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The Necessity of Fundamental Math in College

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THE NECESSITY OF FUNDAMENTAL MATH IN COLLEGE

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Abstract

The purpose of this paper is to illustrate the status of developmental math courses in higher education settings, particularly community colleges, which are designed to increase the likelihood of student success in credit math classes. Non-credit remedial mathematics courses have a long curricular history in community college and university settings. The following discussion will examine the numerous contributing factors impacting the requirements of developmental education in postsecondary settings, while placing specific emphasis on the necessity for a math literate population, as most college students must take at least one course to earn a degree or credential. To improve student persistence in college, there are targeted efforts to decrease the amount of time students spend in remedial classes. The initiatives to improve the placement, retention, and success of students in developmental and college-credit math courses, along with trends in developmental education will be explored. Issues of social class, and gender in higher-education, and how these circumstances influence academic success in math courses will also be examined.

"The study of mathematics, like the Nile, begins in minuteness, but ends in magnificence" (Colton, 1821). College can be a stressful and anxiety-filled experience for many students; specifically, advising, registration, and financial aid can be intimidating for the average individual who is new to college. Furthermore, the need for a placement examination is a shock to most students. The core content areas are assessed during the placement examination process, which includes mathematics. The following anecdote describes the initial experience of a college student. Shaun had gone to sign-up for college and received a date to sit for the placement test. He was nervous about taking the test but knew it was a part of the admissions process so, he made the best of it. After taking the test, he waited anxiously for the results. Upon receiving the scores, his schedule included English, science, history, and a remedial math course. As indicated in the preceding narrative, placement examination scores often highlight the necessity for fundamental math courses upon admissions to college, in order to equip students with foundational knowledge of mathematics.

Demographics of Community College Students

The average age of a community college student is 29-years-old, according to the American Association of Community Colleges (AACC) (Morris, 2016). As a result, testing into remedial education, along with the competing demands of home or work life, due to being a non-traditional student is a reality for many students in a community college setting. It is the responsibility of all individuals serving students in community college settings to be aware of the profiles, and developmental characteristics of these students, so they may successfully reach their goal of earning credentials from an institution of higher education.

Developmental Education in Community Colleges

The primary mission of most community colleges is to serve students in local areas while removing barriers to quality towards postsecondary education opportunities. Cohen and Brawer (2003), argued that open-access to higher education has been a priority for community colleges in the United States since the 1960's as cited in Gerlaugh et.al,(2007, p. 1). Providing access to higher-education offers opportunities for individuals from diverse backgrounds and income-levels to pursue college credentials, where it otherwise may not have been available. According to the National Center for Education Statistics (2003), nearly all community colleges and many universities offer developmental education courses for the purpose of preparing students who would likely otherwise be unable to complete a higher education program of study (NCES, 2003). This is a necessary service for students in need of remediation since degree programs require students to meet general education and elective requirements for completion. Consequently, although students may have demonstrated competence in a discipline, they must be able to acquire knowledge in core subject areas like math. More importantly, the option for developmental education provides students with foundational knowledge not acquired prior to college. State departments of education are increasingly designating community colleges as the primary location of developmental education within higher education (Perin, 2013). The statistics are quite revealing, in that 60% of incoming students may be academically underprepared (McClenney, 2009). In an effort to adequately prepare students for success in college-credit courses, developmental education classes are offered in many community colleges, which assist students in gaining requisite skills in core subject areas like mathematics.

Developmental education is of concern to community colleges, where the majority of developmental students are enrolled (McCabe, 2002). The high concentration of students in

need of remedial math is common in community college, due to less rigorous or non-existent admissions requirements. Colleges are seeking more effective ways to educate students in need of additional academic support while keeping them on pace to graduation. However, all stakeholders in the educational process do not agree on the methods implemented to effectively educate this population. "Postsecondary remediation is a hotly contested topic; yet, remarkably few large-scale, comprehensive, multi-institutional evaluations of remediation have been put forward, leading to an astonishing lack of empirical evidence to inform this debate"(Bahr, 2008). This point demonstrates the need for larger scale initiatives across the country at various colleges to remedy the challenge. A solution will require a multidisciplinary team of individuals that can offer expertise on the experiences of college students from various lenses. Yet, mathematics remediation is extremely effective for students who remediate successfully, and further research is needed to elaborate on the obstacles that are hindering successful remediation for so many (Bahr, 2008).

