

Analyzing Evidence of College Readiness: A Tri-Level Empirical & Conceptual Framework

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ABSTRACT

Research draws a distinction between college eligibility and college readiness. For example, a student may graduate high school with sufficient credits to enroll in a postsecondary institution, but still lack the academic skills, study habits, and college knowledge to succeed. Previous reviews of research on college readiness systems highlight individual-level indicators of whether a student is on track to be ready for college. However, focusing on individual students omits a crucial research finding: the signals and supports that affect students' college readiness, such as course availability, college going culture, and academic resources, operate at setting and system levels. Indicators at these two levels, which include schools, districts, and states, provide the information educators need to inform responses to readiness indicators at the individual level. In this literature review, we synthesize findings on college readiness into a tri-level indicator system, which offers a proactive strategy to support students rather than just a reactive model to predict risk of dropout.

Introduction

Across the United States, students increasingly leave high school unready for college (Choy, Horn, Nuñez, & Chen, 2000; Jackson, 2009). Some studies estimate that only ten percent of eighth graders are on target to graduate from high school without need for remedial work in college (Wimberly & Noeth, 2005). Public universities invest one billion dollars annually to remediate roughly a third of their freshmen (Bettinger & Long, 2009). Beyond remediation, many students are not ready for college in less academic ways. Some lack either the attitudes or skills essential to succeed in a post-secondary setting. Others lack knowledge of how to apply to, finance, and navigate college. Given these factors, promising students often fail to see college as an option, complete the paperwork necessary to apply for and finance a postsecondary education, or take courses that would prepare them for college. Even for those students who enroll in college, many struggle academically and personally in a post-secondary setting and eventually drop out (Conley, 2007b; King, 2004; Roderick, 2006; Wimberly & Noeth, 2005). These findings highlight a fundamental distinction: college readiness means more than college eligibility. For example, a student may graduate high school with the credits to enroll in a postsecondary institution, but still lack the academic skills, study habits, and understanding of college to succeed. Yet, while common indicators exist to identify students at-risk of dropping out of high school,¹ studies documents few valid and reliable indicators of college readiness.

At the societal level, producing college-ready students carries significant social and economic consequences in the United States. For example, a recent Brookings Institution report used quasi-experimental techniques to show that state investment in higher education caused economic growth (Aghion, Boustan, Hoxby, and Vandenbussche, 2009). Research also demonstrates that increasing the percentage of Americans completing a postsecondary education

will prove important to bolstering and sustaining the middle class, largely because the percentage of jobs requiring a college degree (at minimum) will rise sharply over the next decade, increasing to 60 percent in some states (Carnevale, Smith, and Strole, 2010). Further, these thresholds for jobs requiring a postsecondary education will likely spike due to the nature of jobs created after the current recession and the increasing importance of technology in the American economy (Carnevale, Smith, and Strole, 2010). Most troubling (and germane to our literature review), the country is not on pace to meet the demand for college graduates. According to the Bureau of Labor Statistics (2008), only 42 percent of Americans in the workforce at the time of their study possessed a college degree, and that number was not forecast to climb near 60 percent in the following decade. Failing to focus on college readiness carries major implications for the U.S. economy over the long-term.

Our theoretical framework for approaching college readiness, which we define broadly as the knowledge and skills students need to enroll and succeed in college, represents a departure from previous frameworks in three important ways. First, most research on predicting student outcomes tends to focus on building early warning systems. These systems rely on statistical models that incorporate data readily available to districts via administrative datasets, such as test scores and enrollment patterns, to signal whether a student is on track to graduate from high school. In its focus on grades and credits, the literature on early warning systems fails to include important indicators of a student's college readiness: (1) the rigor of the courses he or she takes, (2) motivation to succeed in school and go on to postsecondary education, and (3) knowledge of how to enroll in, finance, and complete college. Given these factors do not figure into typical early warning systems, the predictive power and validity of these systems could be seriously undermined by omitting non-academic factors that can prove as, if not more, important than

standard measures of academic readiness or college eligibility. To address this shortcoming, we consider indicators of college readiness that include not only academic preparedness, but also academic tenacity (Dweck, Walton, & Cohen, 2011), and college knowledge (Conley, 2008). Implicit in this approach is a shift from focusing on simply completing high school to graduating ready for college academically, attitudinally, and in terms of basic knowledge about how postsecondary education works.

Academic tenacity and college knowledge represent two emerging fields of research that provide the best evidence for how to expand the perspective taken in a well-established literature on academic-preparedness indicators to develop a college-readiness framework. For example, research on academic preparedness documents that grade-point average is one of the strongest predictors of college enrollment and completion, yet few studies examine questions of why grades forecast outcomes with some accuracy. One potential explanation is that, unlike test scores, grades capture students' motivation, a possibility we explore by looking at academic tenacity. Further, many students who meet college entry requirements, including those related to grades, still do not enroll, a fact that could be due to a lack of knowledge about college options, as well as related procedures like applying and securing financial aid (i.e., college knowledge). On one hand, considering what factors drive the predictive power of grades may not necessarily improve the accuracy with which college-readiness outcomes can be forecasted. On the other, educators cannot intervene to support students and improve college readiness if they fail to understand the mechanisms underlying the indicators used. In short, we focus on academic preparedness, academic tenacity, and college knowledge because the latter two address omissions in existing indicator literature, holes that constrain educators' ability to provide

meaningful supports and interventions related to college readiness (AIR, 2009; Byrd & Macdonald, 2005; Cabrera & La Nasa, 2001; Rose & Betz, 2001).

Second and related, unlike much early-warning-system literature, we concern ourselves less with improving the accuracy with which models predict college readiness and more with exploring research on indicators that can be tied to meaningful supports and interventions for students. Much research shows that an accurate indicator is not the same as an actionable indicator. For instance, research finds that enrollment in Advance Placement (AP) courses predicts college enrollment. Yet, in reaction to this research, many districts dramatically increased AP course taking, which watered down the content of the courses and reduced their accuracy as forecasters of college readiness (Conley, 2007a). By contrast, we emphasize indicators that suggest viable supports and interventions. In the realm of college knowledge, for example, students who did not understand the college financial aid process benefited from help filling out the Federal Application for Federal Student Aid (Bettinger, Long, Oreopoulos, & Sanbonmatsu, 2009). The purpose of a college readiness indicator system (as opposed to an early warning system) should not only be to identify students off track for college readiness, but also to disrupt the cycles of negative outcomes it predicts.

