



Investigating the Impact of a Multiple Measures Placement Algorithm on Student Achievement in a Dual-Credit College Algebra Course: A Quantitative Study

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Abstract: This quantitative study investigated the efficacy of a multiple measures placement algorithm designed to broaden access to a transferable college algebra course among dual-credit students at a large, suburban community college in the Midwest. Secondary data analysis of course placement and final course grades for a purposive sample of 2928 students was undertaken to determine if student achievement differed significantly by placement method. A one-way, independent groups analysis of variance (ANOVA) and non-parametric Kruskal-Wallis test were performed to evaluate for statistically significant differences in course grades among students in different placement groups. Results of both tests revealed that students who secured placement solely via ACCUPLACER test scores earned significantly lower grades than those who placed via ACT math scores and/or measures of high school achievement. Implications for broadscale revision of placement policies and the long-term impact on student outcomes were discussed.

Keywords: multiple measures assessment, mathematics course placement, placement policies, developmental mathematics education

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Amid widespread cries for developmental education reform, a renewed interest in course placement has emerged (Counterman & Zientek, 2023; Kosiewicz & Ngo, 2020; Marwick, 2002; Melguizo et al., 2014; Ngo & Melguizo, 2016; Weisburst et al., 2017; Xu & Dadgar, 2018; Zhao et al., 2022). With it, the longstanding practice of basing initial mathematics course placement on the outcome of a single standardized test score has been called into question. Those in favor of abandoning traditional approaches to course placement advocate a more holistic method of soundly determining the mathematics courses in which students should initially enroll (Counterman & Zientek, 2023; Ngo & Kwon, 2015). Multiple measures assessment (MMA) is an alternative paradigm wherein non-cognitive indicators, previous academic performance, and standardized placement scores are used to develop an algorithm or rule for optimizing initial mathematics course placements (Counterman & Zientek, 2023; Ngo & Kwon, 2015). This process is multidimensional, engineered to provide a more robust and informed recommendation than the score associated with a single, point-in-time assessment.

While initial research suggests that MMA is a promising alternative, renewed calls for reform underscore the need for additional studies to evaluate its efficacy (Marwick, 2002; Ngo & Kwon, 2015). One area in which the literature is notably sparse involves the use of MMA to determine placement for dual-credit high school students seeking to obtain a head start on college coursework. Insofar as existing studies tend to focus on traditional and non-traditional college students (often referred to in the literature as direct and indirect matriculants, respectively), a gap exists with respect to literature investigating MMA as an indicator of college readiness among high school students pursuing early college programs. The purpose of this study is to address this gap by evaluating whether a mathematics course placement model incorporating MMA can be implemented without compromising academic achievement among dual-credit college algebra students. Specifically, the study aims to answer the following research question: What is the impact of a five-level multiple measures placement algorithm on student achievement in a dual-credit college algebra course at a large, Midwestern suburban community college?

Literature Review

Concerns about mathematics course placement represent the product of broader calls for reform in developmental education (Counterman & Zientek, 2023; Kosiewicz & Ngo, 2020; Marwick, 2002; Melguizo et al., 2014; Ngo & Melguizo, 2016; Weisburst et al., 2017; Xu & Dadgar, 2018; Zhao et al., 2022). Outcomes data seem only to substantiate the need for change, building a compelling case to support allegations regarding the perceived inefficacy of developmental education. Conservative estimates suggested that 60-80% of incoming first-year students in the Los Angeles Community College District (LACCD) were required to enroll in non-transferable developmental mathematics courses (Melguizo et al., 2014). Ngo and Melguizo (2016) elaborated on this situation in the LACCD, noting that a mere fraction of these first-year students would go on to successfully complete the entire multi-course developmental sequence. The implications were far-reaching, in terms of the detrimental impact on students' educational paths. Ngo and Melguizo went as far as to posit an inverse relationship between the number of developmental mathematics courses required and students' likelihood of completing a college

certificate or degree program. In their research involving the Virginia Community College System (VCCS), Xu and Dadgar (2018) echoed this sentiment, concluding from a retrospective transcript review that only 20% of students who placed into developmental mathematics courses eventually found success in a transferable, college-level mathematics course. Not surprisingly, a widespread realization that developmental education was hindering rather than helping students set into motion a philosophical shift in mindset. To the extent that students seemed to get mired down in multiple semesters of developmental mathematics study, subsequent reform efforts would aim to broaden access to gatekeeper, college-level classes that fulfill degree requirements. While developmental education would not initially be abandoned altogether, it would undergo a significant transformation.

Leveraging Placement to Promote Access to College-Level Courses

Dissatisfaction with outcomes in developmental mathematics classes fueled a push to accelerate student access to college-level mathematics coursework (Weisburst et al., 2017; Xu & Dadgar, 2018; Zhao et al., 2022). Initial interventions provided a much-needed facelift to developmental mathematics courses as they had come to be known. Condensing multi-course developmental mathematics sequences into a single course gained widespread popularity while also laying the groundwork for a systematic dismantling of the longstanding placement processes to which colleges and universities had for decades dutifully adhered (Weisburst et al., 2017; Xu & Dadgar, 2018).

Challenges with Determining Course Placement in Mathematics

Mathematics course placement determinations are fraught with challenges, the most problematic of which delay academic progression and culminate with students' failure to earn degrees or credentials (James, 2006; Kolesnikov et al., 2020; Melguizo et al., 2014; Ngo & Melguizo, 2016). Compounding matters is the documented incidence of errors in placement, many of which lead to under-placement of students in mathematics courses (i.e., students are placed in courses for which they are academically overqualified) in up to 25% of cases (Ngo & Melguizo, 2016). Some experts attribute this trend to a systematic lack of validation of assessment and placement measures based on student achievement data. Regardless of the cause, students who are directly impacted face potentially crippling setbacks. Estimates suggest that errors in student placement give rise to costly delays in student progression, unnecessarily extending students' time in college by up to five semesters. Moreover, low placement scores alone have been purported to discourage students from even enrolling in college coursework, developmental or otherwise. This phenomenon has been labeled the "discouragement hypothesis" (Ngo & Melguizo, 2016, p. 174).

The Continuum of Course Placement

The issue of mathematics course placement is multi-faceted and best conceptualized as a continuum along which varying degrees of institutional discretion are exercised (Bahr et al., 2019; Counterman & Zientek, 2023; Daugherty et al., 2021; Kopko et al., 2023; Kosiewicz & Ngo, 2020; Marwick, 2002; Ngo & Kwon, 2015; Woods et al., 2018). At one end of the spectrum is self-placement, whereby as its name implies, students are afforded freedom of choice

with respect to the courses in which they enroll (Counterman & Zientek, 2023; Kosiewicz & Ngo, 2020; Marwick, 2002).

Self-Placement

Kosiewicz and Ngo (2020) investigated the effect of student self-placement in mathematics courses after a single campus of a multi-campus community college district inadvertently failed to renew its license to use ACT's computer-based COMPASS assessment for purposes of facilitating placement. Students attending other campuses in the district served as the control group against which 385 students who self-placed during fall semester 2008 were compared. In seeking to understand whether self-placement resulted in significant differences in mathematics placement before and after the semester in question, researchers conducted a trend analysis. It revealed that prior to self-placement, most students qualified to enroll in the lowest of the district's developmental mathematics courses. During the short-lived era of self-placement, however, Chi-square analyses demonstrated a statistically significant increase ($p < .001$) in the number of students who enrolled in transfer-level mathematics courses versus developmental mathematics courses. Moreover, these students were significantly less likely ($p < .001$) to withdraw from or fail their initial mathematics courses. Self-placement also translated into statistically significant increases ($p < .05$ and $p < .001$, respectively) in students' likelihood of completing college-level and transferable mathematics courses within one year of initial enrollment.

