Article

Community College Review
2015, Vol. 43(2) 165–190

DOI: 10.1177/0091552115569846
crw.sagepub.com

Fuel for Success: Academic Momentum as a Mediator Between Dual Enrollment and Educational Outcomes of Two-Year Technical College Students

Xueli Wang[1], Hsun-yu Chan[1], L. Allen Phelps[1], and Janet I. Washbon[1]

Abstract

Objective: Despite the fairly substantial body of literature devoted to understanding whether dual enrollment programs are related to academic success in college, less is known regarding how dual enrollment transmits its potentially positive influence, especially among two-year college students. In this study, we fill this gap by delving into the process of how dual enrollment is related to academic success among students attending two-year technical colleges. Specifically, we examine academic momentum as a potential mediator of the relationship between dual enrollment and educational outcomes.

Methods: We draw on a sample of more than 15,000 first-time postsecondary students who entered Wisconsin's two-year technical colleges in 2009 to 2010 after graduating from high school between 2007 and 2009. Using a path analysis, we investigate student transcript records, along with data from the National Student Clearinghouse.

Results: Participation in dual enrollment is found to be related to more attempted credits, higher likelihood of college entry without delay, summer enrollment, as well as stronger academic performance. These early academic momentum indicators are then positively related to students' college completion or retention, fully accounting for the positive relationship between dual enrollment participation and college outcomes.

Contributions: Our study provides a finer look into two-year college students' academic progress and success and how dual enrollment may fuel this process by promoting students' academic momentum early during their college careers.

[1]University of Wisconsin–Madison, USA

Corresponding Author:
Xueli Wang, University of Wisconsin–Madison, 270-H Education Building, 1000 Bascom Mall, Madison, WI 53706, USA.
Email: xwang273@wisc.edu

Keywords
dual enrollment, academic momentum, two-year college, technical college, college completion

America's two-year community and technical colleges are known for open admissions, low tuition costs, accessibility, and contributing to democratization of higher education (Alfonso, 2006; Bailey & Averianova, 1998; Bryant, 2001; Cohen & Brawer, 2008; Hagedorn & DuBray, 2010; Leigh & Gill, 2003; Rouse, 1995). Many have looked to these institutions to provide a wide range of academic and career opportunities to allow a greater and more diverse population the prospect of obtaining qualifications leading to further educational and professional success (Cohen, Brawer, & Kisker, 2014; Zamani-Gallaher, Lester, Bragg, & Hagedorn, 2014). Between 2000 and 2010, enrollment in public two-year colleges increased from 5.7 to 7.2 million adults, and currently, these institutions serve 52.6% of all public higher education students in the United States (National Center for Education Statistics, 2012). Yet, despite these soaring numbers, students who begin at two-year colleges often report low persistence and completion rates (Schneider & Yin, 2012). As raising college completion rates becomes a national priority for postsecondary education (Lee, Edwards, Menson, & Rawls, 2011; Lumina Foundation, 2013; White House Press Office, 2009), it is pivotal to expand the knowledge base on factors improving student success, which is integral to the college completion agenda at two-year colleges.

One particularly promising practice that seems to promote two-year college student success is dual enrollment programs that allow high school students to enroll in college courses and potentially earn college credit (Bragg, Kim, & Barnett, 2006). Nationally, there has been a rapidly expanding interest in dual enrollment courses and experiences among high school students (Thomas, Marken, Gray, & Lewis, 2013). In addition, the spectrum of dual enrollment options has broadened to include college courses for students seeking to enter the workplace or postsecondary technical education programs. High school students are increasingly looking for college courses and experiences that are aligned with pathways other than the conventional four-year degree, such as associate degrees, technical diplomas, and industry certifications (Leech, 2014; Rosenbaum, Stephan, & Rosenbaum, 2010).

Compared with the substantial evidence for dual enrollment effects in four-year institutions (e.g., Allen & Dadgar, 2012; An, 2013a, 2013b; Howell, 2011; Puyear, Thor, & Mills, 2001), only a small body of dual enrollment research focuses on students attending two-year colleges and indicates some benefits associated with dual enrollment, such as increased college readiness (Kim & Bragg, 2008), higher grade point average (GPA), and higher persistence rates (D'Amico, Morgan, Robertson, & Rivers, 2013; Karp, Calcagno, Hughes, Jeong, & Bailey, 2008). While some of this research valuably delves into specific ways in which dual enrollment may influence student success, such as how the location of dual enrollment classes (i.e., on a two-year campus versus a high school campus) is related to technical college students'

retention (D'Amico et al., 2013), empirical studies focusing on students enrolling in two-year institutions are simply limited in number, and there is a lack of a finer understanding of the way in which dual enrollment is related to two-year college success.

Adding to this line of inquiry, our research examines not only whether dual enrollment is related to student success at two-year colleges, but also how this relationship, if there is one indeed, is exerted. Despite the fairly substantial body of literature devoted to understanding *whether* dual enrollment programs work in terms of promoting desirable outcomes among program participants, less attention has been directed to *how* these programs transmit their potentially positive effects. As a result, empirical efforts in this vein tend to adopt the traditional input–output approach (Bahr, 2013); that is, assuming that dual enrollment directly influences educational outcomes and seldom delve into the complex processes—the *through* variables—explaining how dual enrollment influences educational outcomes. As indicated in their extensive review of the literature on how dual enrollment is related to critical academic outcomes (e.g., program completion), Kim, Kirby, and Bragg (2006) argued that, given dual enrollment's significance in improving student success in a two-year college context, future research should focus on illuminating the mechanisms underlying dual enrollment—how the effect of dual enrollment unfolds to influence academic outcomes.

One such *through* process that may underlie the relationship between dual enrollment and student success is academic momentum—the course load and progress during the initial phase of college (Adelman, 1999, 2006; Attewell, Heil, & Reisel, 2012). An important dynamic of the initial academic experience at college, the concept of academic momentum holds strong policy implications, in that increasing academic momentum is possibly an inexpensive solution to improve student outcomes, as it requires only a change in operations rather than the addition of another resource-draining program (Adelman, 1999; Freeman, 2009). Connecting dual enrollment with academic momentum, we argue that dual enrollment serves as pre-college momentum that helps build early college academic momentum. In theory, participation in dual enrollment programs provides students with an exposure to college-level work, which gives them a head start in terms of the pace at which they operate in making initial academic progress at college. Dual enrollment program participants may attempt more course credits and make faster academic progress, which then in turn have a positive, substantial influence on their longer-term educational outcomes. Despite this highly plausible theoretical linkage, existing literature seldom empirically examines the intersection between dual enrollment and academic momentum among students attending two-year colleges.

In addition, even within the limited body of literature focusing on two-year college students, studies on dual enrollment or academic momentum do not account for their potentially varying effects on educational outcomes of students enrolled in different programs (e.g., D'Amico et al., 2013; Karp et al., 2008). Given the different curricula and academic requirements as well as the diverse educational goals between students enrolled in technical education programs such as manufacturing-related fields and those enrolled in other programs, it is possible that dual enrollment participation and

academic momentum aid students in different ways. Therefore, a more detailed investigation of the field-specific mechanism of dual enrollment participation and academic momentum in the two-year college context is much warranted.

Aiming to address these gaps in the literature, we focused on students who enrolled in Wisconsin's technical college system shortly after high school and sought to answer the following questions in our study:

> First, is participation in dual enrollment associated with student success as measured by fourth-term college retention or completion?
>
> Second, is academic momentum exhibited by students during their first year at technical colleges associated with their fourth-term success?
>
> Third, on the supposition that dual enrollment is associated with student outcomes and that academic momentum is also related to student outcomes, does academic momentum mediate the relationship between dual enrollment and student outcomes?

We also explored how the relationships modeled above may vary between students enrolled in different fields of study (i.e., manufacturing-related fields vs. other fields of study). In other words, do the relationships specified above equally pertain to students in manufacturing-related and other fields of study, or do students in different fields of study show different paths from dual enrollment to college success via academic momentum?

Relevant Literature and Conceptual Grounding

Dual Enrollment and Student Outcomes

Dual enrollment[1] between high school and postsecondary education has long been believed to have a positive impact on students' educational success. Townsend and Wilson (2006) concluded that there were several educational benefits of participating in dual enrollment, including a smoother transition to college (Kleiner & Lewis, 2005), increased opportunities for access to career and technical education (CTE) programs (Harnish & Lynch, 2005; Karp et al., 2008; Peters & Mann, 2009), and stronger aspirations to participate in postsecondary education (Bailey & Karp, 2005; Marshall & Andrews, 2002; Medvide & Blustein, 2010; Smith, 2007).