Third and perhaps most importantly, while many studies on indicators of college readiness focus entirely on the student as an individual, ours recognizes the role of context in developing college readiness. That is, research shows that students' college eligibility is not always enough for college success: qualified students can find themselves in an educational context that does not foster the skills, attitudes, and aspirations that underpin college readiness and consequently become less likely to attend, and succeed in, a postsecondary institution. To acknowledge the role of context in college readiness, we synthesize current research into a tri-

level indicator system. Within our categories of academic preparedness, academic tenacity, and college knowledge, we discuss indicators and related supports at the individual, setting, and system levels. Indicators at the individual level include students' progress towards college readiness (e.g., courses and credits, study skills, persistence, expectations for the future, and knowledge about college requirements). Setting-level indicators highlight actionable measures around the resources and opportunities for students provided by a program, classroom, or school (e.g., instructional coherence and rigor, presence of a college-focused culture) as well as supports for teachers (e.g. professional development focused on college knowledge, assistance with data use). System-level indicators include the policy and funding infrastructure that impacts school resources, student programs, and college-readiness supports (e.g., district-level professional development around college readiness and resources to support data use). Ultimately, our tri-level framework should make apparent that a student with the skills and desire to attend college will only do so if the benchmarks along the way to college admission are made attainable within a given setting and system context. For example, students may wish to take the courses their state requires for enrollment in a public university, but cannot do so if their high school provides limited access to them. Consequently, schools and districts must monitor their own effectiveness in supporting college readiness.

Broadly, our theoretical framework departs from early-warning-system frames in its expansiveness. We consider much more than academic preparedness, and much more than individual-level indicators. While our approach does not exclude much relevant research, our particular framework constitutes a unique viewpoint and carries implications for the literature our review includes. In particular, our framework yields a few broad consequences for the structure of our review. For one, we do not rehash all of the considerable research on academic

preparedness indicators—those included in traditional administrative datasets and, therefore, early warning systems—in great detail. Rather, we provide an overview of the most important findings from the most methodologically rigorous studies, but then devote more time to the limitations of these studies, which in turn fuel our discussion of academic tenacity and college knowledge. For another, the literature on academic preparedness, academic tenacity, and college knowledge proves asymmetrical in its extensiveness and recentness, which in turn makes the balance of the related sections of our literature review somewhat uneven. For example, academic preparedness research focuses on large-scale descriptive or quasi-experimental studies whereas articles on tenacity tend to rely on smaller-scale randomized control trials. Similarly, research on academic preparedness posits findings that have been replicated and confirmed over decades whereas studies of academic tenacity are emerging and therefore suggest implications that are only just becoming understood. Finally, this asymmetry proves meaningful for how districts and schools use our findings. The indicators we highlight in the research are actionable, but also rely on measures not included in traditional administrative datasets. As a result, to make our findings fully usable for practitioners, researchers will need to develop new measures of academic tenacity and college readiness, and districts will need to collect new types of data, a reality we address at the end of our review in Directions for Future Research.

We begin with a review of research on college readiness indicators, organized by the three dimensions highlighted above: academic preparedness, academic tenacity, and college knowledge. Within each conceptual area, we further categorize and assess literature by level of analysis—individual, setting, and system—noting that the empirical base has privileged academic preparedness and individual-level indicators. We conclude by examining existing gaps in research-based knowledge.

Methods

We utilized LexisNexis, Google Scholar, ERIC, and PubMed to search for college readiness related publications in multiple disciplinary domains including education, psychology, sociology, and health. The search yielded 250 U.S. publications published between 2000 and 2012. These publications included book chapters, handbooks, and other types of reports. Most of these works were excluded from our analysis, as we focused on peer-reviewed journal articles. However, to account for the emergent research base, we also included empirical research reports and books chapters from university research centers. While this approach does not lower the overall quality of the research cited herein, it does mean we cite a slightly smaller percentage of articles from peer-reviewed journals than might otherwise be the case. In total, 140 publications met these criteria. Next, we coded these publications for academic preparedness, academic tenacity, college knowledge, and related terms. We came to a consensus on which publications fit these codes, as well as their data use, level of analysis (individual, setting, or system), and college readiness definition. Finally, we coded these publications for rigor, which we defined as whether the study was experimental, quasi-experimental, or descriptive in nature (in order from most to least rigorous).

Academic Preparedness

A broad empirical base demonstrates that high-school students differ in their degree of academic preparation for postsecondary education. Academic preparedness refers to academic knowledge and skills that students need to succeed in doing college-level work—that is, to be “college ready.” David Conley’s (2007a; 2007b) well-established framework suggested that such preparedness has three main components: 1) content knowledge; 2) academic skills, whereby students use that specific content knowledge to solve problems; and 3) key cognitive strategies

that are not content-specific, such as students' ability to reason, argue, and interpret. This research highlighted a key distinction: being college eligible is not the same as being college ready, a subtlety we consider throughout this section.

Studies show that the following K-12 academic indicators at the individual student level can predict college attendance, persistence to graduation, and postsecondary grade point average (GPA):² 1) standardized test participation and scores; 2) courses taken; and 3) course performance, including GPA and course failures. Most of these findings come from research on early warning systems and, as a result, focus on determining the relative predictive power of different indicators like GPA rather than how these indicators can be used to support students (National Center for Public Policy and Higher Education, 2009).

An emerging line of research has begun to consider how schools, districts, and states can monitor their own capacity to support students' academic preparedness. Much of this research focuses on how the well-documented measures of individual students' college readiness reflect, and are influenced by, school, district, and state policies and practices. For instance, studies show that setting- and system-level actions like expanding rigorous course availability can influence students' college readiness (Fine, 1986; Herlihy, 2007; Jenkins, 1988; Lee & Burkham, 2000; Rumberger, 1995).