According to the National Center for Developmental Education (NCDE), the study of developmental education was conducted between 1990 and 1996, under a grant from the Exxon Education Foundation and the purposes of the study was to describe the demographics of developmental education, establish performance baselines for developmental students, and determine what program components and instructional techniques contributed to student success (Gerlaugh et.al, 2007). The study revealed the effective and ineffective aspects of developmental education. For example, most colleges and universities are doing a phenomenal job of offering additional resources to students outside of class time. These services usually include tutoring, advising, mentoring, etc. However, the study also highlighted the impact of non-academic factors influencing student success. A substantial body of research indicated the impact of non-cognitive

factors on the success of developmental education students (Casazza& Silverman, 1996). Some of the non-cognitive factors include things like work habits, motivation, and the ability to establish goals for the future. Students who are focused and have a clear understanding of their academic path experience greater success and completion rates in comparison to those who are unclear about their academic journey.

AccommodatingStudents: TheNeedforRemedialMath

According to recent research, students enter postsecondary education, and they are not college ready. A study of more than 250,000 students at 57 community colleges in the Achieving the Dream initiative done by the Community College Research Center, (CCRC) found that 59% of entering students were referred to developmental math and 33% were referred to developmental reading (Bailey et.al, 2010). There are a number of factors that contribute to why students are not prepared for college upon entry. For example, the quality of secondary education has suffered in many urban populations across the United States. Moreover, there are significant disparities in the educational chances of students in certain geographic locations (Darling-Hammond & McCloskey, 2008). To further illustrate the need for developmental education, Biancarosa& Snow (2004), found that approximately eight million young people between fourth and twelfth grade struggle to read at grade level; some 70% of older readers require some form of remediation. The research in math is as statistically significant as the information discovered in literacy. Consequently, part of the solution for college readiness begins with the level of instructional experiences students receive in elementary and high school settings, prior to entering higher education.

The Quality of Instruction in Secondary and Post-Secondary Education

The implementation of comprehensive standards in precollege mathematics instructional experiences is an important factor to consider when determining the performance of students on college placement mathematics examinations. One such study examined how secondary education options in mathematics impacted post-secondary mathematics performance and achievement on placement exams. Specifically examined were various student experiences within two secondary standards-based mathematics programs analyzing gender, prior mathematic achievement on college algebra and calculus readiness placement test scores (Davis & Shih, 2007). The students were enrolled in the Core plus Mathematics Project (CPMP) and/or the University of Chicago School Mathematics Project (UCSMP). There was no difference between students who completed three and four years of the CPMP curriculum on the algebra placement calculus readiness exams. However, the UCSMP students statistically outperformed the CPMP students on the assessments with a probability level of .001, while the CPMP averaged a .632 probability level (Davis & Shih, 2007). There were a number of factors that contributed to the difference in performance on the placement exam. First, prior achievement in mathematics was a contributing factor. "Regardless of the high school mathematics curriculum taken, mathematics achievement is an important predictor of students' later academic success" (Davis & Shih, 2007). In addition, males outperformed female students on the algebra placement exam; while students who studied in the CPMP and UCSMP for four-years outperformed all other students on the calculus readiness exam (Davis & Shih, 2007).

The National Council of Teachers for Mathematics (NCTM) has developed mathematics standards to increase the likelihood of quality and continuity in mathematics education across the country. In the 1990s, 13 standards-based mathematics programs were developed, which aligned

with the NCTM curriculum and Evaluation Standard for School Mathematics (1989) (Davis &Shih, 2007). The standards outlined by the NCTM were incorporated into the Core Plus Math Project and the University of Chicago School Mathematics Project. However, these standards were implemented in varying degrees. For instance, the learning environment in a UCSMP course is different than the classroom a student experienced in the CPMP. This is primarily due to the fact that one took place in a college classroom, while the other occurred in a secondary school setting. For example, standards-based mathematics courses recommend for instructors to demonstrate teaching principles of best practice, which include: classes where students engage in communicating their work and working cooperatively in small groups (Davis & Shih, 2007).