In general, empirical research in this domain has confirmed these beliefs and revealed a positive relationship between participation in dual enrollment and various student outcomes. To be specific, students who participated in dual enrollment programs tended to have better academic achievement (An, 2013b; Karp et al., 2008) and were more prepared for postsecondary education (An, 2013b). In addition, compared with their college-going counterparts who were not involved in dual enrollment, these students were more likely to be retained to the second year of college (Eimers & Mullen, 2003) and attain an associate or a bachelor's degree (An, 2013a). Besides these educational benefits, others embraced dual enrollment because of its potential

financial implications for the state and individual students, such as saving the costs associated with offering remedial classes, because dual enrollment helped better align secondary and postsecondary education (Howell, 2011), and lower costs for individual students because of the accelerated time to graduation (Hunt & Carroll, 2006). Despite varying methodological approaches, results from empirical studies are consistent, in that dual enrollment is positively linked to student outcomes when self-selection was controlled for, particularly among those enrolled at four-year institutions (Allen & Dadgar, 2012; An, 2013a, 2013b; Eimers & Mullen, 2003; Puyear et al., 2001).

To maximize the positive effect of dual enrollment, our knowledge of how dual enrollment works must be further expanded. Equally important, we need to know what factors are most influential in generating these outcomes for the diverse array of students enrolling in two-year technical colleges.

Academic Momentum

Earlier, we discussed academic momentum as a plausible mechanism through which the effect of dual enrollment could be demonstrated. Broadly defined as the rate of speed at which students proceed through college, academic momentum is anchored in several critical premises. First, upon entering postsecondary education, students operate at a particular pace, which is self-ascribed based on personal and contextual factors. Students' initial course load and academic progress enable them to establish a momentum, which has a substantial influence on completion. Second, success in early college learning (i.e., gaining momentum in a new environment) is essential for overcoming or supplanting potential disadvantages from high school learning experiences and socio-demographic influences. Third, an academic momentum framework includes practices and processes (such as summer coursework) that can optimize academic progress and engagement in students' early years of college attendance.

Academic momentum has been measured in multiple ways. In his studies on college completion, Adelman (1999, 2006) initiated the idea of academic momentum and highlighted a number of "momentum" measures: high school preparation, undergraduate's academic course load (quantity of effort) and GPA (quality of effort) in the first year of enrollment, course withdrawal/repeat/incomplete rate, summer term credit generation, and continuous enrollment. Adelman (2006) argued that students who have a certain speed to complete their college credentials are more likely to obtain their degrees than students who have a lower speed to proceed through college studies.

Several other studies adopted Adelman's academic momentum measures, especially coursework during the first year as a core momentum indicator. Controlling for potential selection bias, Doyle (2009) found that more regular credit hours completed in the first term of study were associated with higher transfer rates from community colleges to four-year universities. Similarly, Freeman's (2009) study on the relationship between academic momentum and undergraduate degree completion at a historically Black institution considered first-year college credit hour attainment, withdrawal/repeat/incomplete rates, and a continuous enrollment indicator to measure academic momentum.

In a more recent study, Attewell et al. (2012) modified the measures of academic momentum. While agreeing with Adelman that academic course load was one of the primary indicators of academic momentum, the authors deviated from Adelman in that they considered attempted course load, instead of courses passed, to be a more valid measure of momentum, as courses completed would represent the outcome of the momentum rather than momentum per se. We agree with and adopt the approach by Attewell et al. (2012) in this article.

In aggregate, despite the sometimes divergent measures of academic momentum, the small body of research that intentionally built upon this construct have all suggested that most, if not all, of the academic momentum measures were positively associated with a number of educational outcomes, such as upward transfer (Doyle, 2009) and degree attainment (Attewell et al., 2012; Freeman, 2009).

Conceptual Grounding

As previously indicated, dual enrollment and initial postsecondary academic momentum are two promising lines of research that shed great light on two-year college student success. Yet, empirical work to date has not addressed the potentially powerful intersection between the two. In this study, we theorize that dual enrollment, by introducing students to college-level coursework, can be regarded as a pre-collegiate momentum indicator (Adelman, 2006), thus serving as a catalyst for initial postsecondary academic momentum, which in turn influences student retention and completion. This hypothesis is rooted in the notion that dual enrollment programs help high school students establish an early process to transition into college. By completing postsecondary coursework in high school, students enter college with a strong start toward building momentum. This resulting academic momentum then influences college persistence and progress to degree. Figure 1 presents a graphic depiction of the study's conceptual structure.

Research Design

Data and Sample

State context. This study was based on administrative data made available through the Wisconsin Technical College System (WTCS). Two-year technical colleges have long been, and will continue to be, regarded as the cradle of skilled workers and gateway to further postsecondary education, yet empirical research on how to assist these students make educational progress has been extremely scarce. Drawing upon data from all 16 two-year technical colleges in the state of Wisconsin, the present research served as a timely investigation of the proposed questions among the under-studied two-year technical student population. As indicated earlier, the present research also placed a focus on differentiating between students in manufacturing-related engineering programs and their counterparts in other fields of study. Critical shortages of skilled workers and production technicians in the advanced manufacturing industry have been

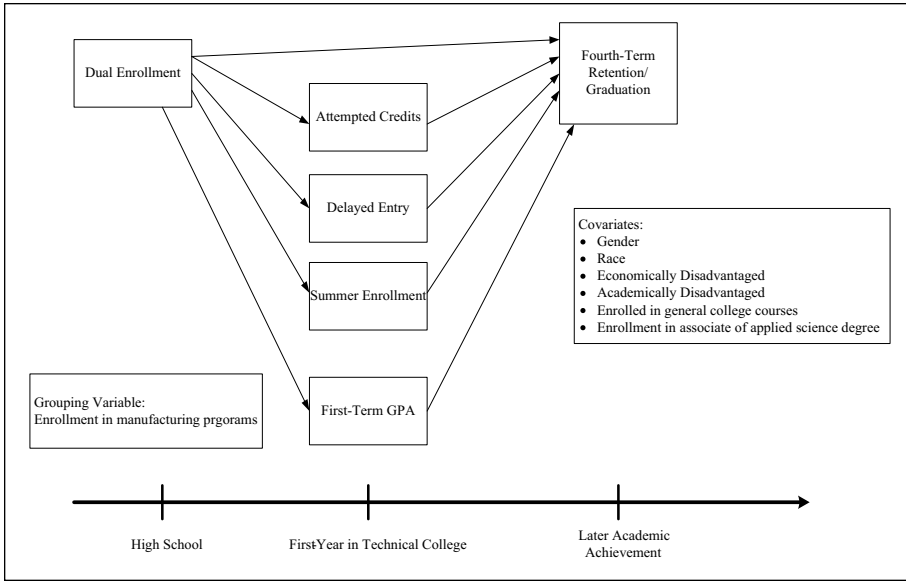

Figure 1. Conceptual model of the study.
Note. Covariates are set constant for the dual enrollment, academic momentum, and the outcome variable. GPA = grade point average.

well documented at the national level (Morrison et al., 2011), by the U.S. Department of Labor (2011), and in recent public media (Foroohar & Saporito, 2013). This is a particularly urgent question for technical colleges in Wisconsin—in 2013, 19% of the non-farm workforce was employed in the manufacturing industry, about twice the national workforce profile (Bureau of Labor Statistics, 2013; Office of Economic Advisors, 2013). Wisconsin also ranks in the top five states in terms of the share of the state's gross domestic product attributable to manufacturing (EconPost, 2011). Given this state context, we explored whether the structure of relationships among dual enrollment participation, academic momentum, and fourth-term retention and completion differs between students in manufacturing-related programs and in other programs. A comprehensive list of manufacturing programs included in the study and their aligned program types and career clusters is available upon request.