Despite this research at the individual, setting, and system levels, the literature that examines measures of academic preparedness has two broad shortcomings. We focus on these shortcomings in the remainder of our section on academic preparedness because they suggest a need to incorporate indicators related to academic tenacity and college knowledge, and to do so according to our tri-level framework. First, research shows that, even if indicators like grades or test scores turn out to be predictive, failing to understand the underlying mechanisms that make

them predictive yields unintended consequences. For example, efforts to align high school and college standards by making the former more rigorous can result in students struggling more academically and, in some cases, dropping out altogether (Conley, 2007a). Second, because underlying mechanisms remain murky, little research connects work on model accuracy to supports and interventions that disrupt the cycles predicted by indicator systems. In combination, these shortcomings mean that current research on these systems deals with the issue of college readiness somewhat superficially, explaining what predicts college outcomes, but not why these indicators prove accurate, nor what is to be done with that knowledge.

In this section, we briefly summarize findings in which academic preparedness indicators predict postsecondary outcomes, then consider their shortcomings. We first examine these questions at the individual level, then proceed to the implications of these findings at setting and system levels.

Individual Level

This subsection examines individual-level academic preparedness indicators. Generally, these indicators fall into three categories: standardized test participation and scores, courses taken, and course performance. We briefly outline findings on the predictive power of these academic-preparedness measures, then discuss their shortcomings, which suggest the need for additional indicators beyond those included in traditional district administrative datasets.

Standardized Test Participation & Scores

Research shows that indicators of academic preparedness in elementary school, including standardized test participation and scores (hereafter referred to as “test scores” or simply “scores” for parsimony), can predict postsecondary outcomes like enrollment, GPA, and graduation (Alexander, Entwisle, & Kabbani, 2001; Barrington & Hendricks, 1989; Entwisle &

Hayduk, 1988; Garnier, Stein, & Jacobs, 1997). College entrance exam scores, for example, can predict postsecondary outcomes, including enrollment, GPA, and completion. Avery and Kane's (2004) analysis of participants in a college outreach program suggested that students who completed major testing milestones by fall of senior year—like taking the PSAT and taking or registering for the SAT—were more likely to attend a four-year college. Roderick's (2006) comparison study of Chicago Public Schools (CPS) students from 2002 to 2003 and 1998 to 1999 revealed similar trends. In Illinois, all students, including those attending CPS, must take the ACT as part of their high school exit process. Roderick (2006) used these data to compare all students, including those who, under other circumstances, would not have taken the exam. She found that students with ACT scores above 18 were more likely to enroll in college than students with lower scores. These results are consistent with Conley's (2007b) findings that higher ACT and SAT scores had a positive correlation with college enrollment and graduation.

In addition to predicting overall postsecondary attainment, ACT and SAT scores have also been shown to predict college achievement, specifically freshman-year GPA. These findings prove especially robust when GPA falls within certain ranges (Burton & Ramist, 2001; Noble & Sawyer, 2004; Roderick et al., 2008). In Chicago, students achieving certain cut scores on the four component ACT tests had a 50 percent chance of earning a “B” or better in freshman college courses and a 75 percent chance of earning a “C” or better (Roderick et al., 2008). Like ACTs, SATs also predict postsecondary outcomes. In a review of studies published since 1980 that predict college performance and completion, SAT scores and high-school records were found to correlate not only with GPA, but also nonacademic accomplishments such as leadership in college and eventual income (Burton & Ramist, 2001). These tests also predict postsecondary

achievement for student subgroups. Ting (2000) found the SAT valid and highly predictive of postsecondary achievement among Asian-American students.

Despite the power of test scores to predict postsecondary outcomes, assessment results have shortcomings. For one, test scores do not necessarily reflect effort. Because of this, assessment results often lose their statistical significance when included in models with measures like GPA that better capture motivation. Specifically, research on early warning systems in Philadelphia and Chicago indicated that test scores are not nearly as predictive of high school completion as other achievement measures such as grades, course failures, and attendance (Neild & Balfanz, 2006). In postsecondary education, these findings held for both attainment and achievement. Among students in the University of California system, secondary measures other than test scores—and GPA in particular—were much better predictors of postsecondary persistence and college grades, even when holding factors like socioeconomic status constant (Geiser & Santelices, 2007). Others found the ACT to be a better predictor of postsecondary outcomes when used in conjunction with other relevant data, such as GPA (Noble & Sawyer, 2004), and that results of practice administrations of the SAT proved worse predictors than GPA and class rank (Adelman, 2006).

Beyond failing to measure motivation, state tests used for accountability purposes also may not be well aligned with college standards (Brown & Conley, 2007). According to Brown and Conley (2007), using these tests to predict college outcomes usually involves risky content and criterion validity assumptions, especially the supposition that these tests align with college academic content. For example, a state accountability test might include reading passages used at the postsecondary level, but not require the same level of critical thinking needed to succeed in a college English course. Brown and Conley (2007) analyzed the content of state tests relative to

academic standards and skills necessary for entry-level postsecondary courses. They discovered that 60 math and English secondary assessments from 20 states were only marginally aligned with postsecondary standards.

Finally, standardized tests can be biased for certain student subpopulations. Research suggests that academic preparedness indicators, and test scores in particular, do not have the same reliability and validity across different races, languages, and socioeconomic statuses (Abedi, 1999, 2003; Ensminger & Slusarcick, 1992; Jordan, Lara, & McPartland, 1994; Rumberger, 1995; Steinberg, Blinde, & Chan, 1984). For example, there were often test reliability and validity concerns for English Language Learners (Abedi, 1999), such as the inclusion of unnecessarily complicated language in a math item that undermined the question's validity. More broadly, achievement tests often overlook students' backgrounds, which could include both strengths and deficits related to college readiness (Byrd & Macdonald, 2005). For instance, achievement tests may have been measuring the quality of instruction a student received or what courses a student had access to rather than his or her ability (Byrd & Macdonald, 2005). Resources also matter. Research from Chicago indicated that, while many students studied hard for the ACT and reported aspirations to attend college, they often did not receive the supports needed to succeed on the ACT (Roderick et al., 2008). Finally, these contextual factors have been shown to influence students' self-perceptions of ability, which in turn influence their test performance (Byrd & Macdonald, 2005).