In contrast, other researchers have found a different course climate in some colleges and universities; for instance, LaBerge, Sons, and Zollman (1999) interviewed 30 math faculty members from 11 Midwestern colleges and universities and found the following: 28 used lecture most of the time or always; 23 never or seldom have students write about math; 19 rarely asked students to work in groups as cited in Davis & Shih, (2007). This significantly contradicts instructional practices to ensure students are authentically engaged with math content. Although students may have been exposed to less than favorable environments in the areas mentioned above, studies have found that students who experience standards-based classrooms have a broader set of mathematical competencies than traditional math programs as cited in Davis & Shih, (2007). This may explain why students who have been exposed to such programs are outperforming others on the placement examinations. Moreover, the number of years students spend in a standards-based math program can also have an effect on their mathematical achievement on placement exams.

Most notably, students who enrolled in the fourth year of the CPMP program were more successful because this particular year includes more practice with symbolic manipulation than the first three years (Schoen & Hirsch, 2003). Not completing the entire sequence of years in a standards-based mathematics program can have negative effects on student achievement on examinations compared to those completing the program, given the nature of content to which students may not be exposed. On the other hand, some researchers will argue that it is not the type of mathematics curriculum a student experiences, such as conventional mathematics, Standards-based, or the University of Chicago School of Mathematics Project (UCSM) rather, a number of mathematics courses in which a student enrolls is the greatest predictor of their enrollment in a pre-calculus versus calculus courses. Essentially, the quality, and comprehensive nature of the course content, along with the number of years a student enrolls in math courses can significantly impact their performance on college placement examinations.

Research behind Placement Examinations

Placement examinations are a measure used by community colleges across the United States to gauge the level of classes students are prepared to take upon enrollment. However, the practice of using placement examinations has been scrutinized for the efficacy of some exams to accurately represent the competency level of students. Although developmental courses can serve as necessary and helpful stepping stones to college success, they can also delay access to critical gateway courses necessary for degree attainment or transfer to 4-year colleges (Ngo & Kwon, 2014). Each semester students are enrolled in non-credit bearing courses, there are a significant time and financial commitment. This is especially important because most of the students in community college settings are non-traditional students. Some of them take courses part-time, to make time for working and rearing families. Other students are receiving financial

aid, or assistance, while another portion of enrollees are paying out of pocket for courses. Consequently, enrolling in a college course requires significant economic and lifestyle commitments.

Self-Efficacy, Academic Achievement, and Developmental Education

The Center for Community College Student Engagement (CCCSE) has found that there is a mismatch between students' beliefs about their academic abilities and their actual performance on a placement exam (Morris, 2016). This discrepancy leads one to ponder why is it that many students have a perception of being prepared for college-level courses especially in math and other core subjects, but their exam results prove otherwise. The statistics reveal that 40% of high school students with an "A" average tested into a developmental education course (Morris, 2016). Consequently, the data has led community college administrators, faculty, and staff to analyze the quality of students' high school educational experiences. A student's academic career in high school is generally used as an indicator of his or her college potential (Morris, 2016). However, based on the latest data trends, there is a lack of continuity between the secondary and postsecondary education curriculum, which has led to more reforms and programs at the community college-level. For example, community colleges are working with k-12 to make sure that high school juniors are taking placement tests, so that if there are gaps, they can be filled while students are still in high school. Taking measures like this will ensure that students will begin to get (remedial education) skills before they come to community college (Morris, 2016). From the perspective of Levin (1991 & 1993), students "at risk" of academic failure must have rigorous instructional opportunities, which are usually utilized with more affluent students. The Accelerated Schools Project found that low-level, unchallenging, and non authentic learning experiences, offered at a slower pace, gave students a significant

disadvantage, while drastically decreasing academic achievement (Levin, 1991). Based on Levin's findings, it is likely that it is counterproductive to provide "watered-down" learning opportunities for developmental education students who may otherwise thrive with higher academic expectations.