To offer some additional state context with regard to dual enrollment programs, Wisconsin's technical colleges provide three options by which high school students can earn college credit that counts toward technical college program completion: Transcripted Credit, Advanced Standing, and Youth Options (Wisconsin Department of Public Instruction, 2013; Wisconsin Technical College System Office, 2014). By completing Transcripted Credit (TC) and Advanced Standing (AS) courses, which are taught by certified high school instructors, student earn college credit on a transcript or AS status, which is activated when they enroll at a WTCS campus. Generally, TC

courses are college courses offered by instructors who receive articulation credit certification from the local technical college. AS instructors offer high school courses, which include content that is aligned with a technical college course. AS instructors meet state high school teacher certification requirements, and students must have a cumulative GPA of 3.0 or higher (on a 4-point scale) to receive AS credit. Under the Department of Public Instruction's Youth Options (YO) program, high school juniors and seniors who are in good academic standing and receive school board approval can enroll in postsecondary courses at two- and four-year public and private institutions, and receive both high school and college credit. When YO requests for non-comparable courses are approved, the school district assumes the cost of tuition, books, and materials. Both TC and AS courses are cost-free for students.

Sample and data source. For our analysis, we included 15,449 students who entered the WTCS as postsecondary students for the first time and enrolled in credential-granting programs in the 2009-2010 academic year after graduating from high school between 2007 and 2009. This dataset contained a complete transcript for each student, including all courses the student may have taken or received credit for between summer 2006 and spring 2011, along with course outcomes and a broad range of student demographics. The focus on the 2009-2010 cohort allowed us to look both forward to examine patterns of student course-taking and success in the academic terms following their initial postsecondary enrollment, and retrospectively, to explore dual enrollment history and any course-taking or remediation that occurred prior to enrollment in their postsecondary program. A unique feature of the database used in this study was an element indicating whether the student received postsecondary credit for work completed prior to high school graduation.

Measures

Below we describe how variables used in our analysis were measured. Definitions for most of the variables relied on information provided by the Wisconsin Technical College System Office (2012a, 2012b).

Dependent variable. Student success in this study was measured by a dichotomously coded variable, with 1 indicating one of the following scenarios: (a) enrolled in the technical college where students started during the fourth term of enrollment in a postsecondary program; (b) enrolled in a postsecondary program at another postsecondary institution as indicated in enrollment records provided by the National Student Clearinghouse, requested through the WTCS; or (c) completed a postsecondary credential and no longer enrolled, and 0 otherwise. Of the sample, 52.7% were retained in postsecondary education or had graduated by the fourth term.

Independent variable. The main independent variable of the study was dual enrollment, a dichotomous variable indicating whether students had earned any technical college credits prior to high school graduation or completed advanced coursework while in

high school that led to receiving credit and AS in their postsecondary program upon enrolling as a postsecondary student at a Wisconsin technical college. This variable was operationalized based on a recognized credit code in the course data to identify students with dual enrollment experiences as described previously. Note that 7.4% of the students in our sample had at least one dual enrollment credit recorded on their transcript when enrolling in the WTCS.

Mediating variables—academic momentum. We hypothesized that academic momentum mediates the effect of dual enrollment on student retention or completion, and we measured momentum using the following indicators:

a. Total attempted credits during the first year: the sum of all credits attempted by students in the first year of enrollment in a postsecondary program at a technical college.
b. Delayed entry: a binary variable indicating whether students delayed enrolling in a technical college postsecondary program after graduating from high school.
c. Summer enrollment: a binary variable measuring whether students enrolled in technical college courses in the summer term following their initial postsecondary enrollment.
d. First-term GPA: a 0.00-4.00 scale calculated by converting the letter grades students earned for courses attempted in their first term of enrollment in technical college to a numerical value, weighting these numerical values by the number of credits assigned to each course, and dividing the weighted sum by the total number of credits attempted by the student.

We should note that a temporal order existed among the independent variable (dual enrollment), the variables indicating academic momentum, and the dependent variable (fourth-term retention or completion). The independent variable stood for students' academic effort in high school. Academic momentum variables captured students' effort (as opposed to outcome) at the onset of college and realized students' academic intent in behavior during their early postsecondary career. Thus, with regard to both the nature and timing of measurement, academic momentum was distinctive from fourth-term retention or completion as later postsecondary outcomes.

Covariates. To control for potentially confounding variables that may also influence dual enrollment and student retention or completion, we included a set of demographic and academic variables as covariates in our analysis. In particular, students' remedial class enrollment history served as a proxy for prior academic preparedness and college readiness. Please refer to Table 1 for the complete list of covariates and their definitions.

Grouping variable. The grouping variable in the study was a dummy variable indicating whether students were enrolled in any of the 66 postsecondary manufacturing engineering technologist or technician education (METTE) programs leading to an

Table 1. Variable Description.

Variables	Description	Variable coding
Dependent variable		
Fourth-term retention or graduation (ReGrad)	Enrolled in WTCS or other postsecondary institutions in the fourth term or graduated before the fourth term	Yes = 1, No = 0
Independent variables		
Dual enrollment (DE)	Dichotomous indicator of concurrent enrollment in high school and postsecondary institutions or advanced coursework offered by secondary institutions that leads to AS in a postsecondary institution	Yes = 1, No = 0
Mediating variables: Academic Momentum		
Attempted credits (ATT)	Sum of credits attempted in the first year	0-36 credits, capped at the value of 36 to prevent bias resulting from extreme outliers
Delayed entry (Delayed)	Whether had gap years between high school graduation and technical college enrollment	Yes = 1, No = 0
Enrolled first summer (Summer)	Enrolled first summer following initial term of postsecondary enrollment	Yes = 1, No = 0
First-term GPA (GPA)	Numeric first-year GPA on a 4.00 scale	
Covariates		
Gender (Female)	Gender of student	Female = 1, Male = 0
Black	Black or African American background	Yes = 1, No = 0
Hispanic	Hispanic background	Yes = 1, No = 0
Asian	Asian, Asian American, or Pacific Islander	Yes = 1, No = 0
Other (Other)	Native American or multiracial background	Yes = 1, No = 0
Enrollment in METTE program (METTE)	Enrollment in METTE-related program	Yes = 1, No = 0
Economic disadvantaged (Econ)	Receiving need-based financial aid	Yes = 1, No = 0
Academically disadvantaged (Acad)	Taking any remedial class	Yes = 1, No = 0
Enrolled in general college courses (College)	Enrolled in one or more postsecondary level general college courses in reading, writing, mathematics, study skills, or natural science	Yes = 1, No = 0
Enrollment in associate of applied science degree (AAS)	Enrolled in associate degree program	Associate degree program = 1, Other types of programs = 0

Note. WTCS = Wisconsin Technical College System; GPA = grade point average; METTE = manufacturing engineering technologist or technician education; AS = advanced standing.

associate of applied science degree or a technical diploma. Of those included in the analysis, 7.1% of the students were enrolled in a METTE program. A complete list of the study's variables is presented in Table 1.

Analytical Procedures

First, using the transcript data, we constructed variables in this study based on the definitions previously presented. Missing data were scarce in that only 5.0% of the students did not report their gender or race/ethnicity. There were no missing values on other variables. Given the small amount of missing values, we employed list-wise deletion in subsequent analyses.

Second, before testing the mediating role of academic momentum, we analyzed three baseline models to explore the direct relationship between dual enrollment and fourth-term retention or completion, without accounting for academic momentum in the analyses. In the first baseline model, a logistic regression model was specified where fourth-term retention or graduation was regressed on dual enrollment. In the second logistic regression baseline model, fourth-term retention or graduation was regressed on dual enrollment and the previously described covariates. The third baseline analysis was based on a path model that, in addition to estimating the relationships in the second model, added paths from the covariates to dual enrollment. Across all three baseline models, dual enrollment was significantly and positively associated with fourth-term retention or completion, with or without controlling for the covariates, lending support to our hypothesis that dual enrollment is associated with student success as measured by fourth-term retention or completion.

Next, we developed a full path model based on our conceptual grounding to specifically address our second and third question. Although strong causal inference cannot be made given the inherent limitations of administrative and transcript data, our conceptual model closely corresponded to the academic momentum theory by charting the temporal progress across students' secondary and postsecondary education. As mentioned earlier, important demographic variables were also specified as covariates, so that the relationships among dual enrollment, academic momentum, and student retention and completion were not confounded by demographic backgrounds.

