facilitated the transition for them (Deil-Amen, 2011, p. 61). Deil-Amen (2011) also emphasized on the importance of classroom interactions as a dominant factor of socio-academic integration (p. 82). Active participation and collaboration in problem solving contribute to students' development and achievement (Deil-Amen, 2011, p. 337).

George (2010) examined the potential of motivation in developmental math education based on the ethical framework developed by Shapiro and Stefkovich (p. 82). Higher education institutions are not solely embedded in the educational context but rather in social connection (George, 2010, p. 82-83). Community colleges have a greater social context compared to four-year universities because they have a bigger population of academically underprepared students, more so in math than any other subject (George, 2010, p. 83). Developmental math faculty are the gatekeepers, entrusted with students' academic and social advancement (George, 2010, p. 83). George (2010) pointed out the broader context that developmental math faculty must be aware of is the overall progress of students' educational goal instead of just mathematical edification (George, 2010, p. 83). Ethical reasoning developed by Shapiro and Stefkovich focused on the decision-making of principals when educational leaders are confronted with progressively complex scenarios in their schools (Polizzi & San Clementi, 2013, p. 515). The article had two essential assertions: Outcome success of developmental math mainly stemmed from student motivation and the aspect of influencing student motivation is rooted from the context of ethics (George, 2010, p. 90). Of the three ethical approaches - justice, care, and critique by Shapiro and Stefkovich, George (2010) contended that ethic of care requires developmental math faculty to include other policies that go beyond exam scores to motivate students (p. 88).

Research Method and Design

This is a quantitative comparative ex post facto research study using archival data with the application of an independent two-sample t-test and Analysis of Variance (ANOVA). Common designs have been used for research on developmental math education and academic assistance programs include post hoc, quantitative and qualitative methodologies or a combination of such. Wolfle (2012) used a post hoc study with archival data to assess the rates for success and persistence of developmental math students at a medium-sized community college in Virginia (p. 45). Collected data consisted of students' gender, ethnicity, age and enrollment status over a period of 5 years, and grades of all the math courses that were taken (p. 45). Wolfle (2012) implemented a binary logistic regression approach to examine the correlation between ethnicity, age and enrollment status – independent variables and success and persistence rates – dependent variables (p. 46). The sample size was 756 students registering in either a college-level math course or developmental math course. This research excluded students of ages 15 and 16 because they did not meet the traditional- or non-traditional age criteria (Wolfle, 2012, p. 45).

Crynes (2013) conducted an ex post facto study that assessed the use of the scores from ACT/SAT and ACT's COMPASS (Computer-Adapted Placement Assessment and Support Services) tests as means to place first-time-enrollment students into math courses (p. 3). Crynes (2013) stated that students who were assigned in the first math course because of these scores performed as well as those who took the college placement exam (p. 2). The goal of this study is to avoid placement test scores misrepresenting students' math skills which could adversely limit their academic options (Crynes, 2013, p. 4). Quasi-experimental research method was chosen due to study samples were not randomly assigned. Ex post facto was the right choice for this research because it was used to determine the outcomes – course GPAs based on the independent variables – ACT/SAT and ACT's COMPASS scores (Crynes, 2013, p. 5). Sample data consisted of students enrolling during fall semesters of 2009 and 2010 and those who had taken the COMPASS test (Crynes, 2013, p. 5). Limitations presented by the author included that some students with ACT and SAT scores that declined to participate, the date on which students took the ACT or SAT exams and the time gap (Crynes, 2013, p. 10).

Conclusions

The effect of developmental education varies between English and math, but the mathematical impact is of particular interest due to higher enrollment and lower success rate (Crisp & Delgado, 2014, p. 5). Although the intention is to afford students with the needed skills to be ready for college-level courses, lengthy developmental sequence is more of a hindrance than help (Bahr et al., 2019, para. 10). Students are less likely to finish college if it takes them longer to complete a degree particularly those who were placed in developmental education (Abraham, Slate, Saxon & Barnes, 2014, p. 37).

Nearly 60% of first-time college goers are assigned a minimum of one developmental math course (Yamada & Bryk, 2016, p. 180). Factors contributing to low success rate in developmental math include multi-course sequence, placement test, and curriculum instruction, plus some students have already had negative past experiences (Yamada & Bryk, 2016, p. 180). According to Brandenberger, Hagenauer & Hascher (2018), there is more connection and emotion involved between self-determination and math more than any other subjects (p. 295). Academic success increases as students becoming more engaged both socially and academically with their learning environment (Natoli, Jackling & Siddique, 2015, p. 462). Engagement is a trait of the mindset that is study-related filled with commitment (Upadyaya & Salmela-Aro, 2013, p. 136). Tinto's 1975 Departure Model asserted that the social transitioning process is indispensable to the accomplishments of first-year students as they establish new connections and adapt to the new environment (Burke, 2019, p. 15). As policy makers increase their attention on success and completion rate, developmental math reform becomes the center of attention for all community colleges (Ariovich & Walker, 2014, p. 45).

Summary

Developmental education is the most typical practice in preparing students for the rigor and content of higher education. Many students accepted to community colleges and universities are not proficient in math, reading and writing (Levin & Calcagno, 2008, p. 181). Over 60% of newcomers to community college have a minimum of one developmental course as prerequisite (Logue, Watanabe-Rose & Doughlas, 2016, p. 578), compared to 29% of newcomers to four-year university (Levin & Calcagno, 2008, p. 182). Students pay for classes that have no college credit and some are deterred from enrolling while others fail out of the sequence of developmental courses (Levin & Calcagno, 2008, p. 182). Reducing the time students spent taking developmental courses and providing supplement support have become key policies to enhance learning outcomes. Community colleges across the country are working on different approaches to structure the curriculum of developmental education and to find more effective teaching methods to deliver lessons to students (Kosiewicz, Ngo & Fong, 2016, p. 206). While curriculum content is necessary, there are other pertinent factors that make up student persistence and success. Many students entering higher education institutions are not familiar with the autonomous and self-directed learning environment (Connolly & Spiller, 2017, p. 874). Faculty and staff can provide supports and guidance to students in the college transitioning process and promote student engagement.

Post hoc studies with data analysis are frequently found in educational research. A review of literature revealed the statistical correlation between poor success rate of developmental math and the overall persistent rate of community college students. Quantitative design method incorporated with aggregate and archival data track student performance and progress. Many studies included best practices in developmental math education but few mentioned specific interventions regarding study skills, persistence and motivation of students enrolling in developmental math courses. Research suggested a large disparity of basic skill proficiency in math among community college students (Parker, Traver & Cornick, 2018, p. 26). This disparity indicated that there is a need for intervention programs focusing on study habits and organizational skills of developmental math students in order to enhance performance and success. Such practices consist of collaborative learning, low-stake quizzes/exams but frequent, usage of manipulatives and mnemonics, visual demonstrations and real-life applications (Cafarella, 2014, p. 35).

Interventions and assistance programs in the literature review are too broad and lacking focus on the underlying issue, study skills. Supplemental Instruction and study-groups have shown positive impact on students' study skills and overall scores (Hesser & Gregory, 2016, p. 22). Supplemental programs and interventions have become the go-to schemes that instructors implement to help students with low academic performance (Hunt, Valentine, Bryant, Pfannenstiel & Bryant, 2016, p. 79). These programs are integrated to the curriculum of the courses and students attend study sessions several times a week in addition to the regular class lectures. Hunt et al. (2016) contended that such systematic instruction and follow-up practice are pertinent when teaching academically underprepared students (p. 79).

Designing curriculum instruction to improve developmental math success is difficult given the disparities in students' basic skills knowledge. Many programs and interventions have been integrated to help developmental students with their academic shortcomings and prepare them for post-developmental courses. In research, integration of mathematics interventions are conceptualized based on scripts, procedures and routines for consistency purpose (Hunt et al., 2016, p. 78). Yet, instructors may not follow guidelines or methods stated in the intervention and instead modify as they see applicable and sufficient for their instruction (Hunt et al., 2016, p. 78). As discrepancies continue between expected versus reality of the integration, there is little known clue about why instructors adjust the interventions and their perceptions on why adjustments are necessary. Such information can be beneficial to researchers in identifying the existing gap in integration and improvement of supplemental curriculum and classroom instruction for students (Hunt et al., 2016, p. 78)

Chapter 3 describes the research methods of this study. Descriptions consist of design methods, research appropriateness and instrumentation. Chapter 3 also includes discussions of data collection process, sample selection, data analysis, research participant protection, validity and reliability of the research.

Chapter 3

Research Methodology

The purpose of this quantitative comparative expo facto study is to compare the retention rate, success rate and GPA of students enrolling in developmental math courses integrated with Supplemental Instruction (SI) program to those without SI program at a community college in Southern California. The study consists of data collected from a targeted population of 9,301 SI students and 14,597 Non-SI students for 5 consecutive years starting summer 2013 to spring 2018. Research process includes retrieving aggregate data from the participating college's Annual Supplemental Instruction Report. Usage of aggregate data of retention rate, success rate and GPA is appropriate to address a broad range of relevant issues regarding to SI program. Non-experimental design are widely known in evaluation studies and adequate for drawing conclusions about interventions and programs (Weisburd, 2010, p. 210). This is a non-experimental quantitative study because archival data used in evaluating the impact of SI program was not controlled.