The Effectiveness of College Placement Exams

The validity of and reliability of college placement exams to accurately place students into courses has been questioned in recent years. Studies have provided evidence that placement tests have low predictive validity and are only weakly correlated with students' college outcomes, such as college GPA or credit completion, and that as many as one-quarter of community college students may be severely misassigned to their math courses by placements tests as cited in Ngo & Kwon, (2013). Based on the findings, there is a need to use other methods of determining students' placement into math courses. For example, evaluating a student's transcript or work history to accompany the placement test results may be promising options. Many colleges are working to combat the issue of incorrect course enrollment due to placement test results by evaluating other factors. For example, there are schools in North Carolina that have developed an assessment procedure, which encompasses multiple sources. These measures include high school grades and non-cognitive measures like work hours to be evaluated along with placement test results. Although there is no one perfect measure, including other sources of evidence gives a more holistic picture of a student's academic abilities. Basing a student's placement into a college course off of one high-stakes measure is a disservice to students seeking to increase their educational attainment. However, supporters of the use of placement tests as a primary means to determine the readiness-level of college students agree that placement exams, which are now largely computerized, is a more efficient method for

enrolling students. For example, evaluating transcripts, verifying work hours, or reviewing portfolios require a significant amount of manpower, and time. This may be thought to slow down the admissions and placement process, thus hindering the student onboarding and enrollment process. Nonetheless, studies have been conducted to determine the efficacy of using alternative measures such as transcripts and interviews in tandem with placement test results, to improve the likelihood that students are accurately placed in math courses.

Placing students accurately in math courses is but one measure to examine, but there must be attention given to how students perform in a course once enrolled. Are these students as successful as other classmates who may have been enrolled using one measure like the placement test? Some studies have found a poor relationship between students' placement exam results and course pass rates. "For example, after investigating the predictive validity of placement tests across the Virginia Community College System, Jenkins et al. (2009) found only weak correlations between placement test scores and student pass rates for both developmental and college-level courses" (Ngo & Kwon, 2014). The results found by the Virginia Community College System leads one to wonder about the overall purpose of the use of placement test examinations, computerized or not, and to further question its use as a common practice in community college admissions processes across the country. Conversely, other findings indicate that high school grades are a better predictor of student achievement in college, especially in institutions like community colleges with lower selectivity requirements (Ngo & Kwon, 2014). In addition, the type of math courses students take, the number of courses, and the performance in said courses have a significant impact on performance in college-math courses (Lewallen, 1994). However, there is some apprehension in regards to using high school information for placement into college courses as a result of the varying degrees of quality that exists across

schools. In assessing the challenges in k-12 education with equity, it is not guaranteed that measures used to determine grades across school systems or the level of rigor throughout school districts will be consistent. Consequently, evaluating students based on high-school transcripts is not an error-free method for placing students. As a result, the use of a combination of measures may prove to be more effective than one single factor. However, there is limited use of multiple measures during assessment and placement for developmental math, and this may stem from lack of evidence about their ability to improve placement decisions (Ngo & Kwon, 2014).

Initiatives to Improve the Effectiveness of Developmental Education

The initiatives set in place by community colleges to help students test into college-level courses will have far-reaching benefits. One such approach to improve placement test scores is the creation of workshops, or review courses for students in math and literacy prior to sitting for a placement exam. "One institution, Washington State Community College, in Marietta, Ohio, implemented a monthly two-hour "brush-up" workshop to provide a review of basic concepts prior to students taking the exam" (Morris, 2016). There was a notable decrease in the number of students needing remedial courses based on this initiative. Opportunities to address the disparities in the number of students who report to college ready for credit bearing coursework is necessary as persistence and retention become an issue for students who are placed in the lowest levels of developmental education courses, which requires them to take up to two semesters or more of developmental education courses. Naturally, the more time students spend in remedial education courses, the longer it will take for them to complete a program of study to improve their academic skills (Merisotis& Phipps, 2000).