Marwick (2002) had previously reported similar findings associated with a controlled experiment in which students were randomly assigned to one of four different placement methods. These included more traditional methods based on ACCUPLACER scores, as well as less conventional approaches such as student choice. Results of the study showed no significant differences in measures of success or academic persistence regardless of the method by which placement was determined. Still, Marwick (2002) cautioned, as did Ngo and Kosiewicz (2020) years later, that student self-determination alone was generally not sufficient for determining proper mathematics course placement. They reasoned that allowing students to self-place without also considering other measures might inadvertently promote underestimation of abilities, unnecessary enrollment in lengthier developmental mathematics courses, and eventual loss of academic momentum (Marwick, 2002; Ngo & Kosiewicz, 2020).

Test-Based Placement

At the opposite end of the spectrum is placement based exclusively on a high stakes standardized mathematics assessment score. In this scenario, rigid adherence to cut scores on a point-in-time assessment of student knowledge provides a criterion-referenced framework for making mathematics course placement determinations (Counterman & Zientek, 2023; Kopko et al., 2023; Marwick, 2002; Ngo & Kwon, 2015). While this method affords an objective approach to placement determination, lingering questions regarding the validity and reliability of instruments like the ACCUPLACER generate cause for concern (James, 2006). So too does the well-documented lack of a systematic process for establishing, evaluating, and revising cut scores for mathematics placement (Kolesnikov et al., 2020; Melguizo et al., 2016). Moreover,

conservative cut scores translate into errors of under-placement, whereby students are relegated to developmental mathematics courses for which they are academically overqualified (James, 2006; Kolesnikov et al., 2020; Ngo & Melguizo, 2016).

Placement via Multiple Measures Assessment

Between the two extremes is placement via multiple measures assessment (MMA), the goal of which is to incorporate a multitude of factors such as student choice, standardized placement scores, and measures of past academic performance (e.g., high school grade point average and relevant, discipline-specific experience) into mathematics placement determinations. The desired outcome is a fluid, dynamic placement process that takes into consideration a more holistic appraisal of a student's potential for success in college-level mathematics coursework (Counterman & Zientek, 2023; Ngo & Kwon, 2015). MMA is gaining support across the country in response to research showcasing its decidedly positive impact.

Recognizing that initial course placements played a pivotal role in students' short- and long-term success and persistence in college, Woods et al. (2018) investigated how high school transcript information could be leveraged to determine student placement in college mathematics courses. Following a review of high school transcript information and college course outcome data for 27,702 first-time-in-college (FTIC) students in Florida, they conducted logistic regression analyses to discern how completion of certain high school courses might yield accurate predictions of success in introductory, college-level mathematics courses. Woods et al. found that 51.1% of intermediate algebra enrollees successfully completed the course. Among them, students who had completed more advanced high school coursework were ultimately more likely to pass intermediate algebra. This was especially true among students who earned high school credit in honors English courses, honors or advanced placement science courses, and mathematics courses beyond Algebra 2. Students fitting this profile boasted passing rates of 76.1% in intermediate algebra. Woods et al.'s evidence of a relationship between high school achievement and student outcomes in college mathematics courses would be further substantiated by later studies, most notably the research of Bahr et al. (2019).

Bahr et al. (2019) sought to determine which specific measures of high school achievement represented the best predictors of student success in college mathematics courses. Using this information, they then endeavored to establish thresholds that would meaningfully rank the degree to which each measure had been achieved. The result, they envisioned, would be an accurate criterion-referenced MMA placement algorithm. After extracting data from a statewide California data repository, the researchers employed decision tree analysis to recursively analyze the relationships between measures of high school achievement and attainment of passing grades in initial community college mathematics courses for 201,986 students. Analyses yielded algorithms designed to predict the attainment of passing grades in each of nine levels of mathematics coursework. Separate algorithms were developed for two distinct subgroups of students: direct matriculants who entered community college directly from high school and indirect matriculants who entered community college several years after completing high school.

Bahr et al. (2019) discovered that cumulative high school grade point average was a strong predictor of success in mathematics courses among students of all skill levels. Moreover, they found that regardless of cumulative high school grade point averages, students who had

successfully completed advanced mathematics coursework in high school were more likely to perform well in college-level math courses. Further, Bahr et al. learned that greater levels of high school achievement were positively correlated with student success in college-level mathematics courses; as a result, higher thresholds of high school achievement should arguably be required to secure placement in more advanced college-level mathematics courses. Lastly, recursive decision tree analysis suggested that placement recommendations for direct and indirect matriculants should be based on similar achievement thresholds.

Findings associated with the work of Woods et al. (2018) and Bahr et al. (2019) constituted promising news for students whose standardized placement scores alone were not reflective of their motivation and potential for success in college-level mathematics coursework. Still, it would require the calculated risks of a select few trailblazers to convince the academic community that multiple measures assessment (MMA) was indeed a viable alternative to more traditional placement modalities.

Experimentation with MMA can be traced back to the work of Ngo and Kwon (2015), who investigated whether placement via MMA would accelerate access to college-level courses without compromising academic outcomes among Black and Hispanic students. They analyzed the transcripts of 44,228 FTIC students whose college mathematics placements had been determined in accordance with MMA. While standardized placement scores factored into placement decisions, so too did any multiple measure points that had been awarded for evidence of high school achievement. Using data transcript reviews, the researchers generated linear regression models to compare academic outcomes among students. They discovered from the models that the implementation of MMA enabled larger percentages of Black and Hispanic students to access college-level mathematics courses; however, those who benefited from multiple measures boosts were less likely to successfully complete the initial courses in which they enrolled. Still, they did not differ from those who placed based on test scores alone, in terms of their long-term progress toward degree or credential attainment (Ngo & Kwon, 2015). This distinction between the short- and long-term impact of MMA would resurface in a later study conducted by Kopko et al. (2023).

Kopko et al. (2023) sought to evaluate whether students persisted after successfully completing college-level mathematics courses in which they had been placed pursuant to MMA. Their longitudinal study relied on the same sample of 13,000 New York community college students who had, just years earlier, been the subjects in a randomized controlled trial involving MMA. They found that students in the MMA group (experimental group) were 18% more likely to secure college-level mathematics placements than students who earned identical placements on the basis of ACCUPLACER scores alone (control group). Moreover, students from the experimental group were 2% more likely to successfully complete a college-level mathematics course within nine semesters of matriculation (Kopko et al., 2023).

Counterman and Zientek (2023) noted similar trends in student persistence when they explored the impact of MMP on student success in college mathematics courses. In their study of 5,684 community college students, they leveraged measures of high school achievement to facilitate more rigorous mathematics course placements. Chi-square analyses uncovered a statistically significant association ($p < .001$) between placement via high school transcript evaluation and persistence in completing a tiered sequence of mathematics courses. These results only strengthen the case for MMA, highlighting yet again the predictive role that high school performance plays in making informed placement determinations.

Summary

Central to developmental mathematics education reform is a commitment to ensure equitable and timely access to college-level mathematics coursework (Marwick, 2002; Ngo & Kwon, 2015; Ngo & Melguizo, 2016; Xu & Dadgar, 2018; Zhao et al., 2022). Mathematics course placement policies have historically limited this access to students achieving threshold scores on standardized placement tests whose content and predictive validity have neither been formally evaluated nor systematically established (James, 2006; Kolesnikov et al., 2020; Ngo & Melguizo, 2016). This well-documented fact is the most often cited rationale underlying institutional and legislative initiatives intended to streamline or altogether eliminate prerequisite developmental coursework (Weisburst et al., 2017; Xu & Dadgar, 2018; Zhao et al., 2022). Leading the collective call for change are states such as Texas, where corequisite models have essentially made lengthy developmental mathematics course sequences obsolete (Weisburst et al., 2017). Equally as innovative are the more holistic multiple measures assessment policies that have been implemented in New York, where students with subpar standardized assessment scores have nonetheless found success in college-level mathematics courses (Kopko et al., 2023). While promising, the outcomes of preliminary studies pose generalizability concerns, owing to lack of uniformity in multiple measures criteria and inconsistencies in terms of the fidelity with which such criteria have been applied to arrive at mathematics placement determinations (Marwick, 2002; Ngo & Kwon, 2015). In addition, studies to date have focused primarily on direct and indirect college matriculants; as a result, the impact of multiple measures placement on dual-credit high school students has gone largely unexamined. It is therefore this study's aim to address the following research question: What is the impact of a five-level multiple measures placement algorithm on student achievement in a dual-credit college algebra course at a large, Midwestern suburban community college?