According to Houser and An (2015), high schools are more successful in getting students into college than preparing them for college (p. 939). There continues to be a discrepancy in the college completion rate despite the overall rise in enrollment. Given the concerns regarding outcome success at community colleges especially in developmental education, knowing what developmental students need is the first step in the right direction (Cox, 2015, p. 264). Many interventions and programs have been established and funded by all levels of government to help students complete their education successfully (Cates & Schaefle, 2011, p. 321). Programs generally focus on providing students with support and services that champion academic preparedness and motivate them to continue on the path of earning a degree.

Included in this study is enrollment headcount of five consecutive years from summer 2013 to spring 2018 and the number of students who were placed below transfer level math at time of enrollment, SI and Non-SI students. Supplemental Instruction program at the participating community college study site is available to biology, English, ESOL (English to Speakers of Other Languages), philosophy, physics, non-developmental and developmental math courses. Only developmental math courses integrated with SI program will be used for this study. Supplemental Instruction program provides academic assistance to students who need help with comprehension of course materials and want to improve their grades. Students attend weekly peer-facilitated group study sessions for study skills and learning strategies. One promising program effort to support students is a crowd of students sharing ideas, studying together, and connecting with one another emotionally (Xu, Solanki, McPartlan & Sato, 2018, p. 436). Key comparison of this study is how well developmental math students with SI support compare to developmental math students without SI support in terms of retention, success and GPA. The program was developed in responding to the learning theory of Tinto 1975's student integration model. Social integration enables students to develop a cohesive connection with the learning environment, faculty and in turns create an institutional commitment that enhances student retention (Talbert, 2012, p. 23).

This chapter includes research methods, appropriateness of design, and instrumentation. Quantitative research is appropriate for deductive reasoning where a hypothesis or theory rationalizes the purpose of the study then guides the direction for the research questions (Borrego, Douglas & Amelink, 2009, p. 54). In reference to teaching and discovery, descriptive approach is an effectual integration tool for data blending and ideas into something compelling (Proches, 2016, p. 2171). For this study, an ex post facto design is chosen with aggregate data from one community college that has integrated SI program into its developmental math courses. An evidence-based research is a demonstration of how intervention works in a real-world context (Santos & Santos, 2015, p. 452). Ex post facto is a good fit for this study to assess the effectiveness of the intervention on student's retention and academic success of these courses. Supplemental Instruction program is the independent variable acting as an intervention that assists students with study skills and in turns improves their grades. Dependent variables include retention rate, success rate, and GPA of SI students. This chapter consists of sample selection procedures, data analysis and research components pertaining to confidentiality, validity and reliability.

Research Method

A quantitative comparative ex post facto design is employed in this study to assess the impact of SI program on students enrolling in developmental math courses. Developmental math courses integrated with SI program and developmental math courses without SI program integration represent the two groups of this research. Ex post facto design with causal comparative approach is quantitative (Lacruz & Cunha, 2018, p. 219). Quantitative method is suitable for deductive reasoning in identifying theories related to the research topic and developing hypotheses based on said theories (Barczak, 2015, p. 658). In ex post facto research, dependent values are examined with retrospect to the collected data to establish cause-and-effect association (Ögeyik, 2016, p. 1508). It is a method that looks at past experiences and explores the correlation between two variables - independent and dependent (Ögeyik, 2016, p. 1508). Researchers of ex post facto study cannot control the correlation between variables because the event has already occurred (Lacruz & Cunha, 2018, p. 219).

Quantitative research utilizes different designs such as correlational, experimental and ex post facto, depending on the collected data from either experiments or surveys (Parylo, 2012, p. 298). Randomized experimental design takes place when participants are assigned to control groups by chance (Chase & Bown, 1997, p. 12). The correlational method looks at data that already exists, identifies the variables and determines if there is a correlation between the variables (Chase & Bown, 1997, p. 131). This study does not employ experimental design because random selection is not an option. Correlational design is not suitable for this study because it centers around the relationship of the predictor and the criterion variables, whereas ex post facto design examines the differences between some pre-existing interventions – independent variables on one or more dependent variables. Quantitative methods frequently follow a format that entails introduction, theoretical framework, hypotheses, results, discussion, implications, limitations of the study and recommendations (Barczak, 2015, p. 658). For this study, variables were chosen based on explicit specification consisted of developmental math courses integrated with SI program. Specification for this study makes quantitative comparative ex post facto design a preferred method of choice.

Quantitative research involves a systematic probe of the treatment through an analytical process of data using statistics and mathematics (Basias & Pollalis, 2018, p. 92). Quantitative method is objective and it utilizes measurements and figures to place emphasis on reliability and validity on the entire study (S.K, 1992, p. 87). Quantitative researchers apply different approaches to identify statistical differences in the data to infer about a population on the basis of a sample (Ercikan & Wolff-Michael, 2006, p. 15). Numerical analysis from this study provides information that helps identify the correlation between SI program and the retention rate, success rate and GPA of students enrolling in developmental math courses.

Included in this study is aggregate data of students enrolling in developmental math courses with and without SI program from one community college in Southern California for five consecutive years. At time of enrollment, community colleges students are assigned to developmental math for basic skills review so they can be ready for non-developmental coursework (Jaggars, Hodara, Cho & Xu, 2015, p. 3). Intervention and support efforts can be enhanced if problems associated with poor math performance can be identified (Hendy, Schorschinsky & Wade, 2014, p. 1225). The purpose of this study is to look further into the learning behaviors of developmental math students that contribute to their success, which can be doing homework, seeking help when needed, reviewing notes, reading textbook, or attending SI tutorial sessions.

Data for this study includes: (1) enrollment headcount of SI and Non-SI students, (2) headcount by math placement of SI and Non-SI students (3) mean values of retention rates of SI and Non-SI students, (4) mean values of success rates of SI and Non-SI students, and (5) mean values of GPAs of SI and Non-SI students. Data collection years start from summer 2013 to spring 2018, with three semester terms per year – fall, spring and summer. For this study, quantitative comparative ex post facto research design is used to examine the impact of SI program on students enrolling in developmental math in terms of retention rate, success rate and GPA.

Quantitative Method. Quantitative method relies on descriptive statistics to assess the relationships between variables. Descriptive statistics includes collecting, analyzing and describing the sample data (Johnson & Kuby, 2007, p. 4). Data collected from a subset of a population enables researchers to project their findings onto a more general and larger population through an objective analysis process (Borreg, Couglas & Amelink, 2009, p. 54). Analysis process includes measurements and computations of correlational values, percentages, means and standard deviations (McKim, 2017, p. 205). Quantitative data analysis details what is at stake, makes prediction, generates a hypothesis about a claim, and demonstrates how strong the evidence is to support the claim (Devitt, 2015, p. 12). Because quantitative research uses data that can be measured, it is an effective method for answering questions that are direct and quantifiable such as how much? what percent? or to what extent? (Goertzen, 2017, p. 12). Results of quantitative analysis do not treat or prove anything, and that there exists an independent truth irrespective to what is being studied or analyzed (Allwood, 2012, p. 1421). Quantitative analysis only provides information and knowledge of what may occur and even if an event or phenomenon has been determined to be likely to transpire, there still is a possibility that it will not (Goertzen, 2017, p. 12).

Qualitative Method. Qualitative method focuses on human experiences and how the events are perceived and understood through the words of the participants (Skinner, Tagg & Holloway, 2000, p. 165). With qualitative studies, an inductive approach is used to construct and develop theories (Barczak, 2015, p. 658). Inductive inquiry generates ideas based on the collected data whereas deductive reasoning starts with an idea and uses the collected data to support or reject the idea (Thorn, 2000, p. 68). Qualitative studies begin with researcher(s) observing the subject of interest, identifying patterns, formulating hypotheses, and developing a theory (Barczak, 2015, p. 658). Qualitative method is a preferred choice for research that investigates policy and practice failures of an organization (Skinner, Tagg & Holloway, 2000, p. 166). Qualitative data takes on various forms such as recorded interviews, observations, transcripts, policy manuals, documents, photographs, or public domain sources (Thorne, 2000, p. 68). Qualitative research often employs an interpretive approach to uncover the meanings behind a phenomenon (Thorn, 2000, p. 68). A contrast between explaining how something works and why it works in the way that it does is what distinguishing qualitative from quantitative analytical process. For this study, a quantitative approach is more compatible.

Research Design

Comparative ex post facto is the chosen design for this study. In a cause-and-effect relationship, researchers may begin with a cause and then determine its effect, or they first focus on the effect then discuss about the cause (Johnson & Kuby, 2007, p. 167). Comparative ex post facto design is ideal for determining causal relationship between independent and dependent variables (Palinkas, 2014, p. 542). A distinctive attribute of ex post facto design is that the independent variables cannot be manipulated (Jarde, Losilla & Vives, 2012, p. 99). Research is conducted after changes already took place in the dependent variables, hence the fundamental retrospective aspect of ex post facto design. For this study, variables are not random but preselected based on the specified condition that students enroll in developmental math courses integrated with SI program.

Appropriateness of the Research Method and Design

Ex post facto design is a type of study that explores causal relationships between circumstances or scenarios (Lord, 1973, p. 3). Ex post facto study is also referred to as causal-comparative because it is a situational analysis using archival data (Knight, Wessel & Markle, 2018, p. 367). Causal-comparative study is used to identify the cause of the observed scenario (Wayne & Boissoneau, 1996, p. 59). Similar to the design of experimental research, Wayne & Boissoneau (1996) emphasized that causal-comparative study does not substantiate or validate the relationship of cause and effect, it only infers a causal relationship (p. 60). Causal-comparative studies are appropriate when used to justify a suitable method of treatment or to compare between different treatments of an intervention (Wayne & Boissoneau, 1996, p. 62). By nature, an ex post facto experiment is considered to be a versatile method of research in a way that researchers can postulate hypotheses with respect to their own personal preferences (Lord, 1973, p. 7). Lord (1973) supported ex post facto study when there is no possibility of directly manipulating or controlling the factors needed for studying the relationship of cause-and-effect (p. 10). For this study, the independent variable – SI program - and the dependent variables - retention rate, success rate and GPA - are chosen based on predetermined specifications, so random selection is not an option.