Courses Taken

Courses taken, which is often measured in credits taken, consistently predict postsecondary outcomes like enrollment (Balfanz & Herzog, 2005; Balfanz & Legters, 2006). (For the remainder of the paper, "courses taken" and "credits taken" will be used interchangeably

given they measure the same construct of interest.) Most research directly related to college readiness focuses on AP courses taken and exams. For instance, Leonard (2010) showed that, when lower-performing students enter college with postsecondary credits including AP courses, they prove less likely to need remediation. Likewise, holding ability indicators constant, AP course completion was statistically significant in all models used by Dougherty, Mellor, and Jian (2006) to predict college enrollment. Of various AP indicators, completing a course and taking the exam was the most significant indicator of postsecondary attendance (Dougherty, Mellor & Jian, 2006). Elmers and Mullen (2003) confirmed this finding. Among their sample, holding proxies of ability like grades constant, students entering college having passed AP exams often had higher first-year GPAs than those students entering college with dual or no college credit (Elmers & Mullen, 2003). Follow-up studies examined AP credit accumulation and its impact on high- and low-performing students. Brody, Assouline, and Stanley (1990) found that, for students entering elite colleges, having accumulated AP credits best predicted high academic achievement, including GPA and academic honors (their models controlled for prior achievement and background characteristics like socioeconomic status). Finally, Willingham and Morris's (1986) four-year longitudinal study showed that AP scores correlate with better academic records and persistence over four years of college.

Yet, research shows that the courses taken may actually be a proxy for critical thinking skills, in which case simply increasing enrollment may not help. For example, math course completion predicts college outcomes in part because math classes often emphasize critical thinking (Adelman, 2005; Bueschel, 2003). Students with a thorough understanding of Algebra principles and techniques were more likely to succeed in college math for that very reason (Conley, 2007b). Among community college students, math completion during freshman year

was the strongest predictor of eventual transfer to a four-year institution (Adelman, 2005). Nonetheless, taking a course is not always enough: according to Conley (2007b), students must be able to do more than solve a particular problem to succeed in college; they must also be able to make strategic computations and understand methods conceptually, a skill tied more to the quality of teaching than the subject itself. Even students who take difficult math courses still did not acquire sufficient critical thinking skills (Facione, Facione, & Sanchez, 1994). A study of college freshmen entering an elite university showed that only 13 percent scored high enough on an assessment of critical thinking to be considered strong critical thinkers (Facione, Facione, & Sanchez, 1994).

Course Performance

Course performance, especially extremely poor performance, predicts college outcomes (Geiser & Santelices, 2007; Kane, 2002; Noble & Sawyer, 2004). Failures in core courses are frequently a bellwether of future academic problems. Overall GPA is used frequently to measure course performance and predict postsecondary outcomes (Geiser & Santelices, 2007; Kane, 2002). Chicago research showed that GPA was the single strongest predictor of college enrollment (Allensworth & Easton, 2005). Moreover, GPA was far more significant in their model than most other academic measures. For example, there was no difference in college going rates among students with ACT scores in top and bottom deciles, but the likelihood of attending college doubled between GPAs in the top and bottom deciles, from 40 to 82 percent (Allensworth & Easton, 2005). One reason GPA can be predictive is that it often represents an eligibility criterion to receive state financial aid, which impacts attendance (Kane, 2002).

Beyond forecasting college enrollment, GPA proves a strong predictor of postsecondary achievement and persistence (Geiser & Santelices, 2007; Noble & Sawyer, 2004). A large-scale

study conducted in the University of California system showed that GPA was the best predictor of achievement during freshman year (Geiser & Santelices, 2007). High school GPA was also a better predictor of college GPA than ACT scores for students with relatively low grades (Noble & Sawyer, 2004). Perhaps surprisingly, high-school GPA has been shown to improve as a predictor of postsecondary achievement beyond freshman year of college (Adelman, 2006). Geiser and Santelices (2007) found that high school GPA explained more of the variance in college GPA after freshman year of college and was generally more predictive than other measures of four-year outcomes.

Despite these arguments in favor of using GPA in predictive models, researchers use three substantive arguments to critique GPA's predictive validity. First, GPA is less predictive for students with very low grades (Allensworth & Easton, 2005). In 1992, less than half of black and Latino students in Chicago Public Schools had a GPA that would even minimally qualify them for admission to a four-year school. Among those students, more than one in three had a GPA below 2.0 (Allensworth & Easton, 2005). When a student's GPA dropped below a certain threshold, it often failed to predict postsecondary outcomes with the same accuracy, if at all (Noble & Sawyer, 2004). Second, like AP courses, GPA has lost predictive power due to grade inflation intended to facilitate students' admission to college (Conley, 2007a). For instance, a "B" today is the equivalent of a "C" thirty years ago, a contention supported by evidence that grades are rising as many other measures of college readiness decline (Conley, 2007a). Third, research shows that grading standards vary significantly not only among schools and districts, but also among teachers within a school (Nunley, Shartle-Galotto, & Smith).

In combination, these issues point to a broader issue: research shows that GPA predicts college outcomes, but studies do little to explain what grades measure and, therefore, why it

proves such an accurate indicator. Geiser and Santelices (2007) suggest that GPA can be less biased than test scores because course availability does not influence grades. Research also suggests that grades capture students' effort and study skills (Fredriksen, 1984). Grade-point average proxies both academic skills and a variety of non-cognitive factors, like motivation, that are vital to postsecondary achievement (Kaplan, D.S., Peck, & Kaplan, 1997; Kennely & Monrad, 2007). Further, grades allowed students, including those from populations considered at risk of not attending college, to demonstrate perseverance, which correlated with success in postsecondary settings (Dille & Mezack, 1991). Nonetheless, these generalizations about GPA do not indicate which element measured by grades should be tied to interventions, a problem we address in our consideration of the setting and system levels.