Theoretical Framework

Academic Momentum Theory

The inextricable link between the academic momentum theory and the assistance-hindrane model affords the inspiration and context for this study. Wang et al. (2015) broadly defined academic momentum as “the rate of speed at which students progress through college” (p. 5). Its conceptual origins can be traced to the earlier work of Adelman (2006) and Doyle (2009), both of whom found that community college students were more likely to transfer to four-year educational institutions and obtain their degrees if they completed more regular (i.e., credit-bearing, non-developmental, non-remedial) credit hours during their initial semesters of post-secondary study. Atwell et al. (2012) expanded on the work of predecessors, further positing that the speed at which undergraduate students initially progress in college significantly impacts their likelihood of earning a degree or credential. They unveiled evidence substantiating that the extent to which academic momentum is generated during the first semester of college is the best indicator of a student's trajectory in later years of college. Knox (2017) replicated earlier findings as well, articulating a direct relationship between the number of transferable, degree-fulfilling credits accumulated during students' first and second semesters of study and their corresponding likelihood of achieving degree completion. The distinction between developmental and non-developmental coursework, and the respective influence of each on

academic momentum, had already gained the attention of those attempting to advance what Venezia and Hughes (2013) referred to as “the college completion agenda” (p. 37).

Venezia and Hughes (2013) were among the first to describe the detrimental impact of developmental coursework on academic momentum. Developmental coursework, they reasoned, diminished academic momentum largely because lengthy, non-transferable course sequences could potentially take years to successfully complete. They estimated that as few as 20% of students who passed the first in a multi-part series of developmental courses went on to complete college-level coursework within three years. Moreover, they attributed this trend to the abundance of “exit opportunities” (p. 41) students encountered as they traversed developmental course offerings. This explanation resonated with the academic community, insofar as it aligned with the key premises underlying both the academic momentum theory and the assistance-hindrance model.

Three tenets form the bedrock of the academic momentum theory (Wang et al., 2015). The first is the assumption that students operate in the post-secondary setting at a pace dictated by personal factors and life circumstances. Closely related to this idea is the second precept of the theory, predicated on the notion that early success in college generates momentum that empowers students to overcome obstacles encountered during their educational journeys. The theory further stipulates that certain practices have been shown to optimize momentum during students’ early college experiences. Among these, completion of dual-credit coursework in high school and participation in summer coursework have demonstrated significant, positive correlations with momentum and student success (Wang et al., 2015). Such has not been the case with respect to developmental or remedial intervention, for reasons best understood in the context of the assistance-hindrance model.

Assistance-Hindrane Model

Also known as the change-hindrane model, the assistance-hindrane model provides a framework for evaluating the efficacy of a change or intervention (Martorell & McFarlin, 2011). As its name implies, the model maintains that the effectiveness of an intervention is measured in terms of the degree to which it promotes rather than hinders the attainment of a desired outcome. Considered in the context of timeless debates regarding the impact of developmental education, opponents of remedial coursework have asserted that its drawbacks far outweigh its benefits; that is, it affords more hindrance than assistance to aspiring college graduates (Venezia & Hughes, 2013).

Research has demonstrated that remedial interventions yield mixed results, often causing more harm than good with respect to student outcomes (Martorell & McFarlin, 2011). This unintended consequence has been attributed to a broad range of factors. At the top of the list is the stigmatization to which developmental students have historically been subjected. Equally as compelling and problematic is what Martorell and McFarlin (2011) coined the “crowding out effect” (p. 438), whereby a developmental student’s schedule is disproportionately comprised of courses that are non-transferable or non-credit-bearing. Compared to their developmental counterparts, non-developmental students earn more general education and/or discipline-specific credits during their initial semesters of study (Martorell & McFarlin, 2011). This in turn heightens their ability to build and sustain the academic momentum that has been heralded as an instrumental determinant of student success (Adelman, 2006; Attewell et al., 2012; Doyle, 2009; Knox, 2017; Wang et al., 2015).

Relevance of Current Study

Inasmuch as academic momentum is a function of the speed with which a student navigates collegiate coursework, any intervention aimed at bolstering it must account for the inherent constraints imposed by placement standards. For most students across the country, placement determinations dictate the starting point for a course of study in collegiate mathematics; consequently, the race to the finish line is longer for some than others. It follows, then, that the issue of course placement is a contextually relevant variable in any discussion involving academic momentum.

The purpose of this study is to evaluate whether a more holistic approach to placement – one in which multiple measures assessment (MMA) broadens access to a college-level mathematics course – can be implemented without compromising student achievement. In essence, the study is situated where the tenets of the academic momentum and assistance-hindrane theories intersect. If expanded access to college algebra via a dual-credit course offering culminates with an early academic win for students who might otherwise be required to enroll in developmental prerequisites, then MMA arguably *assists* in the generation of academic momentum. By contrast, if a more flexible placement model yields significant differences in academic outcomes among students who place in accordance with various alternative measures, one might surmise that MMA potentially *hinders* the cultivation of academic momentum. To the extent that academic outcomes do indeed significantly differ by assessment measure, this information could be leveraged to inform the future development and refinement of course placement policies.

Methods

Participants

A purposive sample of 3304 dual-credit college algebra students was identified through secondary analysis of data provided by the Institutional Research Department at a large, suburban community college in the Midwest. The data included mathematics course placement information, demographic characteristics, and course grade information for students who enrolled in dual-credit college algebra during the 2022-2023 and 2023-2024 school years. All dual-credit students were sophomores, juniors, or seniors who maintained co-enrollment at the community college and one of its neighboring 19 public or four private high schools. Of the 3304 records provided, 376 were missing mathematics course placement and/or course grade information; as a result, these records were excluded from further consideration. The remaining 2928 students consisted of 1712 (58.5%) females, 1187 (40.5%) males, and 29 (1.0%) who opted not to disclose their gender. Students' ages ranged from 15-18 years with a mean of 16.84 ± 0.62 years. In terms of ethnic background, 79 (2.7%) identified as Black; 202 (6.9%) identified as Hispanic; 7 (0.2%) identified as American Indian; 81 (2.8%) identified as Asian; 108 (3.7%) identified as Multiracial; 11 (0.4%) identified as Pacific Islander; 2283 (78.0%) identified as Caucasian/White; 7 (0.2%) identified as Nonresident; and 150 (5.1%) declined to report their ethnic origin.

Study Context

The three-credit-hour college algebra course in which study participants were enrolled was a transferable, college-level mathematics course emphasizing function families and function operations. The course also included an introduction to matrices and their applications in problem solving. Instruction was delivered using what Thorne et al. (2022) referred to as a facilitator model to address the shortage of high school teachers who possessed the subject matter credentials mandated by the Higher Learning Commission (Horn et al., 2018; Washington Student Achievement Council, 2016). The high school teacher retained primary responsibility for the presentation of course content in the secondary classroom setting; however, the co-assigned college professor remained available to high school teachers and dual-enrolled students for consultation at any time.

With respect to course logistics, each high school teacher was given a syllabus template, a list of recommended textbook titles, unit-test reviews, and a comprehensive final exam review, all of which aligned with unit- and course-level objectives. High school and college course grades were calculated separately. The college grade was based entirely on five unit-exams and a comprehensive final exam, all of which were authored, administered, and evaluated by the community college professor. Each student's ratio of points earned was converted to a percentage and corresponding letter grade using the following scale: $\geq 89.5\%$ = A; 79.5% - 89.4% = B; 69.5% - 79.4% = C; 59.5% - 69.4% = D; $< 59.5\%$ = F. Students who withdrew from the course by the applicable deadline were assigned a grade-point-average-neutral, non-credit-bearing grade of "W."