Competency in math is an essential component in the learning progression and timely graduation of community college students (Wang, Wang, Wickersham, Sun & Chan, 2017, p. 99). Most community colleges students were admitted without being academically proficient for the collegial workload and demands (Stone, Alfeld & Pearson, 2008, p. 767). Approximately 37% of high school seniors are tested below basic level in math (Stone, Alfeld & Pearson, 2008, p. 768). Information acquired from this research may prompt future studies applicable to developmental math students and academic assistance programs that focus on college-preparation and study skills.

Research Questions/Hypotheses

Research Questions

Algebra is a fundamental subject for many college majors and it is also the gatekeeper to postsecondary education for many students (Shin & Bryant, 2015, p. 374). Concern about developmental math students' retention and success is the motivation for this quantitative comparative ex post facto study and the theoretical foundation for the research questions. Purpose of this study is to assess the effectiveness of an academic assistance program –

Supplemental Instruction – has on retention rate, success rate and GPA of developmental math students. Based on the familiarity of the subject, research questions arise from an observed knowledge deficiency within a discipline of study (Farrugia, Petrisor, Farrokhyar & Bhandari, 2010, p. 278).

The followings are three research questions established for this study:

RQ 1: What is the difference between the retention rates, if any, of students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program?

RQ 2: What is the difference between the success rates, if any, of students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program?

RQ 3: What is the difference between the GPAs, if any, of students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program?

Hypotheses

A hypothesis is developed at the beginning based on the established research questions to lead the mission of the research (Farrugia et al., 2010, p. 280). Objective of hypothesis testing is to infer on the basis of targeted sample taken from a population of interest (Farrugia et al., 2010, p. 280). When testing for statistical significance between variables, the hypothesis is stated as a null hypothesis. The null hypothesis indicates no change or difference in the population parameter compared to some claimed value (Triola, 2014, p. 384). The alternative hypothesis is established after the null hypothesis declaring the nature of the change or difference, if it occurs (Farrugia et al., 2010, p. 280). In this study, null hypotheses indicate that there are no statistically significant differences in the retention rate, success rate and GPA of SI students in the effectiveness assessment of SI program. Alternative hypotheses in this study imply that statistically significant differences exist in the retention rate, success rate and GPA of SI students compared to Non-SI students.

Based on the research questions, three hypotheses are formed:

$H1_0$ Retention rates are not significantly different between students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program.

$H1_A$ Retention rates are significantly different between students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program.

$H2_0$ Success rates are not significantly different between students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program.

$H2_A$ Success rates are significantly different between students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program.

$H3_0$ GPAs are not significantly different between students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program.

$H3_A$ GPAs are significantly different between students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program.

Population

Supplemental Instruction program is an academic support service that offers weekly tutoring sessions to developmental math students. The intended population for this study comes from archival data of the Annual Supplemental Instruction Report provided by the Office of Institutional Research of a community college in Southern California. Study population is an entire cohort of individuals or objects that are of interest in which some characteristics are needed to be ascertained (Asiamah, Mensah & Oteng-Abayie, 2017, p. 1611). From the chosen population, a collection of sample is targeted. Sample is a subgroup of a population that researchers use to represent the entire population (Tavakol & Sandars, 2014, p. 840). For this study, population includes students enrolling in developmental math courses integrated with and without SI program.

Five years of data consisted of mean values of retention rate, success rate and GPA of Non-SI students from 2013 to 2018 is the baseline control group. The same five years but with data of SI students is used for this quantitative comparative ex post facto study. Student participation in SI weekly study sessions is voluntary and SI program is not a mandated academic assistance program for developmental math courses.

Sample Frame

Purposeful sampling method is identifying and selecting information-rich studies that are relevant to the research interest (Palinkas et al., 2015, p.533). For this study, purposeful sampling with emphasis on variation is used. Emphasis on variation is a strategy used in purposeful sampling describing the typical and unusual objectives that require additional exploratory work for the reason of variation (Palinkas et al., 2015, p. 535). Population specificity and criteria for data collection are reasons for the implementation of purposeful sampling in this study. Supplemental Instruction program was integrated into the curriculum of developmental math to assist students with their study and improve their understanding of the course materials and grades. Retention rate, success rate and GPA represent the dependent variables whereas SI program serves as the independent variable.

The sample chosen from a population for analysis must be of a considerable size in order to be statistically important (Gill, 2010, p. 610). For this study, sample was taken from a population consisted of SI and Non-SI students enrolling in developmental math courses. Sample size was based on enrollment headcounts with n = 9,301 SI students and n = 14,597 Non-SI students. Archival data of five consecutive years from 2013-2014, 2014-2015, 2015-2016, 2016-2017, and 2017-2018 were used. Aggregate data pertaining to the mean values of retention rates, success rates and GPAs of SI and Non-SI students were used for comparative analysis. Supplemental Instruction program is not integrated in all developmental math courses, but SI tutoring sessions are available for all students to participate at the math center or tutoring center. The goal of the program is to positively impact learning outcome and success of individuals from all backgrounds, cultures, identities and abilities by creating an interactive and inclusive learning environment.

Informed Consent

Informed consent is a primary vehicle used by researcher to deliver information about the study to participants along with risks and benefits ensued from interventions (Busquets & Caïs, 2017, p. 431). Informed consent is not only mandatory but also significant because it is a collection of documentation of consent and full disclosure of the research (Karbwang et al., 2018, p. 2). According to Busquets & Caïs (2017), consent means participants have the free will to decide whether or not they want to partake in the study, and above all else they are not coerced to participate (p. 431). For this study, data is produced by the Office of Institutional Research of the participating college and available publicly online through the college's Annual Supplemental Instruction Report. Permission to use the data is addressed by a letter (APPENDIX A) provided by the college's Office of Institutional Research. No participating students were contacted for the study. Because no participants were contacted, documentation of individual informed consent is not needed.

Confidentiality

Confidentiality includes ethical principles associated with privacy, autonomy and commitment (Petrova, Dewing & Camilleri, 2016, p. 444). Researcher must act on the behalf of the participants and establish an honest relationship that adheres to the ethical principles. Confidentiality and anonymity are the two primary objectives of informed consent (Leyva-Moral & Feijoo-Cid, 2017, p. 377). The goal is to promote ethically responsible research studies that are in favor of the participants' interests and needs (Leyva-Moral & Feijoo-Cid, 2017, p. 377). No identifiable data connects participants to this study. Collected information for this research is based on aggregate data so students' confidentiality is protected. All archived publicly available data is numeric and does not contain names or identification numbers thereby assuring students' anonymity.

Data Collection Process

The Office of Institutional Research at the participating college provided the aggregate data through Supplemental Instruction Annual Report that consisted of annual enrollment, retention rates, success rates and GPAs of students enrolling in developmental math courses with and without SI program. This data is publicly available online. Data used for this study included enrollment headcount of SI and Non-SI students, headcount by math placement of SI and Non-SI students, retention rates, success rates and GPAs of both SI and Non-SI students. No research instruments were administered and no students were contacted, as neither needed for the completion of the study. This study includes 9,301 students enrolled in 216 developmental math courses integrated with SI program for 15 semesters from summer 2013 to spring 2018, drawn from one community college in Southern California. Developmental math courses at the participating college consist of basic algebra, pre-algebra, elementary algebra and intermediate algebra. In contrast to 9,301 SI students from the same time frame, there were 14,597 students enrolling in 409 developmental math courses without SI support. The exception is that there are also other subject courses integrated with SI program such as biology, chemistry, English, ESOL, philosophy, physics and non-developmental math courses. Sampled data is well represented the breadth of courses offered at the participating college.

In this study, SI program serves as the independent variable. Dependent variables of interest are retention rate, success rate, and GPA of SI students enrolling in developmental math courses. Aggregate data of three categories consisted of mean values of retention rates, success rates and GPAs for both SI and Non-SI students were drawn from the Annual Supplemental Instruction Report provided online by the participating college's Office of Institutional Research. Mean values from three categories for SI and Non-SI students were compared and analyzed. The college has identified SI program as an academic assistance program available to all students in targeted courses and in recent years, it has grown significantly. In fall 2013, SI program had only four SI-integrated developmental math courses serving 176 students and by spring 2018, there were 22 SI-integrated developmental math courses with the participation of 728 students. Supplemental Instruction program generally offers weekly study sessions for students enrolling in SI integrated courses (Yue, Rico, Vang & Giuffrida, 2018, p. 20). Study sessions are facilitated by SI tutors and students are encouraged to collaborate with their SI tutors and classmates to exchange ideas and develop learning skills.