Setting & System Levels

Keeping potential empirical shortcomings of these individual-level indicators in mind, schools, districts, and states have begun to use them to monitor their own roles in producing college-ready graduates. As in our discussion of individual-level indicators, we organize this subsection by providing a brief summary of accurate setting- and system-level indicators of college readiness, then consider their shortcomings.

Standardized Test Participation & Scores

Research on student-level assessment indicators produces several obvious correlates for using test scores as setting- and system-level indicators. Broadly, these correlates fall into two categories. First, schools, districts, and states can monitor performance on tests that predict postsecondary outcomes, then provide supports and interventions when a student falls off course for college readiness. Second, educators can track participation rates of students on optional tests like the SAT and ACT.

Some schools and districts currently use state test scores to help predict student outcomes and provide localized supports and interventions. Chicago Public Schools, for instance, uses students with high test scores but low grades to identify settings in which students demonstrate potential, but remained unengaged in school (Roderick, Nagaoka, Coca, & Moeller, 2009). These results can then be used to provide teacher supports, such as targeted professional development, designed to increase student engagement. Other school systems and states use test scores to classify students' readiness for college and intervene if the education being provided proves insufficient to prepare those students for college. At the district level, Nunley, Shartle-Galotto, and Smith (2000) studied three pilot high schools in New York City that used a Placement Articulation Software System (PASS) to assess and place sophomores into one of three categories: 1) on track for college in two years, 2) meeting most college-level expectations, or 3) lagging behind on college readiness in some skill areas. Students in the third category received additional academic support, such as extra instruction in math and Language Arts.

Some states also use test scores to measure students' college readiness and provide additional instruction when feasible. California added a supplement to its eleventh-grade Language Arts standardized test that predicts whether students are academically prepared to enter the state college system (Knudson, Zitzer-Comfort, Quirk, & Alexander, 2008). Students who do not demonstrate sufficient proficiency on the test often take university-approved preparatory courses that allow them to avoid remediation upon entering college (Knudson, Zitzer-Comfort, Quirk, & Alexander, 2008). Like California, several states use broadly-administered standardized tests to gauge college readiness. As of 2007, 14 states utilized standardized test scores to make decisions about college readiness, in some cases using them in the admissions process (Brown & Conley, 2007). Though most state tests still do not align with

college expectations, research suggests this mismatch represents a missed opportunity to align high school and postsecondary expectations (Brown & Conley, 2007), as well as provide early remediation programs (Howell, Kurlaender, & Grodsky, 2010).

Beyond tracking available assessment performance data, schools and districts also monitor rates of participation in optional standardized tests serving as gateways to college, such as the SAT and ACT. In a Garvey (2009) study of schools with successful college preparatory programs, the vast majority kept track of PSAT and SAT participation rates. States also monitor student participation rates on tests like the ACT and SAT. Illinois, for instance, required all students to take the ACT as part of its high-school curriculum, a policy designed to help ensure more students have the option of attending college (Roderick et al., 2008). Many of these district and state policies targeted particular student subpopulations with traditionally low rates of college attendance, such as low-income and minority students (Fetler, 1991). According to Fetler (1991), school SAT scores were positively correlated with parent education of the test-takers, as well as twelfth-grade achievement and demographic characteristics.

Despite these efforts at the setting and system levels, uncertainty remains about what to do for students who perform poorly on a test or do not take the assessment at all. That is, some districts and states have begun to provide supports and interventions, but few studies firmly establish the effectiveness of these policies. One of the main reasons that educators do not use test scores more to drive supports and interventions is that assessments provide little information on the phenomena underlying poor performance. For example, low test scores may be due to low academic preparedness, but may also be due to lack of motivation (Kennely & Monrad, 2007), biases for certain populations (Abedi, 2003), insufficient academic offerings (Conley, 2007a), or

the like. In short, test scores do not readily suggest avenues to support students beyond incentivizing more students to take them and providing basic remediation.

Courses Taken

Individual-level findings on course completion and critical thinking have implications for how educators at the setting and system levels monitor college readiness and implement associated supports and interventions. Though research on setting- and system-level measures remains limited, many districts and states already use evidence on student-level indicators to monitor their effectiveness in providing students with the coursework necessary for college readiness (Balfanz & Boccanfuso, 2007). In general, these setting- and system-level indicators fall into three broad categories, which include monitoring: 1) the availability of college-preparatory courses, 2) enrollment in these courses, and 3) the alignment of course content and expectations with postsecondary curriculum. Broadly speaking, schools, districts, and states use these indicators to assume responsibility for ensuring their students take the courses required to attend college and succeed in them.

Perhaps obviously, the first step to enrolling in college is to complete the prerequisite courses (Cabrera & La Nasa, 2001). While students maintain some responsibility for completing the necessary college-preparatory courses in high school, they cannot enroll in those courses if not offered. Research suggests that districts range in how many college preparatory courses they provide and what percentage of students have access to them (Leonard, 2010). For example, according to Leonard (2010), only the top 25 percent of students in the high school he studied accessed AP classes. By contrast, the most effective schools documented in a study by Ascher and Maguire (2007) made at least two AP courses available to all students and offered other opportunities to earn college credit during high school. Studies show that schools and districts

can improve their college-preparatory course offerings by monitoring the availability of such classes and responding to deficiencies in systematic ways (Dougherty, Mellor, & Jian, 2006). Specifically, districts can increase the number of classes available; diversify those courses by mixing AP, IB, and other courses; and coordinate offerings with local postsecondary institutions (Bailey, 2007). For example, the schools identified by Ascher and Maguire (2007) as especially successful in getting high-school students to attend college created partnerships with local colleges that provided students with multiple opportunities to earn postsecondary credit before graduation.