In terms of course operations, each of the dual-credit program's four full-time college professors was assigned to serve as the liaison and college teacher of record for a cluster of four to six high schools. The community college professor proctored and evaluated all exams in the high school settings on the dates requested by the co-assigned high school teachers. Students who missed school on designated test days were required to arrange travel to and from the community college within two weeks to complete proctored makeup exams in the testing center. Each unit-exam consisted of 20 constructed response questions that were mapped directly to practice items on the corresponding unit review and unit-level learning objectives. Similarly, the final exam was comprised of 25 constructed response questions that were mapped directly to the final exam review and course-level learning objectives. Eight comparable forms (two per professor) of each unit-exam, differing only with respect to the numbers used and context provided in the case of application problems, were developed by faculty and subsequently reviewed by the dual-credit mathematics program coordinator to ensure alignment with learning objectives and equivalency in terms of difficulty level. Pursuant to the college's mathematics department policy, two equivalent forms of a collaboratively authored departmental final exam underwent a similar review by a team of independent course content coordinators. All exams were scored using a six-point rubric whose values per question ranged from 0 (no valid problem-solving approach demonstrated) to 5 (a correct response with mathematically sound, written justification provided). Periodic checks for interrater reliability were conducted to ensure adherence to the rubric and consistency in evaluation of student work.

Measures

Multiple Measures Placement Algorithm

Dual-credit students achieved placement in college algebra via one of five pathways outlined in the multiple measures placement algorithm adopted and first implemented by the community college at the beginning of the 2022-2023 school year. Multiple measures assessment (MMA) affords dual-credit students access to college algebra if they meet any one of the following five criteria:

1. Attainment of an ACCUPLACER math score of at least 260;
2. Attainment of an ACCUPLACER math score between 256 and 259, coupled with a cumulative, unweighted high school grade point average of at least 3.25;
3. Attainment of an ACT math score of at least 21;
4. Attainment of an ACT math score of 20, coupled with a cumulative, unweighted high school grade point average of at least 3.25; or
5. Attainment of a grade of “B” or better in the second semester of Algebra 2 or an equivalent course, coupled with a cumulative, unweighted high school grade point average of at least 3.25.

Identification of the various pathways for placement represented the culmination of a year-long investigative process conducted by an institutional committee tasked with implementing MMA. The committee, consisting of mathematics faculty, student success coordinators, and high-ranking academic officials, conducted systematic interviews and inquiries with representatives of similarly sized institutions in the Midwest, South, and Southwest, all of whom had responded to state legislative mandates with the introduction of MMA-based placement policies. The performance criteria comprising each pathway in the five-tier algorithm reflected insights gleaned from this benchmarking process, coupled with administratively mandated concessions regarding minimum ACT math scores and cumulative, unweighted grade point averages. While the committee initially proposed a cut score of 22 on the ACT math section and a minimum cumulative, unweighted grade point average of 3.25, lower ACT math scores and minimum cumulative, unweighted grade point averages of 20-21 and 3.25, respectively, were adopted and subsequently ratified by the institution-wide educational affairs committee.

ACCUPLACER Math Score

The ACCUPLACER math score is a scaled value ranging from 200-300 on an untimed, computerized adaptive test consisting of up to 60 multiple-choice questions designed to assess mathematics knowledge in three subsections: arithmetic, quantitative reasoning, algebra, and statistics (QAS), and advanced algebra and functions (College Board, 2022). The College Board, which maintains oversight of item development and test administration, has adopted the stance that validation of the ACCUPLACER is context-specific; as such, validity should be investigated and established in the setting where the ACCUPLACER will be given (College Board, 2022). As it pertains to reliability, the College Board (2022) has reported Cronbach’s alpha values of .90, .89, and .86 on the ACCUPLACER’s arithmetic, QAS, and advanced algebra and functions subsections, respectively.

ACT Math Score

The ACT math score is a scaled value ranging from 1-36 on a 60-minute, 60-question, multiple-choice test designed to “measure the whole of a student’s mathematical development up

through topics typically taught at the beginning of grade 12 in US schools...” (ACT, 2024, p. 28). Traditional five-item multiple choice questions are grouped into five categories: Number & Quantity, Algebra, Functions, Geometry, and Statistics & Probability. ACT (2024) cites validity evidence to support the use of math sub scores to determine collegiate course placement, cautioning that “it is advisable to consider using additional measures such as high school coursework and grades...in addition to ACT scores when making placement decisions” (p. 133). Results from large-scale placement studies suggest that a cut score of 22 on the ACT math test translates into accurate college algebra placement in 53-62% of cases. In terms of reliability, Cronbach’s alpha of .92 was derived for the math section of the ACT from data associated with seven test forms administered from June 2022 to April 2023.

High School Algebra 2 Coursework

A grade of “B” or better in Algebra 2 denoted satisfactory mastery of standards-based content aimed at extending students’ knowledge of Algebra 1. Course structure varied among participating high schools. In some cases, Algebra 2 represented a standalone course offering. Other institutions adopted an integrated approach, wherein content equivalent to that customarily covered in Algebra 2 was intermingled with advanced topics in plane geometry.

Cumulative, Unweighted High School Grade Point Average

Cumulative, unweighted high school grade point average was operationally defined to be the average of all earned course grades, measured on a scale from 0.0 (a grade of “F”) to 4.0 (a grade of “A”), in high school level courses. The calculation was not weighted or otherwise adjusted to account for the difficulty level of courses (e.g., courses designated as honors or advanced placement courses).

Student Achievement

Student achievement was operationally defined as the dual-credit student’s earned course grade at the conclusion of the college algebra course. Determination of the course grade was based exclusively on cumulative points earned on each of five 100-point unit-exams and the 125-point comprehensive final exam. Letter grades of “A” and “B” denoted exceptional and above average performance, respectively, whereas marks of “C” and “D” signified average and below average performance, respectively. A grade of “F” was reserved for students who failed to achieve the passing threshold, and students who withdrew from the course before its conclusion earned a “W.” Though grades of “D” or better were sufficient to secure academic credit in conjunction with course completion, a minimum grade of “C” was required to fulfill prerequisite, degree, and/or transfer requirements. Grades of “F” and “W” indicated that no academic credit had been awarded for the course. In terms of effect on the student’s semester and college cumulative grade point average, a “W” was devoid of impact, while remaining grades carried familiar per-credit-hour point values ranging from 0.0 - 4.0, where 0.0 = “F,” 1.0 = “D,” 2.0 = “C,” 3.0 = “B,” and 4.0 = “A.”

Procedure

After receiving approval from the Institutional Review Board, the principal investigator obtained the de-identified data set from the college's Institutional Research Department. A signed letter of support from the college's Executive Director of Institutional Planning was included with the data set. Pertinent student records were provided via a secure link to an Excel spreadsheet. This spreadsheet was downloaded directly to a Microsoft One Drive folder to which only the principal investigator and his faculty advisor were granted access. Once categorical variables, including placement method, gender, ethnic designation, and course letter grade, had been numerically coded, the de-identified data set was uploaded to SPSS for analysis.

Statistical Analysis

Frequency counts, along with measures of central tendency and dispersion, were compiled to describe key features of the sample. Initially, a one-way, independent groups analysis of variance (ANOVA) was performed to determine whether final course grades differed significantly among students in each of the five distinct multiple measures placement groups. The use of ANOVA was conditioned on the alignment of the current study with several basic assumptions (Field, 2018). To test the normality assumption for each of the five placement groups, Shapiro-Wilk tests were conducted. Course grade distributions exhibited significant departures from normality in the ACCUPLACER placement group, $W(349) = .87, p < .001$; the ACCUPLACER plus high school grade point average group, $W(33) = .89, p = .011$; the ACT math score group, $W(633) = .79, p < .001$; the ACT math score plus high school grade point average group, $W(111) = .87, p < .001$; and the Algebra 2 grade plus high school grade point average group, $W(1802) = .85, p < .001$. While these results substantiated that the normality assumption had been violated, it is well-documented in the scientific literature that (1) ANOVA is robust against such violations, especially when sample size is large, and (2) departures from normality do not constitute a contraindication to proceeding with ANOVA (Bobbitt, 2019; Caldwell et al., 2022; Laerd Statistics, 2018; Mertler et al., 2022; Penn State, 2025; Schmider et al., 2010). For these reasons, the plan to utilize ANOVA was retained and testing of the homogeneity of variance assumption ensued.