Validity and Reliability

Validity and reliability are integral parts associated with quality in all research (Cypress, 2017, p. 254). Information obtained from validity and reliability for research designs is necessary when deciding a research method that can ensure accuracy in interpreting the outcomes (Pons et al., 2018, para. 4). Quantitative studies follow a more rigid and preset structure with prescribed methods of analysis (Cypress, 2017, p. 254). Validity and reliability in quantitative research are courses of action researchers take to convey and establish rigor and trustworthiness for the study (Roberts, Priest & Traynor, 2006, p. 41). Trustworthiness is identified as the degree of assurance that readers have in the integrity of the research findings (Cypress, 2017, p. 254). To ensure integrity, researchers must be honest, ethical and reporting in accurate and complete detail (Cumming, 2014, p. 9)

Validity describes how well research tools measure or calculate what they are supposed to do (Andrade, 2018, p. 498). Internal validity and external validity are two measures of validity in quantitative research (Roberts, Priest & Traynor, 2006, p. 43). Internal validity examines the research process to see whether it can answer the research questions in a trustworthy manner (Andrade, 2018, p. 499). According to Roberts et al. (2006), content, criterion-related and construct are three approaches used to examine internal validity (p. 43). Content validity is concerned with the subject's representativeness to the intended context. Such representativeness can be supported by any form of evidence, documents or literature reviews. Criterion-related validity exists when a research instrument is analogous to other corroborated tool of the same setting. Construct validity establishes the correlations between the investigated concept and the theory that is pertinent to that concept (Roberts et al., 2006, p. 43). Occasionally an altered or adjusted method of analysis can be used to improve internal validity if it is found compromised (Andrade, 2018, p. 499). In this study, there is no threat to internal validity as sample collection process and instrumentation are both purposeful and consistent with the criteria of the study.

Similar to internal validity, external validity is not based on any computations or measurements, but solely on judgement (Andrade, 2018, p. 499). External validity determines if a causal relationship can be effective in other contexts such as settings, people, or time (Steckler & McLeroy, 2008, p. 9). Study sample drawn from the targeted population must represent that population during the time the research is being conducted (Roberts et al., 2006, p. 43). Representation of the targeted sample must be relevant to the variables of interest (Roberts et al., 2006, p. 43). Sample for this study included students enrolling in developmental math courses integrated with an academic support program. To uphold external validity, interpretation and application for this study are logical and supported by evidence. In this study, threat to external validity includes generalization of developmental math students from other community colleges.

Reliability in a study is the consistency when the same result is produced using different analytical instruments (Pons et al., 2018, para. 4). It is considered as trustworthiness in research method and data processing (Roberts et al., 2006, p. 43). Arab and Feng (2014) defined reliability as the probability that the instruments will perform without failures at a given time period (p. 1679). To increase reliability, technical accuracy in procedures and data processing is recommended (Roberts et al., 2006, p. 43).

A potential hurdle in attaining validity is research bias (Roberts et al., 2006, p. 44). Bias is the wrong assumption in the correlation between intervention and effectiveness on the targeted population (Delgado-Rodriguez & Llorca, 2004, p. 635). Bias can happen at any time, from design method to data processing and analysis, and even during publication. Bias is not a dichotomous issue of whether it is present in the study or not (Pannucci & Wilkins, 2010, p. 619). The notion of bias associates with the lack of internal validity. Researchers must consider appropriate design method and implementation to prevent bias. A thorough knowledge on bias and how it may influence outcomes are fundamental in any research (Pannucci & Wilkins, 2010, p. 624). For this study, sample participants – SI and Non-SI students - were chosen with respect to the specifications coincided with the purpose of the study, which is the impact of SI program on students enrolling in developmental math, which helps reduce misrepresentation of the targeted population.

Data Analysis

Data from this study are used to compare the impact of SI program on retention rate, success rate and GPA of students enrolling in developmental math. Statistics from the databanks are collected from the participating college's Supplemental Instruction Annual Report. Data were analyzed by SPSS (Statistical Package for Social Sciences) Version 25 which includes organizing and evaluating data to establish relationships existed among variables – retention rate, success rate and GPA versus the integration of SI program.

This ex post facto study relies on both descriptive and inferential statistics for data analysis. Descriptive statistics describes, summarizes and presents the collected data through calculations such as means, median, mode, standard deviation or percentage (Vetter, 2017, p. 1797). Placement level, age, gender and race are traits of students described by descriptive statistics in this study. Inferential statistics are used to make generalization or inferences based on the collected data onto a more general population (Gupta, 2012, p. 143). This study involves the comparison of two means from two samples independent of each other. Null hypotheses of this study are tested by the usage of Analysis of Variance (ANOVA) in the manner that they are assumed to be true then a conclusion will be reached to either reject them or fail to reject them. Because two or more samples' means are being compared, a one-way ANOVA is an appropriate statistical test for this study (Gillian, 2007, p. 44). Significant differences among groups can be measured by ANOVA, but the test is limited in a way that it cannot clarify where the significance lies. This study also employs an additional test called the independent two-sample t-test. Like ANOVA, t-test involves the means and tests if there exists a statistical difference between the mean values (Gillian, 2007, p. 42). One-way ANOVA broadens the basic concepts used in the computation of a t-test by comparing means of two or more groups that are independent and unrelated to each other – in this study, the independent and unrelated groups are retention rate, success rate, and GPA.

Independent two-sample t-test was used to compare the differences in the mean values of retention rates, success rates and GPAs for SI and Non-SI students separately. This test statistic is suitable for this study because it looks for the existence of any statistically significant difference in the mean or can be interpreted as by chance (Gillian, 2007, p. 42). A significance value called p-value is used to determine whether a relationship is statistically significant. Levels of significance, represented by alpha or α, are said to be typical if they are 5%, 1% or 0.1% (Gillian, 2007, p. 41). If α is set at 0.01, then p score of greater 0.01 indicates no statistical significant difference and p score of less than 0.01 means there is statistical significant difference. For this study, significance value p is set at 0.05. Sample data consists of mean values of retention rates, success rates and GPAs of SI and Non-SI students. Supplemental Instruction program is the independent variable in this study while success rate, retention rate, and GPA represent the dependent variables. One-way ANOVA and independent two-sample t-test are used in this study to assess whether the independent variable, SI program has any statistically significant impact on the dependent variables of retention rate, success rate, and GPA of SI students compared to Non-SI students.

Summary

Research methods and the rationale for the chosen design approach are included in Chapter 3. This chapter discusses about the population, sample collection process, data analysis, informed consent, validity, reliability and bias. The focus of this study is to compare whether an academic assistance program has any impact on the retention rate, success rate and GPA of developmental math students. Data analysis for this study consists of descriptive and inferential statistics. Included in the data is headcount of students enrolling in developmental math courses integrated with and without SI program for five academic years from summer 2013 to spring 2018. Information regarding to the retention rates, success rates and GPAs of SI and Non-SI students is included in the data. Quantitative comparative ex post facto design is the best choice to depict the correlation between the independent variable – SI program and the dependent variables – retention rate, success rate and GPA, both numerically and statistically. Because differences exist in the comparisons of the retention rate, success rate and GPA of SI students to Non-SI students, ex post facto is the appropriate design method for this causal comparative research.

Chapter 4 contains findings and results from the data analysis process. Data was collected over a period of five years and results are presented with tables using one-way ANOVA and independent two-sample t-test as test statistics. Chapter 4 also covers the demographics of the research population.

Chapter 4

Analysis and Results

The purpose of this quantitative comparative ex post facto design was to examine the impact of an academic assistance program – Supplemental Instruction (SI) on retention and academic success of developmental math students. Results of this study divulge the effectiveness of SI program on retention, success and Grade Point Average (GPA) of students enrolling in developmental math courses with SI support. Statistically significant differences between the retention rates, success rates and GPAs of students enrolling in developmental math courses integrated with and without SI program are reported in the results. To determine the presence of statistically significant differences, null hypotheses were tested using Analysis of Variance (ANOVA) and independent two-sample t-test. Statistical significance value is evaluated at the typical level $p = 0.05$.

Chapter 3 consisted of a framework for methodology and support for research hypotheses. Chapter 4 presents findings and explanations for results analyzed in this study. Data collection process, outcome analysis and interpretation pertaining to the significance of the results are also included in this chapter. Results from this study may be used to signify the positive impact academic assistance programs have on helping students succeed in developmental math. Chapter 4 ends with an analysis summary from SPSS Version 25 for the results of the aggregated data and an introduction to Chapter 5.

Research Questions/Hypotheses

Research Questions

Research questions for this study were established to determine if there were statistically significant differences between the retention rates, success rates and GPAs of SI and Non-SI students. Quantitative comparative ex post facto study was considered most fitting to evaluate the research questions with archival data. Based on the chosen methodology, design and purpose of the study, the following research questions were addressed:

RQ 1: What is the difference between the retention rates, if any, of students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program?

RQ 2: What is the difference between the success rates, if any, of students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program?

RQ 3: What is the difference between the GPAs, if any, of students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program?

Hypotheses

Hypotheses of this study were developed based on archival data where null hypotheses remain as the default and the alternative hypotheses indicate significant changes so that the null hypotheses can be rejected. The following hypotheses were tested based on the established research questions:

$H1_0$ Retention rates are not significantly different between students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program.

$H1_A$ Retention rates are significantly different between students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program.

$H2_0$ Success rates are not significantly different between students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program.

$H2_A$ Success rates are significantly different between students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program.

$H3_0$ GPAs are not significantly different between students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program.

$H3_A$ GPAs are significantly different between students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program.