In addition, to explore whether our proposed full path model operated the same way across students enrolled in different academic programs (i.e., METTE and other programs), we conducted a multiple group path analysis using M*plus* 6.1 (Muthén & Muthén, 1998-2010). We first estimated an unconstrained model where all the paths were freed between METTE and non-METTE students. We then estimated a constrained model where all the paths were set to be equal across the two groups of students. Both models were estimated with the weighted least squares with mean and variance correction (WLSMV) estimator to account for the dichotomous nature of the outcome variable. We used DIFFTEST to compare the difference in chi-square tests between the fully constrained and unconstrained models (Muthén & Muthén, 1998-2010). The DIFFTEST result showed that the path coefficient invariance was retained between the two groups ($\chi^2 = 56.88$, $df = 64$, $p = .72$), suggesting that METTE and

non-METTE students generally followed the same academic pathway as described by our conceptual model. In this sense, the multiple group path model was no longer tenable and in the subsequent analyses, we modeled student programs (METTE vs. non-METTE) as one of the covariates, turning our model into a multiple indicators and multiple causes model (MIMIC; Kaplan, 2009). The MIMIC model was also estimated using WLSMV to accommodate the dichotomous outcome variable.

Results

Sample descriptive statistics are summarized in Table 2 and Table 3. As indicated in Table 3, the outcome variable was significantly correlated with dual enrollment and all the academic momentum variables.

The MIMIC model fit the data well (CFI = .99, TLI = .97, 90% CI of RMSEA = [.01, .02]; probability of RMSEA smaller than .05 = .99), suggesting that our proposed conceptual model was tenable. As indicated earlier through our analyses of the three baseline models without accounting for academic momentum, it was clear that among our sample, dual enrollment was positively associated with fourth-term retention or completion. With the full MIMIC model, we were able to examine the relationship between academic momentum and our outcome measure, and specify the extent to which academic momentum mediated the link between dual enrollment and the outcome. We found that all academic momentum variables were significantly associated with fourth-term retention or completion. Students who attempted more credits, were enrolled in summer terms, did not delay postsecondary entry, or had better first-term GPAs were more likely to be retained in postsecondary education or have completed a postsecondary credential by the fourth term. Among these momentum indicators, summer enrollment emerged as the strongest predictor of retention and completion; students who took summer courses were 13% more likely to be retained at the fourth term or have achieved a credential by then, compared to their counterparts without summer enrollment experience. In addition, students with 1-point higher above the mean in their first-term GPA were 7% more likely to be retained or have completed than students with average first-term GPAs. Students who enrolled in two-year college immediately after high school were 1% more likely to be retained or have graduated by the fourth term than those who delayed postsecondary entry. Finally, as the number of attempted credits increased by one credit, there was a 3% increase in the probability of student retention or completion by the fourth term.

In light of the clear association between academic momentum and the outcome variable, and that between dual enrollment and the outcome, the path model revealed a full picture depicting how academic momentum mediated the relationship between dual enrollment and the outcome. Specifically, our findings indicated that this relationship was fully mediated by academic momentum; that is, the total effect of dual enrollment participation was fully carried by the four academic momentum variables. These indirect effects, respectively, from dual enrollment through cumulative credits attempted in the first year, summer enrollment, delayed entry, and first-term GPA to fourth-term retention or completion were all statistically significant. All academic momentum indicators mediated the relationship between dual enrollment and fourth-term retention or completion. More detailed results are presented in Table 4 and in Figure 2.

Table 2. Summary of Descriptive Statistics.

	Overall		With DE history (7.4%)		Without DE history (92.6%)	
Variable	*M* (*SD*)	%	*M* (*SD*)	%	*M* (*SD*)	%
Dependent variable						
ReGrad		52.7		60.0		52.1
Academic momentum						
ATT	18.98 (9.35)		20.41 (8.85)		18.78 (9.29)	
Delayed		42.6		38.7		42.9
Summer		13.1		15.7		12.9
GPA	2.45 (1.25)		2.74 (1.12)		2.42 (1.26)	
Covariates						
Female[a]		48.1		62.7		46.9
Black		5.2		4.5		5.3
Hispanic		4.4		3.5		4.4
Asian		3.3		1.7		3.5
Other		1.2		0.7		1.3
METTE		7.1		5.6		7.2
Econ		44.1		42.9		44.2
Acad		23.2		20.6		23.5
College		8.2		7.0		8.3
AAS		76.3		76.7		76.2

Note. DE = dual enrollment; ReGrad = fourth-term retention or graduation; ATT = total attempted credits during the first year; Delayed = delayed entry; Summer = summer enrollment status; GPA = first-term GPA; Female = gender; METTE = enrolled in METTE programs; Econ = economically disadvantaged; Acad = academically disadvantaged; College = enrolled in general college courses; AAS = enrollment in associate degree program; GPA = grade point average; METTE = manufacturing engineering technologist or technician education.

[a]Note that while female students account for nearly half of the entire analytical sample (48.1%), including students enrolled in all programs at Wisconsin's technical colleges, female student participation in METTE programs is much lower (5.5%).

In addition to the findings presented above, it is worth mentioning that being enrolled in METTE programs was related to lower probabilities of retention and completion. This finding suggests that, although the observed relationships in our model operate the same way across different programs of study, compared with their counterparts in other programs, students in METTE programs differ in academic momentum indicators, which may well affect their probability of being retained or having completed by the fourth term.

Discussion

In this study, we explored the relationship between dual enrollment, academic momentum, and two-year technical college student success. Our results indicated that, without accounting for academic momentum or its mediating role, dual enrollment did

Table 3. Summary of Correlations.

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1 ReGrad	1														
2 DE	.04***	1													
3 ATT	.24***	.04***	1												
4 Delayed	−.03***	−.02**	−.16***	1											
5 Summer	.24***	.02**	.15***	−.02†	1										
6 GPA	.33***	.07***	.30***	.01	.16***	1									
7 Female	.05***	.08***	−.15***	.04***	.05***	.08***	1								
8 Black	−.04***	−.01	−.11***	.05***	−.01	−.13***	.02*	1							
9 Hispanic	−.02†	−.01	−.06***	.01	−.003	−.02*	.01	−.05***	1						
10 Asian	.001	−.03**	−.04***	.03**	−.01	−.001	.01	−.04***	−.04***	1					
11 Other	−.05***	−.01	−.03***	.004	−.01	−.04***	.003	−.03**	−.02**	−.02*	1				
12 METTE	−.05***	−.02*	.10***	−.03***	−.03**	.03**	−.24***	−.03***	−.02**	−.02†	−.02†	1			
13 Econ	.03**	−.01	.02*	.004	−.03**	−.01	.05***	.16***	.05***	.09***	.01†	−.03**	1		
14 Acad	−.05***	−.02*	−.07***	−.06***	−.04***	−.08***	.02*	.08***	.03***	.09***	.01	−.01	.16***	1	
15 College	.03***	−.01	−.03**	−.08***	.02*	−.03***	.04***	.12***	.07***	.02†	−.01	−.05***	.07***	.11***	1
16 AAS	.13***	.003	.09***	−.03**	.03**	−.07***	.02*	.004	−.01†	.01	−.003	−.19***	.05***	.02*	.08***

Note. ReGrad = fourth-term retention or graduation; DE = dual enrollment; ATT = total attempted credits during the first year; Delayed = delayed entry; Summer = summer enrollment status; GPA = first-term GPA; Female = gender; METTE = enrolled in METTE programs; Econ = economically disadvantaged; Acad = academically disadvantaged; College = enrolled in general courses; AAS = enrollment in associate degree program; GPA = grade point average; METTE = manufacturing engineering technologist or technician education.
†$p < .10$. *$p < .05$. **$p < .01$. ***$p < .001$.

Table 4. Results of the MIMIC Model.