ANOVA has likewise been deemed robust against violations of the homogeneity of variance assumption, provided that roughly equal group sizes are maintained (Bobbitt, 2019; Caldwell et al., 2022; Laerd Statistics, 2018; Mertler et al., 2022; Penn State, 2025). As Table 1 reveals, students relied more heavily on the combination of cumulative, unweighted high school grade point average and Algebra 2 grade than any other measure to secure course placement, thereby giving rise to a significant disparity in group sizes. Perhaps not surprisingly, Levene's test for homogeneity of variance unveiled a significant difference in the variances of course grades among students in the five independent placement groups, $F(4, 2923) = 16.61, p < .001$. Therefore, the assumption of homogeneity of variance was not met. Evidence-based guidelines calling for a Welch's *F*-test and Games Howell post hoc test, if applicable, were subsequently incorporated to account for the unequal variances among groups (Bobbitt, 2019; Caldwell et al., 2022; Laerd Statistics, 2018).

Lastly, an independent-samples Kruskal-Wallis test, widely regarded as the "non-parametric equivalent to ANOVA" (Lomuscio, 2021, para. 2) was conducted, owing to its lack of constraints regarding normality and homogeneity of variance (Bobbitt, 2019; Laerd Statistics, 2018). This final step was undertaken at Bobbitt's (2019) urging to evaluate whether the parametric ANOVA and non-parametric Kruskal-Wallis yielded similar results. Results of the

ANOVA and any relevant post hoc tests, along with the Kruskal-Wallis test, were analyzed using an alpha value of .05 to determine significance.

Table 1
Student Characteristics by Placement Method

Attribute	Placement Method				
	Accuplacer Only (<i>n</i> = 349)	Accuplacer Plus GPA (<i>n</i> = 33)	ACT Math Only (<i>n</i> = 633)	ACT Math Plus GPA (<i>n</i> = 111)	Algebra 2 Plus GPA (<i>n</i> = 1802)
Gender					
Female	156 (44.7%)	18 (54.6%)	317 (50.1%)	68 (61.3%)	1153 (64.0%)
Male	186 (53.3%)	14 (42.4%)	309 (48.8%)	43 (38.7%)	635 (35.2%)
Not disclosed	7 (2.0%)	1 (3.0%)	7 (1.1%)	--	14 (0.8%)
Ethnicity					
Black	14 (4.0%)	--	12 (1.9%)	1 (0.9%)	52 (2.9%)
Hispanic	32 (9.2%)	5 (15.2%)	28 (4.4%)	8 (7.2%)	129 (7.2%)
American Indian	--	--	1 (0.2%)	--	6 (0.3%)
Asian	13 (3.7%)	--	12 (1.9%)	3 (2.7%)	53 (2.9%)
Multiracial	14 (4.0%)	1 (3.0%)	24 (3.8%)	3 (2.7%)	66 (3.7%)
Pacific Islander	--	--	2 (0.3%)	--	9 (0.4%)
Caucasian/White	257 (73.6%)	24 (72.7%)	517 (81.7%)	91 (82%)	1394 (77.4%)
Nonresident	2 (0.6%)	--	2 (0.3%)	--	3 (0.2%)
Not Disclosed	17 (4.9%)	3 (9.1%)	35 (5.5%)	5 (4.5%)	90 (5.0%)
Course Grade					
4.0 = A	95 (27.2%)	4 (12.1%)	266 (42.0%)	32 (28.8%)	515 (28.6%)
3.0 = B	91 (26.1%)	9 (27.3%)	222 (35.1%)	38 (34.3%)	628 (34.9%)
2.0 = C	80 (22.9%)	9 (27.3%)	91 (14.4%)	28 (25.2%)	410 (22.8%)
1.0 = D	33 (9.5%)	4 (12.1%)	26 (4.1%)	8 (7.2%)	87 (4.8%)
0.0 = F	20 (5.7%)	2 (6.1%)	11 (1.7%)	2 (1.8%)	52 (2.8%)
0.0 = W	30 (8.6%)	5 (15.1%)	17 (2.7%)	3 (2.7%)	110 (6.1%)

Results

A one-way, independent groups ANOVA was conducted to determine if the mean final course grade differed across placement groups. Students were stratified into five groups based on the method by which they secured placement in college algebra: ACCUPLACER score only (*n* = 349); ACCUPLACER score plus cumulative, unweighted high school grade point average (*n* = 33); ACT math score only (*n* = 633); ACT math score plus cumulative, unweighted high school grade point average (*n* = 111); and high school Algebra 2 course grade plus cumulative, unweighted high school grade point average (*n* = 1802). There was a statistically significant difference in the mean final course grade across groups as determined by one-way ANOVA ($F(4,188.87) = 22.268, p < .001$). Effect size measured in terms of ω^2 was .028, indicating that

approximately 2.8% of the variation in final course grade could be accounted for by placement method. According to the social-science and education-specific effect size thresholds proposed by Faster Capital (2025), this constitutes a small to medium effect size whose practical significance should not be overlooked. Considered in the context of this study, multiple measures placement afforded dual-credit access to 1802 high school students who would not have qualified on the basis of criterion-referenced test scores alone. Of those 1802 high school students, 1553 (86%) went on to successfully earn transferable, degree-fulfilling mathematics credit.

Games-Howell post-hoc tests revealed that the mean final course grade was significantly lower in the ACCUPLACER score only placement group compared to the ACT math score only group ($M_{\text{difference}} = -0.63754$, $SE = 0.24337$, $p < .001$) and the Algebra 2 course grade plus cumulative, unweighted high school grade point average group ($M_{\text{difference}} = -0.26794$, $SE = 0.07790$, $p = .006$). Similarly, the mean final course grade was significantly lower in the ACCUPLACER score plus cumulative, unweighted high school grade point average group compared to the ACT math score only group ($M_{\text{difference}} = -1.09191$, $SE = 0.23606$, $p < .001$); the ACT math score plus cumulative, unweighted high school grade point average group ($M_{\text{difference}} = -0.78706$, $SE = 0.25423$, $p = .026$); and the Algebra 2 course grade plus cumulative, unweighted high school grade point average group ($M_{\text{difference}} = -0.72231$, $SE = 0.23396$, $p < .001$). By contrast, the mean final course grade was significantly higher in the ACT math score only group compared to the Algebra 2 plus cumulative, unweighted high school grade point average group ($M_{\text{difference}} = 0.36960$, $SE = 0.05065$, $p < .001$).

While the mean final course grade was higher in the ACCUPLACER score only group compared to the ACCUPLACER score plus cumulative, unweighted high school grade point average group, the difference was not significant ($M_{\text{difference}} = 0.45437$, $SE = 0.24337$, $p = .352$). Such was also the case with respect to comparisons of the mean final course grade in the ACT math score plus cumulative, unweighted high school grade point average group and the ACCUPLACER score only group ($M_{\text{difference}} = 0.33269$, $SE = 0.12634$, $p = .068$); the ACT math score only group and the ACT math score plus cumulative, unweighted high school grade point average group ($M_{\text{difference}} = 0.30485$, $SE = 0.11162$, $p = .054$); and ACT math score plus cumulative, unweighted high school grade point average group and the Algebra 2 grade plus cumulative, unweighted high school grade point average group ($M_{\text{difference}} = 0.06475$, $SE = 0.10710$, $p = .974$). Results of the ANOVA and related Games-Howell post-hoc tests are summarized in Tables 2 and 3, respectively.