Data Collection

The Office of Institutional Research at the participating college provided the aggregate data from its Annual Supplemental Instruction Report, which consists of enrollment headcounts, retention rates, success rates and GPAs of students enrolling in developmental math courses with and without SI program. For this study, data also includes section count of developmental math courses, enrollment headcount of SI and Non-SI students, headcount by math placement of SI and Non-SI students, retention rates, success rates and GPAs of both SI and Non-SI students. Completion of this study did not require any research instruments and no students were contacted. Sample population consists of 9,301 students enrolled in 261 sections of developmental math courses integrated with SI program over a period of 15 semesters from summer 2013 to spring 2018. Contrast to the 9,301 SI students from the same time frame, there were 14,597 students enrolling in 409 developmental math courses without SI support.

Developmental math courses at the participating college consist of basic algebra, pre-algebra, elementary algebra and intermediate algebra. For this study, SI program serves as the independent variable and dependent variables are represented by retention rate, success rate and GPA of SI students. Aggregate data of three categories includes mean values of retention rates, success rates and GPAs for both SI and Non-SI students. Mean values from the three categories are compared and analyzed.

Demographics

Sample criteria for this research study includes students enrolling in developmental math integrated with SI program (*n* = 9,301) and without SI program (*n* = 14,597). Retention rate, success rate and GPA of SI students are compared with retention rate, success rate and GPA of Non-SI students. Archived and aggregated data collected from the participating college fits the said criteria. No identifiable data connects students to this study and all archived data is numeric without name or identification number thereby assuring students' anonymity. As reported by the California Community Colleges (2019), community college student demographics by gender for 2015-16 is 53.6% female, 45.2% and 1.2% unknown. The mean gender distribution at the participating college from summer 2013 to spring 2018 is 54% female and 46% male for SI students versus 58% female and 42% male for Non-SI students.

Student demographics by ethnicity for 2016-17 according to the California Community Colleges are as follows: 6.1% African-American, 11.5% Asian, 43.6% Hispanic, 26.4% White, 0.4% Pacific Islander, 2.8% Filipino, 0.4% Native American, 3.7% Multi-Ethnicity and 5% Unknown (California Community Colleges, 2019). The mean ethnic distribution among SI students at the participating college during the time frame of this study includes 11.33% African-American, 3% Asian/Pacific Islander, 65% Hispanic, 12.67% White, 2% Filipino, 0% Native American, 4% Other and 1.33% Unreported. Similarly, Non-SI students' mean ethnic distribution consists of 12% African American, 3.67% Asian/Pacific Islander, 60% Hispanic, 16.33% White, 2% Filipino, 0% Native American, 4.33% Other and 1.33% Unreported. In a study consisted of over 50 community colleges from 10 different states, nearly 60% of the students were assigned to developmental math (Jaggars, Hodara, Cho & Xu, 2015, para. 5). Mean distribution for basic skills placement at the participating college is 54% and 56.67% for SI and Non-SI students, respectively.

Data Analysis

Developmental education is responsible for reviewing basic skills and preparing students for future non-developmental coursework. Many students entering two- and four-year higher education institutions are not ready for collegial academic standards. Based on the assessment tests' results administered at the time of enrollment, students are placed into beginning courses in accordance to their current academic skills (Saxon & Morante, 2014, p. 24). Students who need more developmental education generally have the worst outcomes, be as graduating or transferring to a university (Bremer et al., 2013, p. 156). The purpose of this study is to create a broader informational base for faculty and administrators on curriculum development, instructional planning, study skills alongside with academic supports to enhance success of developmental math students. Social integration ranks amongst one of the highest of importance in providing help for students to succeed in college (Spark, Danie, Tshepiso & Jones, 2017, p. 77). Supplemental Instruction program provides students with long-term study skills to become independent thinkers and life-long learning strategies needed to reach their educational goals. In addition to providing tutorial sessions, SI tutors are also liaisons between the course instructors and students. According to Spark, Danie, Tshepiso & Jones (2017), relationship between tutors and tutees positively influences learning outcomes of students because tutors are more approachable and they possess a better concept of what it takes to be a student (p. 78).

Aggregate data for the mean values of retention rates, success rates and GPAs of developmental courses integrated with and without SI program was provided by the Office of Institutional Research at the participating college. The time frame of this study starts from summer 2013 to spring 2018 which is a total of 15 academic semesters. Sample population consists of 9,301 SI students enrolling in 261 developmental math courses and 14,597 Non-SI students enrolling in 409 developmental math courses. Mean values from three categories (success rates, retention rates and GPAs) of two independent sample groups (SI students and Non-SI students) are compared. Supplemental Instruction program represents the independent variable whereas success rate, retention rate and GPA serve as the dependent variables. One-way ANOVA and independent two-sample t-test are two test statistics used in this study to determine whether the independent variable has any statistically significant effects on the dependent variables.

Table 2

Applied Statistical Analysis for each Hypothesis

Research Questions and Hypotheses	Variables	Data Analysis
RQ 1: What is the difference between the retention rates, if any, of students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program? $H1_0$: Retention rates are not significantly different between	<u>Independent Variable</u> Developmental math courses with SI program <u>Dependent Variable</u> Retention rate	One- Way ANOVA Two-Sample Independent t-test

students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program. $H1_A$: Retention rates are significantly different between students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program.		
RQ 2: What is the difference between the success rates, if any, of students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program? $H2_0$: Success rates are not significantly different between students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program. $H2_A$: Success rates are significantly different between students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program.	<u>Independent Variable</u> Developmental math courses with SI program <u>Dependent Variable</u> Success rate	One- Way ANOVA Two-Sample Independent t-test
RQ 3: What is the difference between the GPA, if any, of students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program? $H3_0$: GPAs are not significantly different between students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program. $H3_A$: GPAs are significantly different between students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program.	<u>Independent Variable</u> Developmental math courses with SI program <u>Dependent Variable</u> GPA	One- Way ANOVA Two-Sample Independent t-test

Results

Data from a five-year period starting summer 2013 to spring 2018 were collected. Data samples included enrollment headcount, retention rates, success rates and GPAs of students enrolling in developmental math courses with and without SI program. Mean values of retention rate, success rate and GPA of SI students were compared with mean values of retention rate, success rate and GPA of Non-SI students.

The first set of data analyzed is the mean values of retention rates for the 2013/14 to 2017/18 academic years of SI and Non-SI students. Retention rate is the percentage of enrollment that is completed with letter grades of A, B, C, D, F, P (pass) or NP (No Pass) out of the entire census enrollment. The second set of data includes the mean values of success rates for the same time period of SI and Non-SI students. Success rate is the percentage of enrollment that is finalized with letters grades of A, B, C or P (pass) out of the entire census enrollment. The third set of data is the mean values of GPA of students enrolling in developmental math courses with and without SI program also from 2013/14 to 2017/18 academic years.

A one-way ANOVA was implemented for testing each null hypothesis with the assumption that mean values are all equal, as in $H_0 : \mu_1 = \mu_2$. Level of significance $\alpha = 0.05$ is designated for this study. A significance value p of 0.05 or less will reject the null hypotheses of equal means. Independent two-sample t-test was also applied in this study. Like ANOVA, t-test also assesses whether a statistical difference is present between the mean values. Statistical difference occurs when the significance value p of analyzed data is less than 0.05.

Research Question 1

RQ 1: What is the difference between the retention rates, if any, of students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program?

Hypothesis 1. $H1_A$: Retention rates are significantly different between students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program.

$H1_0$: Retention rates are not significantly different between students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program.

Table 3 displays the mean values and standard deviations of the retention rates of students enrolling in developmental math courses with SI program (M = 84.73, SD = 3.28) and without SI program (M = 78.13, SD = 4.50). The population for this study includes SI students (*n* = 9,301) and Non-SI students (*n* = 14,597) over a period of 15 semesters starting from summer 2013 to spring 2018. Represented in Table 4 and Table 5 are test statistics one-way ANOVA and independent two-sample t-test with the same significance value of 0.000086, which is less than 0.05.

Table 3

Descriptive Statistics: Tabulate of Retention Rate's Means

Retention Rate	*n*	Mean	Std. Dev.	Range	Variance
SI	9,301	84.7333	3.28344	11.00	10.781
Non-SI	14,597	78.1333	4.50185	16.00	20.267

Table 4

Analysis of Variance of Retention Rate's Means

Retention Rate	Degrees of Freedom	Sum of Squares	Mean Squares	F	Sig.
Between Groups	1	326.700	326.700	21.045	0.000086
Within Groups	28	434.667	15.524		
Total	29	761.367	342.224		

Table 5

Independent Two Sample t Test of Retention Rate's Means

	F	t	Sig. (2-tailed)	Mean Diff	Std. Err Diff	95% Conf. Int Lower	Upper
Equal Variances Assumed	1.221	4.587	0.000086	6.600	1.439	3.653	9.547
Equal Variances Not Assumed		4.587	0.000103	6.600	1.439	3.641	9.559

Note. All tests are normally distributed; alpha was set at 0.05; df = 28 (equal variances assumed) and 25.610 (equal variances not assumed).

Despite the p-value looking the same, Table 4 shows F value of 21.045 contrasting with t value of 4.587 in Table 5. If t value is squared, that is $t^2 = 4.587^2$ then t^2 would equal to F within rounding error. With two groups as shown, $t^2 = F$, one-way ANOVA and t-test are equivalent. Both tests provide the same decision in terms of hypothesis test, as they produce the exact same p-value. The null hypothesis that retention rates are not significantly different between students enrolling in developmental math courses integrated with SI program and students enrolling in developmental math courses without SI program integration is rejected.

Research Question 2

RQ 2: What is the difference between the success rates, if any, of students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program?

Hypothesis 2. $H2_A$: Success rates are significantly different between students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program.