Dependent variable	Independent variable	*B* (*SE*)	β	Probability change[a]	*T*-test
ReGrad	DE	0.03 (.02)	.02	.01	1.22
	ATT	0.01 (.002)	.10	.03	8.46***
	Delayed	−0.04 (.02)	−.03	−.01	−2.21*
	Summer	0.50 (.02)	.40	.13	20.77***
	GPA	0.27 (.01)	.26	.07	23.32***
	Female	0.01 (.03)	.003	.002	0.26
	Black	−0.09 (.06)	−.02	−.02	−1.45
	Hispanic	−0.06 (.06)	−.01	−.01	−0.85
	Asian	0.07 (.07)	.01	.02	0.95
	Other	−0.47 (.12)	−.04	−.11	−3.94***
	METTE	−0.18 (.06)	−.04	−.04	−3.35**
	Econ	0.13 (.03)	.05	.03	5.07***
	Acad	−0.08 (.03)	−.03	−.02	−2.54**
	College	0.09 (.05)	.02	.02	2.06*
	AAS	0.41 (.03)	.14	.10	12.83***
ATT	DE	0.94 (.14)	.10		6.70***
	Female	−2.76 (.16)	−.15		−16.91***
	Black	−4.59 (.39)	−.11		−11.82***
	Hispanic	−2.93 (.38)	−.06		−7.70***
	Asian	−2.12 (.45)	−.04		−4.70***
	Other	−2.56 (.72)	−.03		−3.57***
	METTE	3.21 (.28)	.09		11.33***
	Econ	1.13 (.16)	.06		7.12***
	Acad	−1.36 (.19)	−.06		−7.28***
	College	−0.07 (.32)	−.002		−0.21
	AAS	2.46 (.16)	.11		15.13***
Delayed	DE	−0.06 (.02)	−.06	−.01	−3.98**
	Female	0.11 (.02)	.05	.03	4.78***
	Black	0.34 (.05)	.07	.08	6.92***
	Hispanic	0.14 (.05)	.03	.03	2.67**
	Asian	0.22 (.06)	.04	.05	3.63***
	Other	0.05 (.10)	.01	.01	0.52
	Econ	0.01 (.02)	.004	.002	0.39
	Acad	−0.18 (.03)	−.08	−.04	−6.96***
	College	−0.38 (.04)	−.10	−.09	−9.40***
Summer	DE	0.05 (.02)	.05	.01	2.04*
	Female	0.15 (.03)	.08	.03	5.37***
	Black	−0.03 (.06)	−.01	−.01	−0.44
	Hispanic	−0.02 (.07)	−.003	−.003	−0.24
	Asian	−0.08 (.08)	−.02	−.01	−1.04
	Other	−0.14 (.13)	−.02	−.02	−1.06
	METTE	−0.06 (.06)	−.02	−.01	−1.04
	Econ	−0.08 (.03)	−.04	−.01	−2.94**
	Acad	−0.14 (.03)	−.06	−.02	−4.27***
	College	0.12 (.05)	.03	.02	2.63**
	AAS	0.10 (.03)	.04	.02	3.10**

(continued)

Table 4. (continued)

Dependent variable	Independent variable	*B* (*SE*)	β	Probability change[a]	*T*-test
GPA	DE	0.14 (.02)	.12		7.29***
	Female	0.18 (.02)	.07		8.25***
	Black	−0.70 (.04)	−.13		−16.00***
	Hispanic	−0.15 (.05)	−.02		−2.92**
	Asian	0.03 (.06)	.004		0.43
	Other	−0.44 (.08)	−.04		−5.43***
	METTE	0.15 (.04)	.03		3.47**
	Econ	0.06 (.02)	.03		2.92**
	Acad	−0.21 (.03)	−.07		−8.38***
	College	−0.03 (.04)	−.01		−0.71
	AAS	−0.18 (.02)	−.06		−7.54***
DE	Female	0.32 (.03)	.16	.05	9.86***
	Black	−0.09 (.08)	−.02	−.01	−1.16
	Hispanic	−0.12 (.08)	−.02	−.02	−1.49
	Asian	−0.34 (.11)	−.06	−.04	−3.18**
	Other	−0.28 (.17)	−.03	−.04	−1.67†
	Econ	−0.01 (.03)	−.01	−.002	−0.39
	Acad	−0.07 (.04)	−.03	−.01	−1.74†
Intercept	GPA	2.55 (.03)			
	ATT	18.39 (.17)			
Total, direct, and indirect effect of DE on ReGrad	Total effect	0.11 (.03)	.09		4.34***
	Direct	0.03 (.02)	.03		1.22
	Total indirect	0.08 (.02)	.06		5.24***
Specific indirect effect	DE→ATT→ReGrad	0.01 (.002)	.01		5.33***
	DE→Delayed→ReGrad	0.002 (.001)	.002		1.77†
	DE→Summer→ReGrad	0.03 (.01)	.02		2.03*
	DE→GPA→ReGrad	0.04 (.01)	.03		6.99***
Correlation between Academic Momentum	ATT with Delayed	−0.18***			
	ATT with Summer	0.25***			
	ATT with GPA	0.30***			
	Summer with GPA	0.29***			

Note. N = 14,673. Model fit indices: χ^2 = 27.73 (df = 7, p < .05). CFI = .99. TLI = .97. 90% CI of RMSEA = [.01, .02]; Probability of RMSEA smaller than .05 = .99. MIMIC = model into a multiple indicators and multiple causes model; ReGrad = fourth-term retention or graduation; DE = dual enrollment; ATT = total attempted credits during the first year; Delayed = delayed entry; Summer = summer enrollment status; GPA = first-term GPA; Female = gender; METTE = enrolled in METTE programs; Econ = economically disadvantaged; Acad = academically disadvantaged; College = enrolled in general courses; AAS = enrollment in associate degree program; GPA = grade point average; METTE = manufacturing engineering technologist or technician education; CI = confidence interval; RMSEA = root mean square error approximation.

[a]The probability change for dichotomous dependent variables is the difference in probability between the two groups, whereas for continuous dependent variables, it is the difference in the probability between the mean and one point above the mean. ATT and GPA are continuous variables, so calculation of probability change is not applicable. When controlling for other variables, controlled variables are set at the mean (continuous control) or the mode (dichotomous control).

†p < .10. *p < .05. **p < .01. ***p < .001.

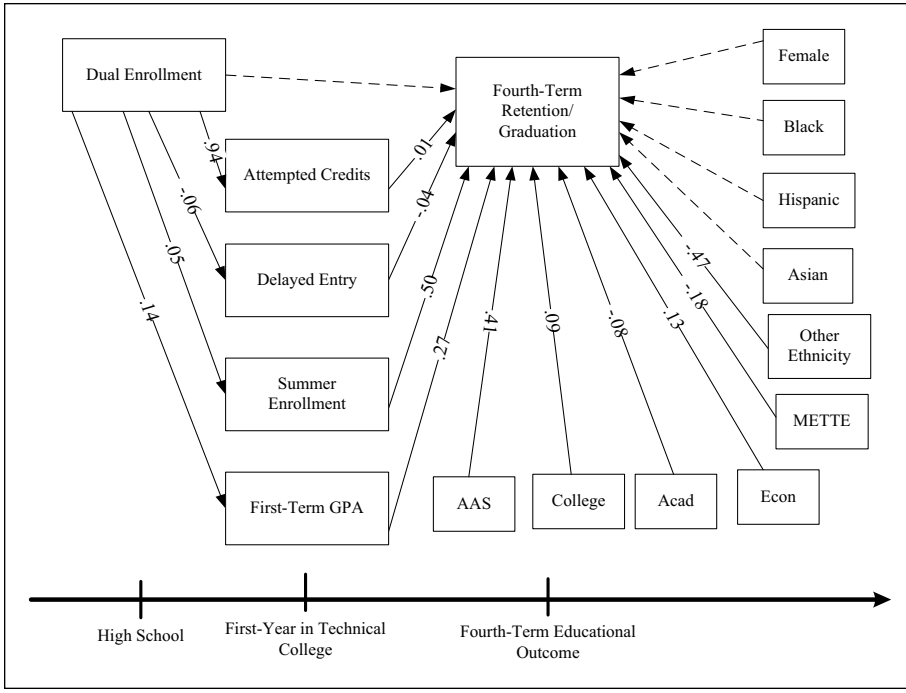

Figure 2. Selected results of MIMIC model.

Note. Path coefficients are unstandardized. Solid lines represent statistically significant paths while dotted lines stand for hypothesized but non-significant paths. To conserve space, correlations among academic momentum variables and covariates of dual enrollment and academic momentum are omitted. Please refer to Table 3 for the correlation coefficients. MIMIC = multiple indicators and multiple causes model; METTE = manufacturing engineering technologist or technician education; GPA = grade point average; AAS = enrollment in associate degree program.

have a positive, direct association with technical college students' fourth-term retention or completion. This finding aligns with empirical evidence showing positive outcomes of dual enrollment programs students entering four-year institutions (e.g., Harnish & Lynch, 2005; Karp et al., 2008; Puyear et al., 2001), and adds to the limited body of dual enrollment literature focusing on community and technical college students (Speroni, 2011). By and large, compared with their four-year counterparts, these students are more likely to come from more disadvantaged socio-economic backgrounds that afford them limited social and cultural capital to navigate college (O'Connor, 2009; Walpole, 2003). By helping these students gain exposure to college-level work, dual enrollment options may serve as a source of college readiness that helps students better prepare for college.