The traditional sequences of courses are offered in many developmental education programs, which can be found in a number of community colleges. Within this model, there are at least 3-to-5 courses in the sequence ranging from basic to complex. The skills targeted in these courses occur in a sequence. In order for students to proceed to the next course in the sequence, the previous course must be successfully completed. However, the traditional sequence has been under close scrutiny in recent research. There is mounting evidence to show that following the traditional sequence of developmental education courses community college students are hindered from progressing to college-level coursework and ultimately earning credentials (Edgecombe, 2011). As a result, students become discouraged and retention becomes an issue. Developmental education, also known as remedial education, is one of the barriers to improved graduation and completion rates at community colleges (Morris, 2016). There are other targeted programs designed to remedy the issue of retention and poor transitions to college-credit courses. To decrease the likelihood that students leave college during their enrollment in the developmental education sequence, acceleration has been introduced as an alternative option at a number of community colleges. Acceleration, which involves the reorganization of instruction and curriculum in ways that facilitate the completion of academic requirements in an expedited manner, is an increasingly popular strategy at community colleges for improving the outcomes of developmental education students (Edgecombe, 2011). In addition, the lower students are placed in the developmental sequence, the less likely they were to continue to the college level. The "multiplication principle" as developed by Myra Snell, was described by Hern (2010), which highlights the process by which the number of students in the developmental sequence decreases at each level, which significantly reduces the number of students who transition to college-level coursework.

There are advocates for and critics of acceleration. Supporters of acceleration view it as an opportunity to increase the chances of student success by helping them to complete remedial requirements more quickly (Edgecombe, 2011). Conversely, the position of critics is that students need more time to acquire the skills necessary for college-level work. Consequently, many opponents of acceleration support the sequential nature of traditional developmental education programs. Current studies imply that if students dedicate less of their academic career to developmental education courses, they are more likely to earn a college credential (Perin, 2011).

Along with acceleration models that decrease the amount of time students must dedicate to the developmental course sequence (Edgecombe, 2011), other research studies suggests including developmental education course material within the context of a college-credit course, rather than teaching the skills in isolated courses (Complete College America, 2012; Carlson, 2011). The idea is that students will have the opportunity to develop necessary reading and writing skills within the context of a credit-bearing course. From this perspective, students are fulfilling multiple requirements simultaneously. For example, paired courses link developmental and college-level courses with complementary subject matter (Edgecombe, 2011). Within the paired course format, students have the opportunity to take courses with the same group of students, often referred to as cohorts in the literature. According to Karp (2011), cohorts can be created when the paired course model is implemented, which has the potential to increase student relationships and course retention based on the learning communities literature (Tinto, 1997; Engstrom& Tinto, 2008). Conversely, Visher et.al (2012) has noted that learning communities have no significant impact on the grade point average or college completion of students.

Mainstreaming students with supplemental support is yet another model that may increase student success and remove the negativity associated with being required to take courses in the developmental sequence. This involves placing students with developmental education referrals directly into introductory college-level courses and providing additional instruction through mandatory companion classes, lab sessions, or other learning supports (Edgecombe, 2011, pg. 12). A college's placement and admissions requirements may limit the likelihood that mainstreaming or other acceleration models are possible. However, these challenges can be addressed through course and curricula redesign. Furthermore, the teaching of basic skills can be included in disciplinary or content specific courses. Basic skills integration makes this alternative possible by incorporating basic skills instruction into college-level courses as a form of contextualization, as a means to accelerate student progress (Edgecombe, 2011). More research is necessary to better understand the literary characteristics of underprepared community post-secondary students (Perin, 2013). The difficulties of underprepared students appear to be similar to those of low-achieving students in secondary and adult literacy education (Perin, 2013). This information has been conferred in the work of the Carnegie Council on Advancing Adolescent Literacy (2010), which highlights the deficits inherent in the k-12 educational experience.

Gender and Performance on Math Examinations

Performance on mathematics examinations is often impacted by a number of factors. Along with socioeconomic influences and exposure to quality math content knowledge, gender can also influence how a student performs on a mathematics exam. "According to the stereotype threat theory, (Steele, 1997; Steele & Aronson, 1995) women's math performance is often hindered by their concerns about confirming the negative stereotype about their group's math ability as cited in Marx, et al., (2013). Negative perceptions of the ability to do math have