$H2_0$: Success rates are not significantly different between students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program.

Table 6 displays the mean values and standard deviations of the success rates of students enrolling in developmental math courses with SI program (M = 54.40, SD = 9.01) and without SI program (M = 42.33, SD = 5.81). The population of the study includes SI students (*n* = 9,301) and Non-SI students (*n* = 14,597) collected over the span of 15 semesters starting summer 2013 to spring 2018. Represented in Tables 7 and 8 are test statistics one-way ANOVA and independent two-sample t-test with the same significance value of 0.000235, which is less than 0.05.

Table 6

Descriptive Statistics: Tabulate of Success Rate's Means

Success Rate	*n*	Mean	Std. Dev.	Range	Variance
SI	9,301	54.4000	9.00635	34.00	81.114
Non-SI	14,597	42.7333	5.81214	22.00	33.781

Table 7

Analysis of Variance of Success Rate's Means

Success Rate	Degrees of Freedom	Sum of Squares	Mean Squares	F	Sig.
Between Groups	1	1020.833	1020.833	17.770	0.000235
Within Groups	28	1608.533	57.448		
Total	29	2629.367	1078.281		

Table 8

Independent Two Sample t Test of Success Rate's Means

	F	t	Sig. (2-tailed)	Mean Diff	Std. Err Diff	95% Conf. Int Lower	95% Conf. Int Upper
Equal Variances Assumed	1.899	4.215	0.000235	11.667	2.768	5.997	17.336
Equal Variances Not Assumed		4.215	0.000307	11.667	2.768	5.954	17.380

Note. All tests are normally distributed; alpha was set at 0.05; df = 28 (equal variances assumed) and 23.937 (equal variances not assumed).

Table 7 shows F value of 17.770 and Table 8 has t value of 4.215. Within rounding error, t^2 = F indicates that one-way ANOVA and t-test are equivalent. With significance value p of less than 0.05, the null hypothesis that success rates are not significantly different between students enrolling in developmental math courses integrated with SI program and students enrolling in developmental math courses without SI program integration is rejected.

Research Question 3

RQ 3: What is the difference between the GPA, if any, of students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program?

Hypothesis 2. $H3_A$: GPAs are significantly different between students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program.

$H3_0$: GPAs are not significantly different between students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program.

As shown in Table 9 are mean values and standard deviations of GPAs of students enrolling in developmental math courses with SI program (M = 2.0267, SD = 0.26) and without SI program (M = 1.7860, SD = 0.15). Population of the study consists of SI students (n = 9,301) and Non-SI students (n = 14,597) enrolling in developmental math courses for 15 semesters starting from summer 2013 to spring 2018. Represented in Tables 10 and 11 are test statistics one-way ANOVA and independent two-sample t-test with the same significance value of 0.005110, which is less than the typical significance value that was set at 0.05 for this study.

Table 9

Descriptive Statistics: Tabulate of GPA's Means

GPA	n	Mean	Std. Dev.	Range	Variance
SI	9,301	2.0267	0.26973	1.09	0.073
Non-SI	14,597	1.7860	0.14618	0.49	0.021

Table 10

Analysis of Variance of GPA's Means

GPA	Degrees of Freedom	Sum of Squares	Mean Squares	F	Sig.
Between Groups	1	0.434	0.434	9.231	0.005110
Within Groups	28	1.318	0.047		
Total	29	1.752	0.481		

Table 11

Independent Two Sample t Test of GPA's Means

	F	t	Sig. (2-tailed)	Mean Diff	Std. Err Diff	95% Conf. Int Lower	95% Conf. Int Upper
Equal Variances Assumed	1.791	3.038	0.005110	0.24067	0.07921	0.07841	0.40293
Equal Variances Not Assumed		3.038	0.006124	0.24067	0.07921	0.07620	0.40513

Note. All tests are normally distributed; alpha was set at 0.05; df = 28 (equal variances assumed) and 21.571 (equal variances not assumed).

With two groups, the test statistics one-way ANOVA and independent two-sample t-test can produce equal p value meaning the same conclusion can be drawn about the hypothesis test. Table 10 displays F = 9.231 and Table 11 shows t = 3.038 in which $t^2 = F$, within rounding error. Because p-value of 0.005110 is less than 0.05 of the significance level set for this study, the null hypothesis that GPAs are not significantly different between students enrolling in developmental math courses integrated with SI program and students enrolling in developmental math courses without SI program integration is rejected.

Table 12

Summary of ANOVA and Independent t Test

Independent Variable	Dependent Variable	Table	F	p	t	ANOVA Results	Independent t Test Results
SI Program	Retention Rates Means	3, 4, 5	21.045	0.000086	4.587	Significant	A statistical significance between SI and Non-SI groups
SI Program	Success Rate's Means	7, 8, 9	17.770	0.000235	4.215	Significant	A statistical significance between SI and Non-SI groups
SI Program	GPA's Means	10, 11, 12	9.231	0.005110	3.038	Significant	A statistical significance between SI and Non-SI groups

Summary

This study was conducted at a community college located in Southern California. Data for this study were collected over a span of five consecutive years. The sample population consisted of students enrolling in developmental math courses integrated with and without SI program for 15 semesters starting from summer 2013 to spring 2018. Result analyses based on three established Research Questions rejected the null hypotheses that there are no significant differences in the retention rates, success rates and GPAs of students enrolling in developmental math courses integrated with SI program and students enrolling in developmental math courses without SI program integration. The null hypotheses were rejected based on the significance values p of 0.000086, 0.000235 and 0.005110 for Research Questions 1, 2 and 3, respectively, of all which were less than the typical significance value that was set at 0.05 for this study.

For Research Question 1, a statistically significant difference existed in the mean values of retention rates between students enrolling in developmental math courses integrated with SI program and students enrolling in developmental math courses without SI program integration. Null hypothesis 1 was rejected based on the significance value p of 0.000086 which was less than the set value of 0.05 for this study. For Research Question 2, a statistically significant difference existed in the mean values of success rates between students enrolling in developmental math courses integrated with SI program and students enrolling in developmental math courses without SI program integration. Null hypothesis 2 was rejected based on the significance value p of 0.000235. For Research Question 3, a statistically significant difference existed in the mean values of GPAs between students enrolling in developmental math courses integrated with SI program and students enrolling in developmental math courses without SI program integration. Null hypothesis 3 was rejected based on the significance value p of 0.005110.

Chapter 4 consisted of an explanation for the purpose of this study, a description of the chosen population, study design and method, data processing and result analysis. Chapter 4 concluded with a summary of statistical findings. Chapter 5 contains an overall evaluation of the problem, conclusion and suggestions. Implications, limitations and recommendations to leaders, practitioners and for future studies are also mentioned in Chapter 5.

Chapter 5

Conclusions and Recommendations

Academic assistance programs and services provide educational support to students in need of getting ready for higher education and adapting to the collegial learning environment. Many students entering college face numerous challenges ranging from academic inadequacy, tuition, family, work and limited knowledge of the learning environment (Bettinger, Boatman & Long, 2013, p. 94). As many as 42% of first-year students across the nation lack of basic mathematical knowledge and about 30% are not prepared for college-level math (Deshler, Fuller & Darrah, 2019, p. 87-88). Developmental education is a form of academic support used by higher education institutions to cater to academically underprepared students (Bettinger, Boatman & Long, 2013, p. 94). A growing concern that developmental students, especially math, are less likely to transfer or earning an associate degree (Park, Woods, Hu, Bertrand Jones & Tandberg, 2018, p. 318). While it is a controversial topic, developmental education in its simplest form is to provide academically struggled students the necessary skills for college-level work (Royer & Baker, 2018, p. 31). Of all the possible benefits of developmental education, enhancing student participation has been of particular interest. A study by Kern and Kingsbury based on Tinto's student retention model (2019) provided evidence for the correlation between student engagement in an academic learning community and retention (p. 49). As students participate more in classroom activities, their learning experiences become more engaged and the probability of them achieving better exam scores and completing the courses is higher (Hussain, Zhu, Zhang & Abidi, 2018, p. 2).

The purpose of this quantitative ex post facto study was to compare whether students enrolling in developmental math courses integrated with Supplemental Instruction (SI) program, has any statistically significant differences in terms of retention rate, success rate and Grade Point Average (GPA) than students enrolling in developmental math courses without SI program integration. Aggregate data were collected from 15 consecutive semesters starting summer 2013 to spring 2018 from one community college in Southern California. Sample criteria included 9,301 students enrolling 261 sections of developmental math courses integrated with SI program and 14,597 students enrolling in 409 sections of developmental math courses without SI program integration. Supplemental Instruction program is an academic assistance program with embedded tutors assigned to help students enrolling in pre-algebra, basic algebra, elementary algebra and intermediate algebra courses at the participating college. Participation in SI program in this study is voluntary for both instructors of the courses as well as students. Study sessions provided by SI tutors are held at either the math center or tutoring center at the participating college where students are benefiting from reviews of course materials, study skills and test preparation.

Problem prompted this research study was the concern about retention and success of developmental math students at community colleges and that only a few successful assistance programs exist to help enhance retention and success of these students. Data from 15 semesters from summer 2013 to spring 2018 were collected from the Annual Supplemental Instruction Report provided by the Office of Institutional Research of one community college in Southern California. Aggregate data consisted of retention rates, success rates and GPAs of students enrolling in developmental math integrated with and without SI program. Data analysis for this study included mean values of retention rates, success rates and GPAs of SI and Non-SI students for comparison. Research data was analyzed using quantitative method with both descriptive and inferential statistics. Statistically significant differences in the mean values of retention rates, success rates and GPAs of SI and Non-SI students were identified.