Table 2

One-way, Independent Groups ANOVA for Final Course Grade by Placement Group

Source	ss	df	ms	F	p
Between Groups	123.975	4	30.994	22.268*	< .001**
Within Groups	4099.302	188.887*	1.488		
Total	4223.277	192.887*			

Note. * df and F values adjusted to reflect violation of the homogeneity of variances assumption. ** $\alpha = 0.05$ for this study.

Table 3

Games-Howell Post Hoc Tests for ANOVA for Final Course Grade by Placement Group

Group	<i>M</i>	<i>SD</i>	Comparison	<i>Mean</i>	
				<i>Difference</i>	<i>p</i>
(1) ACCUPLACER only	2.4241	1.35744	(1) – (2)	0.45437	.352
(2) ACCUPLACER + HSGPA	1.9697	1.33428	(1) – (3)	-0.63754	< .001*
(3) ACTM only	3.0616	1.06036	(1) – (4)	-0.33269	.068
(4) ACTM + HSGPA	2.7568	1.08892	(1) – (5)	-0.26794	.006*
(5) Algebra 2 + HSGPA	2.6920	1.19225	(2) – (3)	-1.09191	< .001*
			(2) – (4)	-0.78706	.026*
			(2) – (5)	-0.72231	.031*
			(3) – (4)	0.30485	.054
			(3) – (5)	0.36960	< .001*
			(4) – (5)	-0.06475	.974

Note. ACTM only = ACT Math score only group. HSGPA = cumulative, unweighted high school grade point average group. Algebra 2 = Algebra 2 course grade plus cumulative, unweighted high school grade point average group. * $\alpha = .05$ for this study.

Kruskal-Wallis Test and Dunn's Post Hoc Tests

While violation of the homogeneity of variances assumption underlying ANOVA was addressed with a Welch's *F*-test, the non-parametric Kruskal Wallis test was nonetheless performed and found to yield findings comparable to those of its parametric counterpart. Specifically, the Kruskal-Wallis test indicated that there was a significant difference in mean final course grade across the five placement groups, $\chi^2(4, n = 2928) = 84.052, p < .001$. The mean rank final course grade was 1284.41 for the ACCUPLACER score only group; 978.17 for the ACCUPLACER score plus cumulative, unweighted high school grade point average group; 1695.60 for the ACT math score only group; 1445.09 for the ACT math score plus cumulative, unweighted high school grade point average group; and 1428.30 for the Algebra 2 course grade plus cumulative, unweighted high school grade point average group.

Post hoc comparisons using Dunn's method with a Bonferroni correction for multiple tests revealed that the mean rank final course grade of the ACCUPLACER score plus cumulative, unweighted high school grade point average group was significantly lower than that of the Algebra 2 course grade plus cumulative, unweighted high school grade point average group, $p = .016$; the ACT math score plus cumulative, unweighted high school grade point average group, $p = .037$; and the ACT math score only group, $p < .001$. Similarly, the mean rank final course grade of the ACCUPLACER score only group was significantly lower than that of the Algebra 2 course grade plus cumulative, unweighted high school grade point average group, $p = .024$, and the ACT math score only group, $p < .001$. Such was also the case when comparing the mean rank final course grade of the Algebra 2 course grade plus cumulative, unweighted high school grade point average group to that of the ACT math score only group; the former was significantly lower than the latter, $p < .001$. Likewise, the mean rank final course grade of the ACT math score plus cumulative, unweighted high school grade point average group was significantly lower than that of the ACT math score only group, $p = .027$. There was no significant difference between the mean rank final course grade of the ACCUPLACER score plus cumulative, unweighted high school grade point average group and the ACCUPLACER score only group, $p = .382$. Nor were significant differences in mean rank final course grades noted with respect to (1) the ACCUPLACER score only group and the ACT math score plus cumulative, unweighted high school grade point average group, $p = .692$, or (2) the Algebra 2

course grade plus cumulative, unweighted high school grade point average group and the ACT math score plus cumulative, unweighted high school grade point average group, $p = 1.00$. Results of the Kruskal-Wallis test and related Dunn post-hoc tests are summarized in Tables 4 and 5, respectively.

Table 4

Kruskal-Wallis Test for Final Course Grade by Placement Group

Variable	Group	<i>n</i>	Mean Rank	Kruskal-Wallis Chi-square	<i>p</i>
Final grade	ACCUPLACER only	349	1284.41	84.052	< .001*
	ACCUPLACER + HSGPA	33	978.17		
	ACTM only	633	1695.60		
	ACTM + HSGPA	111	1445.09		
	Algebra 2 + HSGPA	1802	1428.30		
	Total	2928			

Note. ACTM only = ACT Math score only group. HSGPA = cumulative, unweighted high school grade point average group. Algebra 2 = Algebra 2 course grade plus cumulative, unweighted high school grade point average group. * $\alpha = .05$ for this study.

Table 5

Dunn Post Hoc Tests for Kruskal-Wallis Test for Final Course Grade by Placement Group

Group	Mean Rank	Comparison	Mean Rank Difference	<i>p</i> *
(1) ACCUPLACER only	1284.41	(1) – (2)	306.24	.382
(2) ACCUPLACER + HSGPA	978.17	(1) – (3)	-411.19	< .001**
(3) ACTM only	1695.60	(1) – (4)	-160.68	.692
(4) ACTM + HSGPA	1445.09	(1) – (5)	-143.89	.024**
(5) Algebra 2 + HSGPA	1428.30	(2) – (3)	-717.43	< .001**
		(2) – (4)	-466.92	.037**
		(2) – (5)	-450.13	.016**
		(3) – (4)	250.51	.027**
		(3) – (5)	267.30	< .001**
		(4) – (5)	16.79	1.00

Note. ACTM = ACT Math score only group. HSGPA = cumulative, unweighted high school grade point average group. Algebra 2 = Algebra 2 course grade plus cumulative, unweighted high school grade point average group. *Adjusted by the Bonferroni correction for multiple tests. ** $\alpha = .05$ for this study.

Summary

Results of the Kruskal-Wallis test align closely with those of the ANOVA, in terms of the significant differences between groups that were uncovered in the respective post hoc analyses. Whereas the Games-Howell post hoc tests revealed six significant differences between groups, the Dunn post hoc tests with Bonferroni corrections for multiple tests identified a seventh

significant difference between the mean rank final course grades of the ACT math score only and ACT math score plus cumulative, unweighted high school grade point average groups ($p = .027$). A difference in mean final course grades between these two groups emerged in the Games-Howell post hoc tests as well; however, this difference did not prove to be significant ($p = .054$).

Discussion

Results of this study suggest that academic achievement among dual-credit mathematics students varies across a range of different placement modalities. Most compelling is the finding that dual-credit students who placed into college algebra on the basis of ACCUPLACER scores with or without a “boost” for cumulative, unweighted high school grade point average earned significantly lower course grades than their counterparts who qualified via alternative placement routes. This discovery substantiated the concerns of James (2006) and others (Kolesnikov et al., 2020; Melguizo et al., 2014) who repeatedly questioned the merits of any placement policy relying exclusively on ACCUPLACER scores to determine initial mathematics course enrollment.

While it might be tempting to abandon standardized test scores as a viable placement measure, findings from the current study suggest that such a drastic measure would be premature and ill-advised. This is best exemplified by comparative data demonstrating the extent to which ACT math scores outperformed ACCUPLACER scores and measures of high school achievement as placement indicators. With respect to outcomes, the average course grade of students who placed via ACT math scores was significantly higher than that of students in all other placement groups except the ACT math score plus cumulative, unweighted high school grade point average cohort. A close second to ACT math scores’ efficacy is evidence of high school achievement, measured in terms of previous mathematics course grades and cumulative, unweighted high school grade point average. This finding closely aligns with the earlier work of Woods et al. (2018) and others (Bahr et al., 2019; Counterman & Zientek, 2023; Kopko et al., 2023), whose steadfast appeals thrust multiple measures assessment (MMA) into the educational spotlight, effectively signaling a philosophical shift in mindset regarding course placement paradigms.