As for our second question regarding the relationship between academic momentum and student outcomes, our findings indicated that all momentum measures were significant predictors of fourth-term retention or completion. For example, the number of credit hours students attempted during the first year is positively related to retention

and completion, a result echoing previous research that examined similar relationships (Adelman, 2006; Attewell et al., 2012). Clearly, early attempted credits set students up in a positive motion toward stronger chances of retention and degree completion. A similar pattern was observed with regard to the positive link among summer enrollment, retention, and completion. Although according to Attewell et al. (2012), the effects of enrolling in summer sessions were more pronounced among students' academic momentum in four-year rather than two-year colleges, our results indicate that summer enrollment exhibited a positive relationship with technical college student retention and completion. The same positive association between summer enrollment and degree completion for two-year college students has also been found elsewhere (e.g., Richburg-Hayes, Sommo, & Welbeck, 2011). It should also be noted that two-year college students take summer credits at a lower rate than four-year college students (Attewell et al., 2012), which may be due to the limited course offerings provided by institutions, multiple responsibilities students have to juggle, or lack of financial aid (e.g., summer Pell Grant; Katsinas, 2012).

With the positive link of dual enrollment and academic momentum to student retention or completion established, it is possible to examine whether and how academic momentum mediates this relationship. Several intriguing findings from this investigation are worthy of note. First of all, dual enrollment seems to promote uninterrupted high school-to-postsecondary pathways by reducing the likelihood of delayed college entry. Also, first-term GPA and attempted credits during the first year both positively mediated the relationship between dual enrollment and student retention or completion. That is, dual enrollment students tended to report better GPAs during the first semester of college and attempt more credit hours during the first year, which in turn was associated with their longer-term outcomes. Finally, the positive relationship between dual enrollment and retention or completion was in part carried by summer enrollment, which in turn was positively connected to the same educational outcomes.

Taken together, these results suggest that the positive association between dual enrollment and student retention or completion is exerted by reducing the risk of delayed entry, boosting student achievement during the initial phase of college, and encouraging students to attempt a higher course load and enroll in the summer. Furthermore, the fact that the relationship between dual enrollment and student success was attenuated by academic momentum underscores the mechanism underlying how dual enrollment's positive relationship to student success is exercised—plausibly by prompting students to engage in persistent early college enrollment behavior.

Moreover, the fact that the direct relationship between dual enrollment and fourth-term retention or graduation was attenuated by the academic momentum indicators suggests that this observed link can be fully accounted for by academic momentum. This finding illuminates the salience of academic momentum building at earlier stages of postsecondary education. In particular, two-year colleges are well positioned to help develop momentum among students in STEM fields of study, as revealed by recent research (Wang, 2014). Our result further implies that having dual enrollment experiences motivates students to attempt more credits, enter postsecondary education without delay, enroll in summer sessions, and achieve a better first-year GPA, which

is ultimately related to later academic success. Metaphorically, dual enrollment ignites the "fire" of a student's interest in and pursuit of postsecondary education, while early academic momentum represents the "fuel" that sustains the forward motion to carry students to subsequent educational milestones.

Limitations of the Study

Our study should be interpreted with several limitations in mind. First, although we worked with a robust statewide administrative dataset, some variables of potential pertinence to our study were not available. For example, in the dataset, there are not a sufficient number of sound covariates at the secondary level, particularly motivational attributes and academic experiences and performance, which could help address the potential selection bias of students participating in dual enrollment programs. While we did control for enrollment in remedial courses as a proxy for prior academic performance, this measure is not ideal. As such, what we focused on in our study were relationships among dual enrollment, academic momentum, and student retention or completion, not the causal impacts of dual enrollment or academic momentum.

Also, as a foundational piece to our future inquiries, we took a global perspective when looking at the overall path from dual enrollment to academic momentum and student outcomes. To feasibly accomplish this, we resorted to aggregated measures of dual enrollment and momentum. To be sure, we did not focus on the specific types and subject matter of dual enrolled courses (e.g., transcripted credit, advanced standing, etc.) or examine the attempted credit hours within individual programs or courses. We made these choices purposefully in the sense that, without first exploring these overall patterns of relationships among dual enrollment, academic momentum, and educational outcomes of technical college students, the directions in which to focus more nuanced analyses would remain unclear and would not be guided by empirical evidence. In addition, given the unique state context for the two-year technical college system and how dual enrollment offerings are structured in Wisconsin as we described earlier, our findings may not be generalizable to other states with different organizational structures for two-year colleges, career and technical education, and dual enrollment experiences.

Implications for Future Research

Given our findings, we suggest that future research in this domain focus on the following topics: First, it is important for future research to track the early success and academic momentum of later entering (post 2009-2010) cohorts. The rate of dual enrollment participation is likely attributed to a number of contextual factors, including the rising college tuition costs in recent years. As a larger proportion of high school graduates enter two-year colleges with dual enrollment credit, examining the influence of those pre-college learning experiences on their academic momentum and postsecondary success will help address significant public policy priorities for expanding postsecondary access, allocating financial aid, and investing state and private funds in human capital development.

In light of the consistently positive effects of academic momentum uncovered by our study, the necessary next step is to study potential strategies that could build momentum among students. As a starting point, more nuanced curriculum data could help further explain the influence of early academic momentum on academic outcomes (Bahr, 2013). More specifically, transcript and curriculum data could be analyzed to examine whether early commitment to a major (Jenkins & Cho, 2011), timing of gatekeeper course completion, and completion of college success courses help boost momentum. In addition, the optimal first semester or first-year pairing of general education and technical courses is worth studying as an alternative measure of academic momentum.

Implications for Policy and Practice

Our study points to several implications for policy and practice, especially for improving two-year community and technical college student outcomes. First of all, the benefits of dual enrollment participation are central to technical and vocational education. Exposure to CTE is increasingly limited in regular high school curriculum due to a growing push for college readiness with limited resources (Stone & Lewis, 2012). These articulated programs of study, which span high school courses and early two- or four-year college courses, expose students to different career choices and prepare them academically for programs or majors in both two- and four-year postsecondary institutions. The positive linkage between dual enrollment and academic momentum which in turn seems to boost college completion and persistence, as uncovered by this study, highlights the need for continued efforts to strengthen dual enrollment partnerships between two-year colleges and high schools.

More specifically, in developing these offerings, the focus should be on a strong alignment between dual enrollment courses and other components of the curriculum at the level of both high school and two-year colleges. Using manufacturing, engineering, and other STEM fields as an example, dual enrollment options in these areas must be anchored in strong STEM curricula at the high school and associate degree level, which should be tightly linked with other competencies required in STEM-related educational and occupational outcomes. Such a strong alignment will help students taking dual enrollment options experience a smooth transition to postsecondary education that not only promotes their earlier academic efforts but also accelerates their educational progress.

The largely positive relation of dual enrollment to early academic momentum and ultimately to educational success, as shown in our study, highlights the importance of building early academic momentum among two-year college students. Clearly, stronger momentum is associated with longer-term positive outcomes of these students, but it is important to keep in mind that these are also the type of students who tend to deal with complex social and educational challenges from high school through postsecondary education, and the lack of academic momentum is likely compounded with disadvantaged socio-demographic backgrounds (Attewell et al., 2012). In this study, the positive relationship between academic momentum and long-term college success

remained significant even after controlling for a number of highly relevant demographic background variables, such as financial aid receipt and taking remedial courses. Therefore, policymakers and practitioners need to design momentum-promoting policies, programs, practices, and services that specifically target the needs of the most disadvantaged students. For example, while academic advising should place an intentional focus on helping build early momentum among students, financial aid policy and practices should be used as a promising strategy to promote the academic momentum and continued participation of two-year college students and account for the often complicated life situations and competing priorities facing students who are most sensitive to affordability.