Research Questions/Hypotheses

Research Questions

Three research questions were established for this quantitative comparative ex post facto study addressing the differences between retention rates, success rates and GPAs of students enrolling in developmental math courses integrated with and without SI program. The questions are as follows:

RQ 1: What is the difference between the retention rates, if any, of students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program?

RQ 2: What is the difference between the success rates, if any, of students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program?

RQ 3: What is the difference between the GPAs, if any, of students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program?

Hypotheses

For this study, variables are not random but preselected based on a specified condition that students enrolling in developmental math courses integrated with SI program. Supplemental Instruction program serves as the independent variable whereas retention rate, success rate and GPA are the dependent variables. When testing for statistical significance between variables, the hypothesis is stated as a null hypothesis. For this study, the null hypotheses suggest no significant differences are present in the retention rate, success rate and GPA of SI students in the effectiveness assessment of SI program. Alternative hypotheses imply that significant differences are present in the comparison of retention rates, success rates and GPAs of SI and Non-SI students. Based on the research questions, three hypotheses are as follows:

$H1_0$ Retention rates are not significantly different between students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program.

$H1_A$ Retention rates are significantly different between students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program.

$H2_0$ Success rates are not significantly different between students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program.

$H2_A$ Success rates are significantly different between students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program.

$H3_0$ GPAs are not significantly different between students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program.

$H3_A$ GPAs are significantly different between students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program.

Discussion of Findings

Hypotheses of this study provided guidance in determining if there is a correlation between the variables. Supplemental Instruction program is an academic assistance program integrated into the curriculum of developmental math courses to assist students with learning skills and improve their grasp of the course materials and grades. Dependent variables were the retention rate, success rate and GPA whereas SI program served as the independent variable in this study. Statistically significant differences were observed among the means of retention rates, success rates and GPAs of SI and Non-SI students. Foundation for this research study was built on three research questions focusing on developmental math students' retention, academic success and GPA.

Research Question 1 states: What is the difference between the retention rates, if any, of students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program? There is a statistically significant difference between the retention rates of students enrolling in developmental math courses integrated with SI program and students enrolling in developmental math courses without SI program integration. Results from a one-way ANOVA ($F = 21.045$) and independent two-samples t-test ($t = 4.587$) display a statistically significant difference in the mean values of retention rates with a significance value of 0.000086, which is less than the designated 0.05 for this analysis. Test statistics independent two-sample t-test and one-way ANOVA are both equivalent with two groups as $t^2 = F$. With significance level value of less than 0.05 (i.e. $p < 0.05$), equal means in retention rates of SI and Non-SI students assumed in null hypothesis 1 was rejected. Aside from being underprepared, as noted by Diehl (2017) retention rate of developmental students can also be affected negatively due to self-doubt, lack of study skills, responsibilities and perseverance, among others (p. 32). Academic progression and retention are the primary concerns of higher education institutions especially for first-time college goers transitioning from high school to college (Gordanier, Hauk & Sankaran, 2019, p. 23). First-year college experience has a very impactful impression on students' motivation to achieve their undergraduate goal (Chrysikos, Ahmed & Ward, 2017, p. 97). When students are a part of the learning community socially and academically, they tend to remain in school according to Tinto's integration theory for early departure (Chrysikos, Ahmed & Ward, 2017, p. 97). Through data analysis of this study, it may be noteworthy that as participation in study sessions increases among developmental math students, rate of retention increases as well. Conclusive results may depend on further research.

Research Question 2 states: What is the difference between the success rates, if any, of students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program? Observed in the findings was a statistically significant difference exists between the means of success rates of SI and Non-SI students. Test statistics one-way ANOVA ($F = 17.770$) and independent two-sample t-test ($t = 4.215$) both yielded a significance level of 0.000235, which is less than the typical significance level set for this study of 0.05. Within rounding error, $t^2 = F$ indicates that one-way ANOVA and t test are equivalent. With significance level value $p < 0.05$, equal means in success rates of SI and Non-SI students stated in null hypothesis 2 was rejected. Engagement with lessons is identified as one of the main predictors of student success (Hirn & Scott, 2014, p. 590). Participation and discussion with peers can be beneficial to students' academic success (Arikan, 2016, p. 119). Supplemental Instruction program in this study provides study sessions carried out by SI tutors who attend the same class lectures as the students. Students who engage in class activities insert more effort in those activities, have better self-worth while doing them, and bring about higher results (Archambault, Janosz & Chouinard, 2012, p. 320). It could be assumed that academic success of developmental math students increases as they become more actively engaged in their learning environment.

Research Question 3 states: What is the difference between the GPAs, if any, of students enrolling in developmental math courses with SI program and students enrolling in developmental math courses without SI program? A statistically significant difference existed between the mean values of GPAs of SI and Non-SI students. Both independent two-sample t-test and ANOVA assessments revealed the same significance value $p < 0.05$. With two groups, two assessments produced the same p of 0.005110 which allows for the rejection of null hypothesis 3 that GPAs are not significantly different between students enrolling in developmental math courses integrated with SI program and students enrolling in developmental math courses without SI program integration. Time and effort invested by students are strong indicators of college success (Lancaster & Lundberg, 2019, para. 3). Developmental math students at the participating college attend SI study sessions facilitated by tutors who are current or past students that exhibit good interpersonal skills and academic excellence. Relatedness with fellow students in the same class has a positive effect on academic learning because it creates a context of safe learning environment (Mikami, Ruzek, Hafen, Gregory & Allen, 2017, p. 2342). In this study, SI tutors are liaisons between students and the course instructors. Effective academic modeling is proven to be beneficial to students by not only giving them the insider information of their learning environment but also by reaffirming their accomplishments and goals (Morales, Ambrose-Roman & Perez-Maldonado, 2016, p. 123). Social support and student-to-student networking are essential components of a student's college experience and it is a great possibility that some students find this support system and connection via tutors

(DeFeo & Ossiander-Gobeille, 2017, p. 21). Additional studies may be necessary to better understand the effective and successful nature of tutor-tutee relationships. Study sessions provided by SI tutors at the tutoring and math centers were mentioned in this research but the effectiveness of this type of tutoring was not analyzed. This study did not focus on the efficacy of SI tutors related to each individual level of developmental math course. Rather, the purpose was to assess a more comprehensive aspect of the benefits of SI tutoring provided by SI program for developmental math students. Future research studies might focus on tutoring associated with students' non-cognitive characteristics such as motivation and persistence (qualitative study) or whether students' final course grades are affected by the number of hours they spend at tutoring (quantitative study).

Limitations

Basic requirement for designing an experimental study is to separate participants into two groups called control and experimental (Raja & Najmonnisa, 2018, p. 282). For this research study, random assignment into control (Non-SI students) and experimental (SI students) groups is not possible. Integration of SI program into the curriculum of developmental math courses at the participating college depends on several factors including funding, availability of SI tutors and the consents of the course instructors whether or not they are willing to participate in the program.

Although SI program provides academic assistance to all students of targeted courses (biology, chemistry, English, ESOL, philosophy, physics, developmental and non-developmental math), sample population for this study was limited to only developmental math students. This study is confined to one community college in Southern California and aggregate data is restricted within 15 semesters from summer 2013 to spring 2018. Because the research took place at one community college, findings may be generalized to only that population or other general populations with similar settings such as cultural backgrounds, perspectives, socioeconomic levels, and abilities. Population for this study includes developmental math students participating in a voluntary academic assistance program outside the classroom at the tutoring or math center of the participating college.

This study focused on the impact of SI program on retention, success and GPA of developmental math students. The scope is applicable to faculty and administrators of community colleges. Findings of this research study may support the important contribution of an academic assistance program – Supplemental Instruction to positively impact students' learning outcomes and success. Higher education leaders may use the research to extend academic assistance programs to other non-developmental and high-risk-for-failure courses or subjects.

Recommendations to Leaders and Practitioners

This is a quantitative comparative ex post facto study focusing on the impact of an academic assistance program – Supplemental Instruction - on the retention, success and GPA of developmental math students. Research findings of this study support the important contribution of SI program to positively impact students' learning outcomes and success. Higher education faculty and administrators may use the study as an informational base for curriculum development and instructional planning that align with different types of learners and what teaching/learning methods are most effective for students. Leaders and practitioners may use the research to extend academic assistance programs to other non-developmental and high-risk-for-failure courses or subjects. Given the reality of low success rate in developmental math education, three objectives were considered for recommendations and suggestions. First was curriculum development, second was assessment/placement policies and procedure, and third was college readiness among minority students.

Curriculum Development and Instructional Planning. Developmental math education generally consists of basic algebra, elementary algebra and intermediate algebra which are equivalent to three or four semesters before students can register for college-level courses (Ariovich & Walker, 2014, p. 46). In addition to this long sequence of multiple courses, developmental math is taught in the traditional format of lecture-based that is not connected to other subjects or applicable to real-life scenarios (Kosiewicz, Ngo & Fong, 2016, p. 208). It is recommended that educators and policy makers explore alternative methods for instructional delivery to improve student success. Contextualized curriculum is an instructional strategy focusing on context that are of interest to students and creating a connection between abstract concepts and practical implications (Wang, Sun & Wickersham, 2017, p. 428-429). When students are able to apply knowledge into their daily activities, their participation in the learning process will increase (Ambrose, Davis & Ziegler, 2013, p. 39). Learning basic skills with contextualized instruction is the foundation for critical thinking (Perin, 2011, p. 272). According to Wang, Sun & Wickersham (2017), contextualization has the potential of elevating students' belief in their own efficacy, motivation and confidence (p. 429).