Representing approximately 62% of total enrollment ($n = 2928$) in the dual-credit college algebra program, the 1802 students who placed via Algebra 2 grade of “B” or better and cumulative, unweighted grade point average of at least 3.25 performed significantly better as a cohort than those who relied on ACCUPLACER scores or a combination of ACCUPLACER scores and cumulative, unweighted grade point average of at least 3.25 to secure placement. Whereas the percentage of students in the ACCUPLACER score only and ACCUPLACER score plus cumulative, unweighted high school grade point average groups earning grades of “C” or better amounted to 76.2% and 66.7%, respectively, 86.3% of those in the Algebra 2 plus cumulative, unweighted high school grade point average group completed college algebra with at least a “C” (see Table 1). While slightly lower than the ACT score only and ACT score plus cumulative, unweighted high school grade point average groups, whose “C” or better rates were 91.5% and 88.3%, respectively, the Algebra 2 plus cumulative, unweighted grade point average group’s “C” or better rate is nonetheless competitive, given that this cohort’s size exceeded that of the other four placement groups combined (see Table 1). Success of this magnitude is a driver of academic momentum, leaving dual-credit high school students poised for whatever challenges may lie ahead (Adelman, 2006; Atwell et al., 2012; Doyle, 2009; Knox, 2017; Wang et al.,

2015). Moreover, it strengthens the case made by Woods et al. (2018) and others (Bahr et al., 2019; Counterman & Zientek, 2023; Kopko et al., 2023) who envisioned a preferred future in which multiple measures assessment (MMA) would afford a more student-centered approach for determining initial collegiate mathematics course placement. Without MMA, many of the 2928 participants in this study would have been unable to access an academically fruitful early college learning experience.

Limitations

While this study addresses a gap in the literature regarding the use of MMA to determine initial collegiate course placement among dual-credit high school students, it does so at the expense of generalizability of findings. The results provide convincing evidence as to the role MMA plays in broadening access to transferrable, college-level mathematics courses; however, any conclusions drawn from this evidence are limited in applicability to the population of dual-credit high school students. Broadening the generalizability of findings to other subgroups, including traditional and non-traditional college matriculants, would require additional research designed to target these populations. In addition, reliance on the facilitator model (Thorne et al., 2022) to decentralize teaching responsibility introduces variability with respect to fidelity of curriculum implementation and quality of instruction. Factors such as teacher preparation and experience, pedagogical leanings, engagement strategies, and familiarity with the college algebra curriculum will predictably differ across participating schools, potentially contributing to differences in student achievement. Ensuring that each high school teacher receives a course content kit containing unit- and course-level objectives, suggested learning activities, and review guides for all summative assessments helps to minimize the risk of measurement bias. Still, at least marginal variability in performance among students at different schools seems inevitable.

Differences in achievement may likewise be attributable to subtle contrasts in how each of the college professors constructs and evaluates exams. While the dual-credit team comprised of four full-time college professors works collaboratively to develop an item map prior to each unit-exam, nuances in question formulation and presentation will invariably contribute to error in the evaluation and measurement process. Despite review of all exams by the dual-credit program coordinator to ensure equivalency, stylistic differences with respect to instrument formatting, verbiage contained in instructions, and conventions such as the use of integer versus rational coefficients in test items might unintentionally impact scores across participating schools. So too might inconsistencies in how each professor interprets the six-point scoring rubric. Distinctions between minor, moderate, and significant errors of algebra are largely a matter of judgment; however, periodic validation of the rubric via interrater reliability checks helps to mitigate the incidence of significant deviations in scoring among different professors.

Future Directions

The current study represents just the beginning in terms of a sustainable program of research designed to explore the impact of MMA on student achievement among dual-credit students. Findings from prior research (Atwell et al., 2012; Knox, 2017; Venezia & Hughes, 2013; Wang et al., 2015) suggest that early successes in college, such as those celebrated by nearly 86% of the students in the featured dual-credit college algebra program, are positively correlated with on-time degree completion and/or credential attainment. A longitudinal study

involving the sample of 2928 students in the present study would represent a viable approach for testing this conjecture. Results from this type of study would be useful in gauging the extent to which academic momentum generated by early college success yields long-term wins and culminates with the eventual completion of a degree or certificate program.

From a short-term perspective, data gathered for the present study might be utilized to investigate whether performance within and across placement groups varies by age, gender, ethnicity, and/or age of participants. Knowledge gleaned from such a study would represent a logical first step in gaining a better understanding of why some dual-credit students benefit more from MMA placement than others. At the same time, this information would do little to address what is arguably the key limitation of this study: its generalizability. Performing a similar study involving direct and indirect college matriculants would be useful in gauging the efficacy of placement via MMA in these respective populations. It would be especially important to determine whether the relevance of measures of past high school achievement diminish over time, especially among indirect matriculants who might be returning to school after serving in the military or joining the workforce immediately after high school graduation. If ACT math scores and prior high school performance are found to be less reliable determinants of initial collegiate mathematics course placement among indirect matriculants, the focus of research should arguably shift to facilitate the identification of more pertinent predictive measures of student success (e.g., non-cognitive factors such as motivation, past work experience or training, etc.). Moreover, these measures may differ by course level, thus highlighting the need for further research to investigate outcomes associated with the use of MMA placement algorithms in successor mathematics courses for which college algebra is a prerequisite, namely trigonometry, precalculus, calculus, and statistics.

Conclusion

Few educational debates have become as contentious as those regarding initial collegiate mathematics course placement determinations. This topic is understandably fraught with controversy given the magnitude of the stakes involved. Inaccurate course placement triggers a vicious cycle in which students are saddled with lengthy developmental mathematics sequences that ultimately restrict their access to required college-level course offerings. Delays in progression, coupled with loss of academic momentum, induce an educational stall from which some students never recover.

As decades-long debates about the merits of respective placement modalities continue to unfold, MMA has attracted increasing attention, owing to its student-centeredness and holistic philosophical underpinnings. This study investigated whether academic achievement in a dual-credit college algebra course differed significantly among students who met placement requirements via a five-tier MMA placement algorithm. Differing placement criteria by group included standalone ACCUPLACER or ACT math scores; ACCUPLACER or ACT math scores paired with cumulative, unweighted high school grade point average; and high school Algebra 2 grades paired with cumulative, unweighted high school grade point average. Of interest was whether one measure or combination of measures for determining placement outperformed the others in terms of academic outcomes.

Results of a one-way, independent groups ANOVA and Kruskal-Wallis test revealed statistically significant differences in mean course grades across five distinct placement groups. With respect to the largely understudied dual-credit student population, these findings suggest

that standardized assessments like the ACCUPLACER – designed exclusively for the purpose of determining a college matriculant’s initial mathematics course placement – may lack predictive validity. By contrast, high school achievement indicators such as previous mathematics grades and cumulative, unweighted grade point average demonstrate promise with respect to their role in rewriting the placement narrative.

While this study is a testament to the efficacy of MMA as a viable placement modality, its results are limited in terms of generalizability. Future research is needed to ascertain whether similar results can be replicated with traditional and non-traditional college matriculants. Moreover, MMA will only gain traction as a credible and sustainable approach if its usefulness in accurately determining course placement for a broad range of mathematics courses can be firmly established in follow-up studies. Not until then is MMA likely to become a contemporary mainstay in placement policies across the country, at educational institutions large and small.