discouraged women from performing well in math courses, on exams, and entering professions which require math mastery. In particular, when an individual takes a placement exam and performs poorly, she is at risk of not doing well in the math course when she enrolls. “Females have exceptional hurdles to face throughout the STEM pipeline: lack of female STEM role models in school, gender discrimination in science, and negative messages regarding girls in STEM on k-12 campuses to name a few as cited in Palmer & Wood, (2014). However, the research of Marx and colleagues recommends using positive role-modeling to reverse the negative effects that many women have experienced in terms of math competence. Conversely, males can also experience a math stereotype of superior mathematical abilities. Research has found that male counterparts benefit from having role models who slightly underestimate their math ability, which has positive effects on their mathematical achievement (Marx, et.al, 2013). This research highlights the important role of all secondary and post-secondary faculty and staff with whom students interact with regularly. All members must be charged with keeping the expectations high for all students while differentiating instruction and providing remediation or enrichment for students as needed. More importantly, student support services such as tutoring and advising are integral parts of ensuring students are given the tools to be successful in a learning environment. Finally, internship programs and guest speaker opportunities are great ways to showcase the types of careers males and females have pursued. In particular, finding individuals to visit campus who are minorities in their profession and/or based on their gender identity can have powerful impacts on the perceived math abilities of college students.

Mathematics and Motivation

Efforts must be made to maintain the interest of the students. Research that suggests the self-efficacy and motivation of students required to enroll in the developmental education

sequence is negatively impacted. Many developmental education students view enrollment in these courses as a negative reflection of their academic abilities, which decreases motivation, and hinders success (Bailey, 2008). Math anxiety or phobias is a reality for many students entering a college math course. According to Merriam Webster (2017) anxiety is apprehensive uneasiness or nervousness usually over an impending or anticipated ill: a state of being anxious. Quite often, the feeling of anxiety is due to doubt. This doubt is attributed to years of poor confidence in one's abilities and education. For some students, once fear of failure is a reality, they search for other alternatives, which usually start with poor attendance. Inconsistent attendance is one of the primary factors associated with poor persistence in college, yet developmental education students show promise. "On the average, the percentage of students remaining on the enrollment roster in developmental classes throughout the term was high" (Gerlaugh et.al, 2007). This indicates that students are concerned with completing the course while gaining the requisite skills to be successful in a college course. In addition, developmental students must have a relatively high level of motivation given the fact that attendance is not necessarily mandatory, but strongly encouraged in college. "Most professors assign grades based not on student attendance, but rather on students' mastery of academic skills and content associated with their courses" (Moore, 2003). Although attendance is not mandatory, it is pertinent to a student's overall mastery of course content. Consequently, many instructors connect course concepts or tasks directly to attendance. There is a strong correlation with higher attendance and excellent grades. Often, those students who attend class regularly understand the work or are willing to do what is necessary to attain the knowledge and pass the class. To reap the benefits of a remedial course, students must take full responsibility for their education, and should also give maximum effort

towards proper completion of their course. However, if a student is not interested or afraid of a subject, he or she may avoid contact by any means necessary.

Science, Technology, Engineering and Math (STEM)

Technology is a key factor in positively impacting the outcomes of developmental education students. Many experts in the world of mathematics and beyond contend that we cannot meet our developmental math student success goals without incorporating technology (Epper& Baker, 2009). The ability to extend instruction beyond the walls of the classroom is a key benefit of implementing technology into instruction. Furthermore, there are methods for students to receive real-time feedback on various algorithms or mathematical problems to reach accurate solutions. The implementation of innovative technology in program design and practice provides an initial look at how technology can be used to expand, strengthen, and create efficiencies in the delivery of developmental math practice (Epper& Baker, 2009). As a result, it is essential for educators, institutions, and other stakeholders to stay informed and knowledgeable of cutting-edge technology in the area of mathematics.

"Preparing a high-skilled and selected STEM workforce for today's pressing market economy has become a daunting challenge for institutions of higher education, as undergraduates are less inclined to pursue STEM in comparison to other academic fields of study" (Wood & Palmer, 2014). The lack of prepared individuals in STEM fields will leave a void in the job market and there will be more of demand than what the workforce will be able to supply. This is especially critical information for current college students to note, in order to enter professions that are consistently growing, and that may offer economic and lifestyle benefits. For example, The National Center for Education Statistics (Cataldi et al., 2011) reports that only 16% of all 2007-2008 baccalaureate graduates earned a degree in STEM in comparison to disciplines with

social sciences and humanities, which combined, totaled nearly 30% as cited in Wood & Palmer, (2014, p.2). Furthermore, students of color, in particular are underrepresented in the STEM profession, and it is the responsibility of institutions like community colleges to further stimulate interest in the profession of today and in the future. However, students who enter community colleges in need of remedial math courses have been the recipients of poor schooling experiences in STEM, and are completely uninterested in entering these professions. More importantly, there is a lack of qualified and skilled math and science teachers, especially in low-income k-12 classrooms (Wood & Palmer, 2014). As a result, students miss foundational skills at an early age, which lead to a need for remediation once they arrive in a college setting.