Assessment and Placement. A large number of college goers are unprepared academically for the standards and demands of college-level instruction (Goldwasser, Martin & Harris, 2017, p. 10). Quality assessments that recommend students to be placed in the appropriate developmental courses equipped with support services are essential to student success (Saxon & Morante, 2014, p. 24). Appropriate placement is critical to student retention because there is a higher probability that students will stay in college if they successfully complete first college-level math course (Hilgoe, Brinkley, Hattingh & Bernhardt, 2016, p. 370). It is recommended that educational leaders explore different practices related to the process of assessment/placement and how these practices can be evaluated by faculty and educational researchers. According to Saxon & Morante (2014), practice tests are only available at some colleges and with very minimal promotion of their availability (p. 25). Common dereliction in the assessment/placement process is students are not informed of an assessment test to prepare for it until after being admitted to the college (Saxon & Morante, 2014, p. 25). There is also an inconsistency in defining what readiness means across all institutions and for that reason, policies and procedures related to assessment/placement need to be reexamined within each institution to best serve students (Goldwasser, Martin & Harris, 2017, p. 14).

There is not one test that can absolutely give the exact measurement of a student's skills or any other attribute (Saxon & Morante, 2014, p. 25). It is suggested that institutions to incorporate different measures into the assessment and placement policies to ensure validity and appropriateness of developmental placement (Ngo & Kwon, 2015, p. 443). Students' future academic success may depend on more than just one score from a standardized test – perhaps combining other non-cognitive assessments or previous academic experiences (Hughes & Scott-Clayton, 2011, p. 338). Non-cognitive assessments such as motivation, perception and adjustment are strong predictors of college success especially motivation is considered one of the strongest factor in determining future achievement (Ngo & Kwon, 2015, p. 446).

College Readiness among Minority. By 2050, Hispanics will make up to nearly 30% of the entire U.S. population and currently Hispanic students account for almost 58% of community college enrollments (Crisp & Nora, 2010, p. 176). There are more minority students placed in developmental math than white students and yet they have a lower probability progressing through the sequence to reach college-level math (Yamada & Bryk, 2016, p. 180). Hispanic students are more academically underprepared going into college with more than 61% enroll in a minimum of one developmental course (Crisp & Nora, 2010, p. 176). Despite the fact that nearly 50% of community college students fail to obtain a degree, researchers have noted that developmental math in fact helps improve persistence rate especially among minority students (Wolfle, 2012, p. 42; Fike & Fike, 2008, p. 80). Student body at community colleges is more diverse compared to universities and this diverseness requires greater accommodation to meet various needs of students (Wolfle, 2012, p. 43). It is recommended that educators and practitioners shift their attention on the relationship between success and persistence among minority students so better services and resources can be provided for specific needs and demands (Wolfle, 2012, p. 44).

Recommendations for Future Research

Integration of an academic assistance program into the curriculum of developmental math provides learning support to students including study skills and test preparation. Community colleges offer multiple levels of developmental education with, on average, four developmental math courses and 3 in reading courses (Bailey, Jeong & Cho, 2010, p. 259). A longitudinal quantitative study on a cohort of students enrolling in the first to last course of developmental math sequence integrated with a support program is recommended for the determination of student progression (retention/success) and the effectiveness of the support program throughout the sequence. Many first-year college goers are academically underprepared and because of that, learning interventions and support services are necessary to help these students succeed (Qonda, 2017, p. 18).

In general, students enrolling at community colleges are expected to have an associate degree or certificate in the span of 2 years (Xu & Dadgar, 2018, p. 78). Developmental math sequence consisted of multiple courses can take more than three semesters for students to finish before enrolling in the first college-level math (Collins, 2013, p. 89). A mixed methods study focused on the lowest-level developmental math students is recommended to explore their perceptions of personal challenges, strengths and factors contributing to their willingness to participate in any support programs at the college, and suggestions for ideal interventions to help enhance their academic success. Qualitative data consists of interviews exploring students' perceptions in these areas: (1) personal challenges – family, finance, work or others, (2) personal strengths – time management, family support or others, (3) why they choose not to participate in any social or academic support programs that are tailored to their needs, and (4) suggestions and ideas on what resources or support system that might benefit future developmental math students for them complete the sequence successfully and to succeed in college. Quantitative data includes 5-point Likert-scale survey with questions measuring students' perception related to seeking support socially and academically, awareness of resources for developmental math students, and being affiliated with programs created solely for students enrolling in developmental math courses. Likert's scale for this study is from 1 to 5 for Very Uncomfortable, Uncomfortable, Neither Uncomfortable nor Comfortable, Comfortable and Very Comfortable, respectively. Sample population consists of students enrolling in the lowest level of developmental math sequence at a community college for one semester. There is no age or gender restriction for participating in the study and students from all ethnic backgrounds are included.

A quantitative comparative ex post facto study focuses on first-year students enrolling in the first college-level math to examine the effectiveness of an academic support program – Supplemental Instruction (SI) that concentrates on reviewing basic skills. According to Bahr et al. (2019), many newcomers to community college are under-placed when going through the assessment and placement process (para. 3), but referring academically unprepared students directly to college-level course is not only detrimental to themselves academically but they might interfere with the achievement of those better-prepared students (Scott-Clayton, Crosta & Belfield, 2014, p. 372). There is evidence of higher persistence and degree outcomes of students who signed up for developmental education first before taking on college-level curriculum (Scott-Clayton, Crosta & Belfield, 2014, p. 372). Comparative aspect of the quantitative ex post facto design is to assess if the independent variable – SI support program with basic skills – affects the outcomes, dependent variables – persistence rate, success rate and GPA of first-year students enrolling in the first college-level math. Aggregate data consists of mean values of persistence rate, success rate and GPA of first-year students enrolling in the first college-level math course integrated with and without SI support program. Test statistics one-way ANOVA and independent two-sample t-test may provide better insight into the effectiveness of the program for students who entered college-level coursework directly without the assistance of developmental courses.

Summary

Nearly a third of all undergraduate enrollment across the country is with community colleges (Pratt, 2017, p. 36). Community colleges are more inclined to admit academically underprepared students because universities have a more selective admission policy that restricts enrollment of those underprepared students (Fike & Fike, 2008, p. 70). Approximately two-thirds of newcomers to community colleges require developmental math assistance (Bahr, 2013, p. 171). Completion rates among community college students remain low, with only 20% of developmental math students can pass a non-developmental course of similar content area (Xu & Dadgar, 2018, para. 3). Students enrolling in developmental math courses generally need academic support but also from support, these students are getting help with adapting to the college life (Deshler, Fuller & Darrah, 2019, p. 87).

There is an urgency to help developmental math students to successfully complete the sequence because the longer they are enrolled in these courses, the potential of earning a degree or transferring is lessened (Diehl, 2017, p. 32). Such help may equip students with the necessary learning skills to be independent learners and prepare them for future courses. Findings from this research may indicate that developmental math students are in need of not only academic but also psychosocial support to navigate through the sequence. Academic and psychosocial supports can provide a wide range of assistance from academic to personal, which help students develop a sense of belonging (Deshler, Fuller & Darrah, 2019, p. 91). According to Dewberry and Jackson (2018), students' attitude toward their courses associates with their intention to drop out or remain in college (p. 102). Whether students drop out of college or not, it is the commitment and goal of the institution to enhance student immersion, academically and socially (Dewberry & Jackson, 2018, p. 101).

Continued research and study are necessary so that more services and programs are available to support developmental math students in terms of retention, persistence and success. The scope of knowledge in literature for retention/success of developmental math and academic interventions is limited primarily to students' social and academic integration to their learning environment. Results from this research study help bridge the gap that currently exists within developmental math and academic assistance programs. Common struggles are shared among developmental math education at community colleges are poor success rate (Cafarella, 2014, p. 35), lack of active participation (Meling, Kupczynski, Mundy & Green, 2012, p. 20), cost (Fong, Melguizo & Prather, 2015, p. 719) and long sequence of developmental math courses (Xu & Dadgar, 2018, para. 4).

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Appendix A

DATA ACCESS AND USE PERMISSION

*** CERTAIN INFORMATION IN THIS LETTER HAS BEEN REDACTED TO PROTECT THE CONFIDENTIALITY OF THE PARTICIPATING COLLEGE.

July 10, 2018

Dear Mai On-Thai,

This letter is to provide assurance that [redacted] does not require completion of the Institutional Review Board (IRB) research review process in order to use properly cited results produced by the [redacted] Institutional Research Office, provided those results are publically available online. Specifically, citing data from the "2016/17 Supplemental Instruction Annual Report" for use in your dissertation will not require IRB approval.

Any requests for information beyond what is publically available (e.g., further disaggregation, individual-level data) are not exempt from review and will require the submission of an IRB proposal.

Additionally, you will be responsible for proper interpretation of any reports you access, as well as any published conclusions you draw from the results. The staff of the Institutional Research Office at [redacted] is available to answer questions you may have about data definitions, processing, and interpretation.

Furthermore, depending on office capacity, the research staff is willing to review draft documents that cite [redacted] reports.

Please let us know if you have further questions, and best of luck with your dissertation.

Sincerely,
[redacted] Office of Institutional Research