Our research also has implications for the use of statewide administrative data. At the state level, policy initiatives are needed to expand the content and use of K-16 student record data systems. More specifically, data system structures and elements should include measures aligned with robust theories for informing the personal, instructional, and contextual factors influencing student success in two- and four-year colleges and the workplace. In the longer term, having such data systems in place would allow us to track students' career outcomes longitudinally and explore whether dual enrollment and other interventions are associated with labor market outcomes. One of the central missions of two-year technical colleges is to educate skilled workers so that students are able to land careers where they can apply their skills and earn a viable income. Whether technical colleges meet this goal could be investigated if employment and earnings data are seamlessly integrated with other types of data noted above. Future research can then explore the long-lasting relationship between educational experiences, such as dual enrollment and academic momentum, and longitudinal success measures of employment, job retention, and earnings.

Conclusion

Taking dual enrollment and academic momentum as a continuum showing academic progression among Wisconsin technical college students, this study illuminates the cumulative power of academic efforts from high school to postsecondary education in shaping two-year college students' longer-term retention and completion. The most noteworthy finding of this study is that the positive link between dual enrollment and student outcomes, confirmed by prior literature, is fully mediated by academic momentum. In essence, our results suggest that, once students are in college, the potential benefits associated with their dual enrollment participation seem to indeed translate into early academic momentum to sustain them on their postsecondary trajectory. Therefore, dual enrollment's critical role in charting a seamless, uninterrupted pathway from high school to postsecondary education is mostly exhibited through academic momentum.

Acknowledgments

The authors thank the Wisconsin Technical College System Office for help with the data. Jaime Lester and Amy Prevost provided insightful feedback on earlier drafts of the paper.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: The National Science Foundation (Award 1104226) provided funding for this study, conducted in partnership with the Wisconsin Technical College System, the Wisconsin Department of Public Instruction, and the Wisconsin Department of Workforce Development. Any opinions, findings, and conclusions or recommendations expressed herein are those of the authors and do not necessarily reflect the views of the National Science Foundation.

Note

1. "Dual enrollment" and "dual credit" are sometimes used interchangeably in academic articles. Based on Andrews's (2004) definition, "dual enrollment" describes the process of concurrent enrollment in high school and programs offering college credits, whereas "dual credit" refers to the awarded credits as the outcome of successful completion of dual enrollment programs. In this article, we use "dual enrollment" because, like academic momentum, it potentially represents the process that helps students achieve desirable educational outcomes. In the analyses, the outcome of such academic endeavor and progress is captured by the awarded dual credits or advanced standing.

References

Adelman, C. (1999). *Answers in the toolbox: Academic intensity, attendance patterns, and bachelor's degree attainment*. Retrieved from http://www2.ed.gov/pubs/Toolbox/toolbox.html

Adelman, C. (2006). *The toolbox revisited: Paths to degree completion from high school through college*. Retrieved from http://www2.ed.gov/rschstat/research/pubs/toolboxrevisit/toolbox.pdf

Alfonso, M. (2006). The impact of community college attendance on baccalaureate attainment. *Research in Higher Education*, *47*, 873-903. doi:10.1007/s11162-006-9019-2

Allen, D., & Dadgar, M. (2012). Does dual enrollment increase students' success in college? Evidence from a quasi-experimental analysis of dual enrollment in New York City. *New Directions for Higher Education*, *2012*(158), 11-19. doi:10.1002/he.20010

An, B. P. (2013a). The impact of dual enrollment on college degree attainment: Do low-SES students benefit? *Educational Evaluation and Policy Analysis*, *35*, 57-75. doi:10.3102/0162373712461933

An, B. P. (2013b). The influence of dual enrollment on academic performance and college readiness: Differences by socioeconomic status. *Research in Higher Education*, *54*, 407-432. doi:10.1007/s11162-012-9278-z

Andrews, H. A. (2004). Dual credit research outcomes for students. *Community College Journal of Research and Practice*, *28*, 415-422. doi:10.1080/1066892049044445

Attewell, P., Heil, S., & Reisel, L. (2012). What is academic momentum? And does it matter? *Educational Evaluation and Policy Analysis*, *34*, 27-44. doi:10.3102/0162373711421958

Bahr, P. R. (2013). The deconstructive approach to understanding community college students' pathways and outcomes. *Community College Review*, *41*, 137-153. doi:10.1177/0091552113486341

Bailey, T., & Karp, M. M. (2005). Expanding the reach of dual-enrollment programs. *Community College Journal*, *75*(3), 8-11.

Bailey, T., & Averianova, I. E. (1998). *Multiple missions of community colleges: Conflicting or complementary?* New York, NY: Community College Research Center, Teachers College, Columbia University. Retrieved from http://ccrc.tc.columbia.edu/media/k2/attachments/multiple-missions-conflicting-complementary.pdf

Bragg, D. D., Kim, E., & Barnett, E. A. (2006). Creating access and success: Academic pathways reaching underserved students. *New Directions for Community Colleges*, *2006*(135), 39-47. doi:10.1002/cc.243

Bryant, A. N. (2001). Community college students: Recent findings and trends. *Community College Review*, *29*, 77-93. doi:10.1177/009155210102900305

Bureau of Labor Statistics. (2013). *Table B-1. Employees on nonfarm payrolls by industry sector and selected industry detail*. Washington, DC: U.S. Department of Labor. Retrieved from http://www.bls.gov/news.release/empsit.t17.htm

Cohen, A. M., & Brawer, F. B. (2008). *The American community college* (5th ed.). San Francisco, CA: Jossey-Bass.

Cohen, A. M., Brawer, F. B., & Kisker, C. B. (2014). *The American community college* (6th ed.). San Francisco, CA: Jossey-Bass.

D'Amico, M. M., Morgan, G. B., Robertson, S., & Rivers, H. E. (2013). Dual enrollment variables and college student persistence. *Community College Journal of Research and Practice*, *37*, 769-779. doi:10.1080/10668921003723334

Doyle, W. R. (2009). Impact of increased academic intensity on transfer rates: An application of matching estimators to student-unit record data. *Research in Higher Education*, *50*, 52-72. doi:10.1007/s11162-008-9107-6

EconPost. (2011). *Wisconsin GDP size and rank*. Retrieved from http://econpost.com/wisconsineconomy/wisconsin-gdp-size-rank

Eimers, M. T., & Mullen, R. (2003, May). *Dual credit and advanced placement: Do they help prepare students for success in college?* Paper presented at the 43rd Annual Association of Institutional Research Conference, Tampa, FL.

Foroohar, R., & Saporito, B. (2013, April 22). Made in the USA. *Time*, *181*(15), 22-29.

Freeman, S. (2009). *The relationship between academic momentum and undergraduate degree completion at one historically black institution* (Doctoral dissertation). Mississippi Valley State University, Itta Bena.

Hagedorn, L. S., & DuBray, D. (2010). Math and science success and nonsuccess: Journeys within the community college. *Journal of Women and Minorities in Science and Engineering*, *16*, 31-50. doi:10.1615/JWomenMinorScienEng.v16.i1.30

Harnish, D., & Lynch, R. L. (2005). Secondary to postsecondary technical education transitions: An exploratory study of dual enrollment in Georgia. *Career and Technical Education Research*, *30*, 169-188. doi:10.5328/CTER30.3.169

Howell, J. S. (2011). What influences students' need for remediation in college? Evidence from California. *The Journal of Higher Education*, *82*, 292-318. doi:10.1353/jhe.2011.0014

Hunt, E., & Carroll, C. E. (2006). Florida's dual enrollment initiative: How state policy influences community colleges' service to underrepresented youth. *New Directions for Community Colleges*, *2006*(135), 39-47. doi:10.1002/cc.246

Jenkins, D., & Cho, S. W. (2011). *Get with the program: Accelerating community college students' entry into and completion of programs of study*. New York, NY: Community College Research Center, Teachers College, Columbia University. Retrieved from http://ccrc.tc.columbia.edu/media/k2/attachments/accelerating-student-entry-completion.pdf

Kaplan, D. (2009). *Structural equation modeling: Foundations and extensions* (2nd ed.). Thousand Oaks, CA: Sage.