Authentic Learning Experiences and Instructional Practices

It will be helpful for future research to document instructional practices across developmental education, accelerated and traditional college-credit courses, as it relates to student learning. Moreover, two instructional approaches have been described to categorize the teaching strategies of developmental education instructors, which are discrete skills (skills-based) and meaning-making (constructivist) (Perin, 2013). Discrete skills refer to the explicit teaching of skills such as locating main ideas, making inferences, understanding vocabulary and writing sentences (Perin, 2013). On the other hand, meaning-making draw reading and writing components together by focusing on problem-solving and critical thinking, and by using authentic materials related directly to students' personal or academic needs and interests (Perin, 2013). Constructivist or meaning making instructional strategies may hold more promise in impacting student performance because the learner is actively involved in the instructional process. As noted by Lesgold& Welch-Ross (2011), improving instruction is among the goals for increasing the success rates for underprepared students in college courses.

Recommendations for the Future of Developmental Education

The future of developmental education in the area of math is uncertain as many colleges chart out initiatives to improve the learning outcomes of students. In particular, developmental education in mathematics must be structured in such a way that provides students with the necessary skills but properly accounts for the time and financial commitments of students. An accelerated or embedded developmental education course achieves the outlined goals. Also, forming a more collaborative relationship between secondary and postsecondary institutions can begin to improve the issue of poor academic preparation in core content areas. Currently, bridge and dual-credit course offerings are initiatives that move the relationship between high school and colleges in a healthy direction. The instructional climate, practices, and depth of content covered must be effective in order for students to develop the necessary skills. This will require that college and high school instructors to become knowledgeable of the demographics and backgrounds of the students they have been charged to teach. This can ensure that learning experiences are relevant and meaningful, which will increase the likelihood that students are actually learning the math content. In addition, the use of multiple measures to place students in developmental education courses can also decrease the chances of students being placed incorrectly into developmental education courses. The use of student transcripts, interviews, and work history in conjunction with placement test exam scores can give a more holistic picture of the competencies of students before being placed in a course. Colleges are in direct contact with students and must be vigilant about documenting the effects of various initiatives to continue to create a baseline for best admissions and placement practices across the country. Finally, there must be continuity across colleges and universities in the United States on the philosophy and implementation of admissions and placement practices.

In order for the United States to remain a dominant force in the global knowledge economy, more rigor and preparation of the populace is necessary. As a developed nation, the country is being outperformed by other countries on international assessments.
Math literacy is increasingly becoming a focal point in the efforts of the United States to remain competitive in the global economy. Among the "troubling international comparisons" cited in a new report was a 2007 assessment finding that 15-year-olds in the United States ranked 25th among their peers in 30 developed nations in math literacy and problem-solving. According to the report, commissioned by Department of Education Secretary Margaret Spellings, "the sharp falloff in mathematics achievement in the U.S. begins as students reach late middle school, where, for more and more students, algebra course work begins. This juncture is particularly important for community colleges because pre-algebra and beginning algebra are the levels in which large numbers of community college students are assessed and placed. If we accept the report finding that students who complete Algebra II are more than twice as likely to graduate from college than students with less mathematical preparation, then the ability of developmental math programs to prepare students for college level math is key to the success of large numbers of students who arrive at college without the skills necessary to succeed. The alarming status of math skills comes as no surprise to faculty and staff at community colleges, whose mission encompasses the task of raising the skill levels of students who enter college with pre-college skills. The challenge of raising math skills is further compounded by the fact that students who test into remedial math coursework are disproportionately minority and disproportionately first-generation, two characteristics of at-risk students (Epper& Baker, 2009).

This highlights how underprepared students are upon entering college, and the overrepresentation of minority students in remedial education courses. The longer it takes for students to transition from developmental education, the increased likelihood of their inability to successfully complete college. Ultimately, ensuring comprehensive programs that focus not only on providing students with foundational skills but support for circumstances outside of school, will have a positive influence on academic performance.

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