References

- ACT. (2024). *ACT technical manual*.
https://www.education.ky.gov/AA/Reports/Documents/2024_ACT_Technical_Manual.pdf
- Adelman, C. (2006). *The toolbox revisited: Paths to degree completion from high school through college*.
<https://www.ed.gov/sites/ed/files/rschstat/research/pubs/toolboxrevisit/toolbox.pdf>
- Attewell, P., Heil, S., & Reisel, L. (2012). What is academic momentum? And does it matter? *Educational Evaluation and Policy Analysis*, 34(1), 27-44.
<https://doi.org/10.3102/0162373711421958>
- Bahr, P. R., Fagioli, L. P., Hetts, J., Hayward, C., Willett, T., Lamoree, D., Newell, M. A., Sorey, K., & Baker, R. B. (2019). Improving placement accuracy in California’s community colleges using multiple measures of high school achievement. *Community College Review*, 47(2), 178-211.
<https://doi.org/10.1177/0091552119840705>
- Bobbitt, Z. (2021, August 3). *How to check ANOVA assumptions*. Statology.
<https://www.statology.org/anova-assumptions/>
- Caldwell, A. R., Lakens, D., Parlett-Pelleriti, C. M., Prochilo, G., & Aust, F. (2022). *Power analysis with Superpower*. <https://aaroncaldwell.us/SuperpowerBook/violations-of-assumptions.html>
- College Board. (2022). *Multiple factors in college placement decisions*.
<https://accuplacer.collegeboard.org/accuplacer/pdf/multiple-factors-in-college-placement-decisions.pdf>
- Counterman, C., & Zientek, L. R. (2023). High school transcript placement in developmental mathematics courses: A case study at one college. *European Journal of Science and Mathematics Education*, 11(1), 1-14. <https://doi.org/10.30935/scimath/12430>

- Daugherty, L., Gerber, R., Martorell, F., Miller, T., & Weisburst, E. (2021). Heterogeneity in the effects of college course placement. *Research in Higher Education*, 62, 1086-1111. <https://doi.org/10.1007/s11162-021-09630-2>
- Doyle, W. R. (2009). Impact of increased academic intensity on transfer rates: An application of matching estimators to student-unit recorded data. *Research in Higher Education*, 50, 52-72. <https://link.springer.com/article/10.1007/s11162-008-9107-6>
- Faster Capital. (2025, April 12). *Omega squared: The Omega of effect size interpretation*. <https://fastercapital.com/content/Omega-Squared--Omega-Squared--The-Omega-of-Effect-Size-Interpretation.html>
- Field, A. (2018). *Discovering statistics using IBM SPSS Statistics* (5th ed.). SAGE.
- Horn, A. S., Parks, J. L., Zinth, J. D., & Sisneros, L. (2018). *Increasing the supply of qualified high school teachers for dual enrollment programs: An overview of state and regional accreditor policies*. <https://www.ecs.org/wp-content/uploads/Increasing-the-Supply-of-Qualified-High-School-Teachers-for-Dual-Enrollment-Programs.pdf>
- James, C. L. (2006). ACCUPLACER™ OnLine: Accurate placement tool for developmental programs? *Journal of Developmental Education*, 30(2), 2-8.
- Knox, D. (2017). *The influence of academic momentum and associate degree credit requirements on community college student degree completion* [Doctoral dissertation, University at Albany, State University of New York]. Legacy Theses & Dissertations (2009-2024). <https://scholarsarchive.library.albany.edu/legacy-etd/1866>
- Kolesnikov, A., Wang, X., Bonaduce, M., Cunningham, M., Fontinell, L., Halliwell, T., & Twillman, M. (2020). Imagine no remediation: Evaluation of a placement policy change. *Research in Higher Education*, 61, 849-870. <https://doi.org/10.1007/s11162-019-09568-6>
- Kopko, E., Daniels, H., & Cullinan, D. (2023, October). *The long-term effectiveness of multiple measures assessment: Evidence from a randomized controlled trial*. Center for the Analysis of Postsecondary Readiness (CAPR). https://www.mdrc.org/sites/default/files/long-term-effectiveness-multiple-measures-assessment_0.pdf
- Kosiewicz, H., & Ngo, F. (2020). Giving community college students choice: The impact of self-placement in math courses. *American Educational Research Journal*, 57(3), 1358-1391. <https://doi.org/10.3102/0002831219872500>
- Laerd Statistics. (2018). *One-way ANOVA*. <https://statistics.laerd.com/statistical-guides/one-way-anova-statistical-guide-3.php>
- Lomuscio, S. (2021, December 7). *Getting started with the Kruskal-Wallis Test*. UVA Library StatLab. <https://library.virginia.edu/data/articles/getting-started-with-the-kruskal-wallis-test>

- Martorell, P., & McFarlin Jr., I. (2011). Help or hindrance? The effects of college remediation on academic and labor market outcomes. *The Review of Economics and Statistics*, 93(2), 436-454. https://doi.org/10.1162/REST_a_00098
- Marwick, J. (2002). Alternative methods of mathematics placement. *Community College Enterprise*, 8(2), 41. <https://eric.ed.gov/?id=EJ659722>
- Melguizo, T., Kosiewicz, H., Prather, G., & Bos, J. (2014). How are community college students assessed and placed in developmental math? Grounding our understanding in reality. *The Journal of Higher Education*, 85(5), 691-722. <https://doi.org/10.1080/00221546.2014.11777345>
- Mertler, C. A., Vannatta, R. A., & LaVenja, K. N. (2022). *Advanced and multivariate statistical methods: Practical application and interpretation* (7th ed.). Routledge.
- Ngo, F., & Kwon, W. W. (2015). Using multiple measures to make math placement decisions: Implications for access and success in community colleges. *Research in Higher Education*, 56, 442-470. <https://doi.org/10.1007/s11162-014-9352-9>
- Ngo, F., & Melguizo, T. (2016). How can placement policy improve math remediation outcomes? Evidence from experimentation in community colleges. *Educational Evaluation and Policy Analysis*, 38(1), 171-196. <https://doi.org/10.3102/016237371560350>
- Penn State Eberly College of Science. (2025). *ANOVA assumptions*. <https://online.stat.psu.edu/stat502/lesson/3/3.2>
- Schmider, E., Ziegler, M., Danay, E., Beyer, L., & Bühner, M. (2010). Is it really robust? Reinvestigating the robustness of ANOVA against violations of the normal distribution assumption. *Methodology*, 6(4), 147-151. <https://doi.org/10.1027/1614-2241/a000016>
- Thorne, S., Strimel, G. J., Mentzer, N., & Sears, D. (2022). The facilitator model: Investigating a novel dual credit experience for open-ended design coursework. *Journal for STEM Education Research*, 5, 479-508. <https://doi.org/10.1007/s41979-022-00075-5>
- Venezia, A., & Hughes, K. L. (2013). Acceleration strategies in the new developmental education landscape. *New Directions for Community Colleges*, 164, 37-45. <https://doi.org/10.1002/cc.20079>
- Wang, X., Chan, H., Phelps, L. A., & Washbon, J. I. (2015). Fuel for success: Academic momentum as a mediator between dual enrollment and educational outcomes of two-year technical college students. *Community College Review*, 43(2), 165-190. <https://doi.org/10.1177/0091552115569846>
- Washington Student Achievement Council. (2016). *Dual credit report*. <https://wsac.wa.gov/sites/default/files/2016.10.07.WSAC.Dual%20Credit%20Report.pdf>

Weisburst, E., Daughterty, L., Miller, T., Martorell, P., & Cossairt, J. (2017). Innovative pathways through developmental education and postsecondary success: An examination of developmental math interventions across Texas. *The Journal of Higher Education*, 88(2), 183-209. <http://dx.doi.org/10.1080/00221546.2016.1243956>

Woods, C. S., Park, T., Hu, S., & Jones, T. B. (2018). How high school coursework predicts introductory college-level course success. *Community College Review*, 46(2), 176-196. <https://doi.org/10.1177/0091552118759419>

Xu, D., & Dadgar, M. (2018). How effective are community college remedial math courses for students with the lowest math skills? *Community College Review*, 46(1), 62-81. <https://doi.org/10.1177/0091552117743789>

Zhao, K., Park-Gaghan, T. J., Mokhe, C. G., & Hu, S. (2022). Examining the impacts of Florida's developmental education reform for non-exempt students: The case of first-year English and math course enrollment and success. *Community College Review*, 50(2), 171-192. <https://doi.org/10.1177/009155212110614>

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