A district's job, however, does not end once it offers college-preparatory courses; students will not enroll in such classes if underprepared. Given that college-preparatory courses, such as Algebra, are frequently offered in middle school, studies suggest postsecondary course alignment should begin before students enter high school (Wimberly & Noeth, 2005). Further, middle-school offerings can serve as the first step towards college readiness in twelfth grade (Conley, McGaughy, Kirtner, van der Valk, & Martinez-Wenzl, 2010; Nunley, Shartle-Galotto, & Smith, 2007). Specific to AP offerings, studies indicate that schools with high rates of enrollment in AP courses begin building a curricular pipeline in middle school (ACT, 2005). For example, some districts and states have developed programs like the Maryland Partnership, which offers comprehensive AP preparation courses that build towards college-level classes at the end of high school (Nunley, Shartle-Galotto, & Smith, 2000). Though less formal than AP-preparatory courses, some districts also provide supports for students off-track to enroll in the AP curriculum, such as assigning the student to an adult at the school personally responsible for monitoring his or her progress towards college readiness (Ascher & Maguire, 2007).

Finally, research shows that simply offering and enrolling students in the necessary courses is not enough to produce college-ready students; rather, school and district leaders can also improve a student's chances of attending and completing college by ensuring academic expectations in high school match those of postsecondary institutions (Cabrera & La Nasa, 2001). For instance, districts can develop grading policies and assignments that parallel postsecondary expectations and policies (Conley, McGaughy, Kirtner, van der Valk, & Martinez-Wenzl, 2010). This form of alignment becomes especially important as students approach high school graduation, yet seniors frequently take less rigorous math and science courses, or none at all (Conley, McGaughy, Kirtner, van der Valk, & Martinez-Wenzl, 2010). Schools and districts can therefore monitor rates of enrollment in higher-level math and science courses, even if not AP specifically. At the state level, a growing number of legislatures and education departments now tailor curricula more to college expectations by changing state graduation requirements (Achieve, 2011). As of 2011, 47 states had adopted Math and Language Arts graduation requirements that mirror those of their university systems (ACT, 2011).

However, like test scores, course-taking indicators do not necessarily help educators at the setting and system levels understand the mechanisms that make completion of courses like AP classes so important. Research shows that poorly conceptualized course policies often lead to unintended consequences. For example, districts have reacted to low AP enrollment trends by dramatically increasing AP course participation, which dilutes the signaling power of AP enrollment and therefore makes colleges wary of its use in the admissions process (Conley, 2007a). That is, a higher number of students may enroll in AP courses, but a lower percent actually complete AP exams, raising questions about course quality (Conley, 2007a). As an example, Chicago Public Schools tried to align expectations with those of local postsecondary

institutions and provide support for students struggling to meet expectations, but the policy resulted in higher dropout rates and largely failed to boost college attendance (Roderick et al., 2008). This finding suggests that the courses themselves are less important than other factors that are more difficult to measure, such as readiness for classes that require critical thinking and motivation to participate in them.

Course Performance

According to research, monitoring students' GPA allows educators at setting and system levels to provide supports and interventions for students not on track to attend college (Balfanz & Boccanfuso, 2007; Herlihy, 2007; Noble & Sawyer, 2004). In general, GPA and course failures can be used at the setting and system levels in two ways. First, educators can better identify pockets of students—especially by school or grade level—not on course to college readiness and determine how best to allocate resources devoted to interventions and supports. Second, consistent patterns of low GPA in particular settings can be used as a sign of a problem with aspects of a school's culture, such as its curriculum or student expectations, that may be contributing to low performance (Allensworth & Easton, 2007). In other words, although course performance reflects how individual students perform, this indicator also reflects the structure and culture of the schools those students attend. Nonetheless, without a better understanding of what GPA measures, exactly, knowing how to support students with low GPAs remains murky at best.

Schools, districts, and states have limited resources to provide instructional supports and interventions for students, such as remedial courses, extra instructional time, and the like. Tracking trends in course failures across grade levels, schools, and districts can help educators better target resources for students most at risk of failing to be college ready. Monitoring GPA

across settings can be effective before students even begin high school (Kennelly & Monrad, 2007). Middle school grades and course failures can predict college readiness, which provides an opportunity for educators to intervene early (Kennelly & Monrad, 2007). Once students enter high school, monitoring freshman-year grades at the beginning of the year can help target supports and interventions, such as additional classes and instructional time (Kennelly & Monrad, 2007). Further, studies show that end-of-year freshmen grades can then be used to refine models predicting college readiness and, therefore, refresh the pools of students most in need of academic support to be college ready (Kennelly & Monrad, 2007).

Beyond identifying students most at risk of falling off track to perform well in college, grades have also identified students who might otherwise escape notice, like the “forgotten middle-school student” (Leonard, 2010). These students come regularly, are never in trouble, rarely sign up for difficult courses, receive “C’s” in most classes, and rarely participate. Taken in conjunction, these traits suggest that a student may not have the motivation to enroll in and complete college (Leonard, 2010). For these students, districts can track trends across schools and provide targeted professional development for teachers to increase student motivation and engagement where measures of these student attitudes appear particularly low (Balfanz, Herzog, & Iver, 2007).

Some studies suggest that remediation, when based on setting-level indicators like course failure patterns, can boost college readiness (Balfanz & Boccanfuso, 2007). Limited research connects remediation directly to GPA, showing that additional instructional time and support in class can improve outcomes for students already off track after the first half of freshman year (Kennelly & Monrad, 2007). These interventions aggressively targeted students failing freshman-year courses and provided academic supports to improve performance (Kennelly &

Monrad, 2007). Other studies find similar results, though they tend to focus on high-school completion rather than college readiness. As previously discussed, Balfanz (2007) found that an early warning system using GPA helped target extra learning time for students and professional development on increasing student engagement for teachers, which, in combination, reduced dropout rates.

As the professional development component of the intervention studied by Balfanz, Herzog, and Iver (2007) indicates, research also suggests that trends in GPA can help pinpoint when the setting plays a role in poor performance. That is, consistent patterns of course failure may indicate a problem with a school's academic culture, an issue better addressed by district-level reforms. In such cases, interventions and supports may be better targeted at teachers than students. For instance, the intervention described by Balfanz, Herzog, and Iver (2007) helped teachers across Baltimore Public Schools develop techniques for making learning more contextual and applied, a strategy designed to increase engagement for more students than those specifically identified as likely to drop out. Similarly, a CCSR study found that trends in course failures could be related to lack of instructional coordination across classes or school-wide attendance problems related not only to the students, but to their schooling context (Allensworth & Easton, 2007).