Karp, M. M., Calcagno, J. C., Hughes, K. L., Jeong, D. W., & Bailey, T. (2008). *Dual enrollment students in Florida and New York City: Postsecondary outcomes*. New York, NY: Community College Research Center, Teachers College, Columbia University. Retrieved from http://files.eric.ed.gov/fulltext/ED500537.pdf

Katsinas, S. (2012). Public education/private funding: The growing impact of the new Pell Grant funding. *Journal of Collective Bargaining in the Academy*, *0*(6), 1-40. Retrieved from http://thekeep.eiu.edu/cgi/viewcontent.cgi?article=1239&;context=jcba

Kim, J., & Bragg, D. D. (2008). The impact of dual and articulated credit on college readiness and retention in four community colleges. *Career and Technical Education Research*, *33*, 133-158. doi:10.5328/CTER33.2.133

Kim, J., Kirby, C., & Bragg, D. D. (2006, May). *Dual credit: Then and now* (OCCRL in Brief). Champaign, IL: Office of Community College Research and Leadership, University of Illinois. Retrieved from http://occrl.illinois.edu/files/InBrief/Brief-spring-06.pdf

Kleiner, B., & Lewis, L. (2005). *Dual enrollment of high school students at postsecondary institutions, 2002-03* (NCES-2005-008). Washington, DC: National Center for Education Statistics. Retrieved from http://nces.ed.gov/pubs2005/2005008.pdf

Lee, J. M., Edwards, K., Menson, R., & Rawls, A. (2011). *The college completion agenda 2011 progress report*. New York, NY: College Board Advocacy and Policy Center. Retrieved from http://knowledgecenter.completionbydesign.org/sites/default/files/303%20Lee%20College%20Board%202011%20FULL.pdf

Leech, R. (2014). Rethinking high school pathways. *Educational Leadership*, *72*(1), 68-70.

Leigh, D. E., & Gill, A. M. (2003). Do community colleges really divert students from earning bachelor's degrees? *Economics of Education Review*, *22*, 23-30. doi:10.1016/S0272-7757(01)00057-7

Lumina Foundation. (2013). *Strategic plan 2013-2016*. Indianapolis, IN: Author. Retrieved from http://www.luminafoundation.org/files/file/2013-lumina-strategic-plan.pdf

Marshall, R. P., & Andrews, H. A. (2002). Dual-credit outcomes: A second visit. *Community College Journal of Research and Practice*, *26*, 237-242. doi:10.1080/106689202317245437

Medvide, M. B., & Blustein, D. L. (2010). Exploring the educational and career plans of urban minority students in a dual enrollment program. *Journal of Career Development*, *37*, 541-558. doi:10.1177/0894845309350920

Morrison, T., DeRocco, E., Maciejewski, B., McNelly, J., Giffi, C., & Carrick, G. (2011). *Boiling point? The skills gap in U.S. manufacturing*. Retrieved from http://www.themanufacturinginstitute.org/~/media/A07730B2A798437D98501E798C2E13AA.ashx

Muthén, L. K., & Muthén, B. O. (1998-2010). *Mplus user's guide*. Los Angeles, CA: Author.

National Center for Education Statistics. (2012). *The condition of education 2012* (NCES 2012-045). Washington, DC: Author. Retrieved from http://nces.ed.gov/pubs2012/2012045.pdf

Office of Economic Advisors. (2013). *Annual average employment, 2012, current employment statistics*. Madison, WI: Wisconsin Department of Workforce Development.

O'Connor, N. (2009). Hispanic origin, socio-economic status, and community college enrollment. *Journal of Higher Education*, *80*, 121-145. doi:10.1353/jhe.0.0038

Peters, S. J., & Mann, R. L. (2009). Getting ahead: Current secondary and postsecondary acceleration options for high-ability students in Indiana. *Journal of Advanced Academics*, *20*, 630-657. doi:10.1177/1932202X0902000404

Puyear, D., Thor, L., & Mills, K. (2001). Concurrent enrollment in Arizona: Encouraging success in high school. *New Directions for Community Colleges*, *2001*(113), 33-42. doi:10.1002/cc.6

Richburg-Hayes, L., Sommo, C., & Welbeck, R. (2011). *Promoting full-time attendance among adults in community college: Early impacts from the performance-based scholarship demonstration in New York*. New York, NY: MDRC. Retrieved from http://www.mdrc.org/sites/default/files/full_480.pdf

Rosenbaum, J. E., Stephan, J. L., & Rosenbaum, J. E. (2010). Beyond one-size-fits-all college dreams: Alternative pathways to desirable careers. *American Educator*, *34*(3), 2-13.

Rouse, C. E. (1995). Democratization or diversion? The effect of community colleges on educational attainment. *Journal of Business & Economic Statistics*, *13*, 217-224. doi:10.1080/07350015.1995.10524596

Schneider, M., & Yin, L. M. (2012). *Completion matters: The high costs of low community college graduation rates* (Education Outlook No. 2). Washington, DC: American Enterprise Institute for Public Policy Research. Retrieved from http://199.87.225.222/ournextbigidea/documents/5_Completion_Matters.pdf

Smith, D. (2007). Why expand dual-credit programs? *Community College Journal of Research and Practice*, *31*, 371-387. doi:10.1080/10668920600932884

Speroni, C. (2011). *Determinants of students' success: The role of advanced placement and dual enrollment programs* (NCPR Working Paper). New York, NY: National Center for Postsecondary Research, Teachers College, Columbia University. Retrieved from http://ccrc.tc.columbia.edu/media/k2/attachments/role-advanced-placement-dual-enrollment.pdf

Stone, J. R., & Lewis, M. V. (2012). *College and career ready in the 21st century: Making high school matter*. New York, NY: Teachers College Press.

Thomas, N., Marken, S., Gray, L., & Lewis, L. (2013). *Dual credit and exam-based courses in U.S. public high schools: 2010-11*. Washington, DC: National Center for Education Statistics. Retrieved from http://nces.ed.gov/pubs2013/2013001.pdf

Townsend, B. K., & Wilson, K. B. (2006). The transfer mission: Tried and true, but troubled? *New Directions for Community Colleges*, *2006*(136), 33-41. doi:10.1002/cc.257

U.S. Department of Labor. (2011). *Advanced manufacturing industry: Addressing the workforce challenges of America's advanced manufacturing workforce*. Washington, DC: Author. Retrieved from http://www.doleta.gov/brg/pdf/Advanced%20Manufacturing%20Report%2011.1.05.pdf

Walpole, M. (2003). Socioeconomic status and college: How SES affects college experiences and outcomes. *Review of Higher Education*, *27*, 45-73. doi:10.1353/rhe.2003.0044

Wang, X. (2014). Pathway to a baccalaureate in STEM fields: Are community colleges a viable route and does early STEM momentum matter? *Educational Evaluation and Policy Analysis*. Advance online publication. doi:10.3102/0162373714552561

White House Press Office. (2009, February 24). *Remarks of President Barack Obama-As prepared for delivery address to joint session of Congress*. Retrieved from http://www.whitehouse.gov/the_press_office/Remarks-of-President-Barack-Obama-Address-to-Joint-Session-of-Congress

Wisconsin Department of Public Instruction. (2013, May). *Youth options program: Information for students and parents*. Madison, WI: Author. Retrieved from http://youthoptions.dpi.wi.gov/files/youthoptions/pdf/yo_brochure.pdf

Wisconsin Technical College System Office. (2012a). *Client reporting system manual* (Fiscal Year 2011-12). Madison, WI: Author.

Wisconsin Technical College System Office. (2012b). *Education services manual*. Madison, WI: Author.

Wisconsin Technical College System Office. (2014). *Dual credit articulation*. Retrieved from http://www.wistechcolleges.org/preparing-college/college-credit-high-school/dual-credit/dual-credit-articulation

Zamani-Gallaher, E. M., Lester, J., Bragg, D. D., & Hagedorn, L. (Eds.). (2014). *ASHE reader on community colleges* (4th ed.). Boston, MA: Pearson Learning.

Author Biographies

Xueli Wang is an assistant professor of higher education in the Department of Educational Leadership and Policy Analysis at the University of Wisconsin–Madison. Her research centers on postsecondary pathways and success of students beginning at community colleges, as well as undergraduate STEM education.

Hsun-yu Chan is a PhD candidate of human development in the Department of Educational Psychology at the University of Wisconsin-Madison. His research interest focuses on student development and learning at community colleges.

L. Allen Phelps is a senior scientist at the Wisconsin Center for Education Research. His research has focused on improving policy and leadership in career and technical education, secondary special education, and other education initiatives seeking to integrate high schools, colleges, and the economy.

Janet I. Washbon is a senior researcher at the Wisconsin Center for Education Research. Her work centers on state labor force training needs, the school to careers transition, state and regional economic development issues, and improving collegiate transfer for technical college students.