Despite this emergent research on GPA-based interventions, few studies show why GPA proves so predictive. Consequently, educators do not know whether supports and interventions should target preparation, motivation, engagement, or any of a variety of factors that grades may measure. As we discuss in the remainder of this paper, an effective college readiness indicator system must include measures not typically available in large administrative datasets in order to parse the inputs to GPA that separate college-eligible and college-ready students.

Academic Tenacity

In addition to academics, non-cognitive³ factors like students' resilience, self-regulation, and beliefs about their intelligence are also important predictors of college readiness and may help explain some of the mechanisms underlying academic preparedness indicators like grades (Cury, Elliot, Da Fonseca, & Moller, 2006; Durlak, Weissberg, Dymnicki, Taylor, & Schellinger, 2011). Although extensive bodies of work suggest the importance of these non-cognitive factors for long-term academic success, research is much less clear on how best to make them measurable and actionable. Academic tenacity groups these non-cognitive constructs under a single term and has therefore garnered considerable empirical attention (Dweck, Walton, & Cohen, 2011). Essentially, academic tenacity is “about working hard (and working smart) for a long time...[it] is about the mindsets and skills that allow students to look beyond short-term concerns to longer-term ... goals, and to withstand challenges and setbacks to persevere toward these goals” (Dweck, Walton, & Cohen, 2011, p. 5). In some instances, tenacity and related factors like grit have predicted long-term academic achievement even better than academics (Deke & Haimson, 2006; Duckworth, 2009, 2011; Good & Dweck, 2006).

Tenacity involves the beliefs, attitudes, values, and behaviors that motivate students to embrace and engage with challenging work, and to pursue academic achievement (Dweck, Walton, & Cohen, 2011). Indicators of tenacity include academic self-confidence and belief in the importance of education. Students' attitudes towards school (including college) manifest as specific behaviors like active participation in class and extracurricular activities, consistent attendance, and persistence through academic adversity. More specifically, Dweck and her colleagues have identified five conceptual categories that suffuse academic tenacity: 1) mindsets

about one's own intelligence, 2) long-term achievement goals, 3) social belonging and connectedness, 4) self-regulation and control, and 5) grit.

Extant literature that tests the predictive value of academic tenacity indicators for student achievement and attainment relies on fine-grained data collected in classrooms at frequent intervals. While most academic preparedness studies draw upon large administrative datasets, tenacity studies utilize classroom experiments around particular student interventions. That is, these studies require detailed information about student behavior not easily captured in administrative data. The majority of tenacity research currently focuses on designing and implementing interventions—which entails building measures from the ground up—rather than on validating existing metrics. Consequently, researchers lack consensus on how best to prioritize and validate these indicators.

We begin with a review of the evidence at the individual level for each of the conceptual elements of academic tenacity identified by Dweck. Unlike in other sections of the review, we embed a discussion of classroom-level (setting) supports and interventions in our consideration of individual-level indicators. We take this approach because teachers often use the setting-level interventions themselves to monitor students' tenacity. In other words, the indicators used to diagnose individual-level tenacity issues cannot be separated from the setting-level interventions used to address those issues. We close with a broader discussion of setting and system levels, including a pedagogic strategy—scaffolding—that cuts across indicators of tenacity. Given the emergent nature of tenacity research, much of our analysis focuses on outcomes that are high-school precursors to college readiness, such as high-school achievement and graduation.

Individual and Setting Levels

Intelligence mindsets and long-term goals. Although few experimental studies directly link academic tenacity to postsecondary outcomes, many have shown a positive correlation between tenacity and the beliefs and habits that drive K-12 achievement. Students' mindsets about their intelligence directly impact tenacity and achievement (Dweck & Leggett, 1988; Mangels, Butterfield, Lamb, Good, & Dweck, 2006). In particular, students with a fixed mindset view intelligence as a stable, unchanging attribute. A growth mindset, by contrast, is a perception of intelligence as a changing characteristic that one can influence. Students with a fixed mindset focus on showing how smart they are, and teachers who see mindsets as fixed are likely to categorize students by exhibited ability. Students and teachers with a growth mindset, by comparison, tend to see learning challenges as opportunities to improve ability, which allows them to transcend setbacks by keeping a long-term focus on learning (Dweck & Leggett, 1988).⁴ Growth-oriented mindsets predict greater levels of academic achievement than fixed ones, and growth-oriented students earn higher grades over time in both correlational and experimental studies (Aronson, Fried, & Good, 2002; Blackwell, Trzesniewski, & Dweck, 2007; Mueller & Dweck, 1998; Strobel, 2010). Although these studies indicate a positive relationship between growth mindsets and academics at the middle- and high-school levels, more research is needed that explicitly links mindsets and goal orientation to college readiness rather than solely to eligibility.

Two kinds of achievement goals that correspond to intelligence mindsets influence academic outcomes (Button, Mathieu, & Zajac, 1996; Dweck & Legget, 1988). First—and associated with a fixed mindset—students often focus on performance goals as a means of proving their ability (Dweck, Walton, & Cohen, 2011). In the same study by Dweck, Walton,

and Cohen (2011), when students saw intelligence as fixed, they were likely to prioritize doing well, which also meant avoiding doing poorly. Subsequently, the students oftentimes selected paths of least resistance and avoided challenging coursework since they were concerned about low performance and being perceived as unintelligent (Blackwell, Trzesniewski, & Dweck, 2007). Second, growth-oriented students tended to select learning (also termed “mastery”) goals, and wanted to master challenging content. In contrast to performance goals, learning goals emphasize embracing difficult academic situations and measuring success not by a single grade or score, but by the learning that occurs. Across several studies, learning goals correlated with sustained levels of higher motivation and achievement.

Teachers can, in turn, influence the goal-setting process. A recent study found that when teachers praised students for their intelligence, those students were more likely to select performance goals. Other students who received encouragement related to their work ethic and effort, meanwhile, were more likely to opt for mastery goals and enhance their learning (Mueller & Dweck, 1998; Strobel, 2010). Teachers also used those encouragements as an opportunity to gauge their students’ mindsets, thus embedding an individual indicator within a classroom intervention (Mueller & Dweck, 1998; Strobel, 2010). In many of these intervention studies, teachers explicitly cultivate mastery learning goals and growth-oriented mindsets (Cohen, Garcia, Purdie-Vaughns, Apfel, & Brzustoski, 2009; Walton & Cohen, 2011). Concept-Oriented Reading Instruction, for instance, showed that simply teaching new reading strategies alone did not influence students’ motivation to learn or their reading achievement. However, combining this practice with validated motivational interventions corresponded to an increase in both motivation and achievement (Guthrie et al., 2004). Similarly, Dweck’s (2011) “Brainology” intervention exposed students to an online workshop of information regarding study skills and a

growth mindset. Students who experienced this intervention had greater long-term academic achievement in middle and high school than their control-group counterparts.

Teaching interventions that focus on classroom goals and feedback also foster growth-oriented mindsets. For example, Brophy (1981) found that practices like lauding students for work or effort rather than intelligence or academic ability promoted achievement. In general, for middle- and high-school students, praising intelligence has been linked to performance goals and lower levels of persistence with challenging academic tasks. In contrast, praising effort predicted learning goals and greater academic success, especially with difficult activities. Blackwell, Trzesniewski, and Dweck (2007) tested the effect of a classroom intervention that targeted learning goals and effort beliefs for two groups of 373 and 1,091 seventh-grade minority students in an urban district. Having a growth-oriented mindset predicted increasing grades over the course of two years in middle school, in contrast to a fixed mindset, which predicted plateaus in GPA. Growth orientation further predicted increased academic motivation compared to a fixed orientation (Blackwell, Trzesniewski, & Dweck, 2007). Finally, activities that focused on cooperative and communal goals, rather than individualistic and competitive ones, also promoted growth-oriented mindsets (Johnson & Johnson, 2009; Slavin, Hurley, & Chamberlain, 2003).

Research also examines interstices among growth mindsets and students' long-term academic and personal goals. Lee, McInerney, Liem, and Ortega (2010) established a connection between students' future goals and their desire to achieve in school using a sample of 5,733 Singaporean high school students. They discovered strong ties between intrinsic goals, like those related to one's career path, family, and culture, and a mastery goal orientation. Prioritizing performance, on the other hand, was more closely linked to extrinsic goals, such as those related to money and status. While there is nothing innately wrong with seeking money or status,

research shows that intrinsic goals tend to generate better performance on a range of tasks, especially those that require analytical thinking (Ryan & Deci, 2000). Lee, McInerney, Liem, and Ortega's (2010) work also supports the idea that teachers' classroom practices can cultivate intrinsic objectives for students. Ames and Archer (1988) produced a stratified random sample of 176 middle and high school gifted students, then administered questionnaires about students' perceptions of goal orientations in their classrooms. Students focused on mastery goals—and who were more intrinsically motivated—showed preferences for more difficult tasks, positive feelings about the class, and a stronger belief in the relationship between work and academic achievement.

Despite a strong conceptual foundation and empirical support for the importance of growth mindsets and mastery goals, disagreement exists about the most effective way to measure them, and their predictive value for academic achievement. Pintrich (2000) found mixed evidence when using mastery and performance goals as predictors of math achievement among eighth and ninth graders over three years. Using 150 students' self-report questionnaires and math grades, he showed that mastery and performance goals promoted long-term achievement and intelligence malleability. That is, mastery and performance goals are not mutually exclusive, and a combination of the two can help students persevere academically and engage with more difficult tasks over time. Elliot and Murayama's (2008) and Elliot and McGregor's (2001) studies using the Achievement Goal Questionnaire corroborated these findings for a sample of 229 college students.

Social belonging and connectedness. Students' sense of social belonging—the extent to which they feel included and respected by peers and adults in school (Goodenow, 1992)—contributes to academic tenacity and predicts academic success (Dweck, Walton, & Cohen,

2011). Research validates the significance of students' sense of collaboration and community for academic achievement and emotional support in studies dating back to the 1950s (Dewey, 1958; McMillan & Chavis, 1986; Vygotsky, 1978). Students who felt more connected were better motivated, more engaged in classes, and earned better grades, even when controlling for prior levels of motivation and achievement (Cohen & Garcia, 2008).

For teachers, setting clear, high, and consistent behavioral and disciplinary policies helps students feel more connected and allows teachers to monitor connectedness (Akey, 2006). Further, classroom practices can increase belonging: for example, encouraging students' effort and creating a caring learning environment also impacted achievement by boosting motivation (Strobel, 2010). Other emotional supports that foster trust, engagement, and self-esteem include counseling, peer groups, application of social-emotional interaction standards, and concrete feedback that supports self-assessment (Savitz-Romer, Jager-Hyman, & Cole, 2009). More targeted classroom interventions and school policies have also been shown to influence students' perceptions of social belonging. "Values affirmation," for example, has proven successful in generating belonging. In these affirmations, teachers and counselors remind students about attributes the students value in themselves, especially related to schooling. These interventions have been successful at improving grades across content areas, especially for minority students (Cohen, Garcia, Apfel, & Master, 2006; Cohen et al., 2009; Walton & Cohen, 2011).

Although studies have consistently and positively correlated belonging with postsecondary outcomes, empirical work focuses largely on connectedness interventions in K-12. Nonetheless, the importance of connectedness and belonging in middle- and high-school settings finds support in the few similar studies undertaken in a higher education context. Several studies of postsecondary connectedness explored variation in college graduation rates for different

ethnic groups. Ingram (2012) found that, for 159 college sophomores at a small private college, social and academic belonging were significantly associated with GPA, satisfaction, and classroom participation.

Research also shows that certain behaviors which, at face value suggest a lack of connectedness, may not necessarily be capturing a student's sense of connection. For example, attendance and discipline data are not necessarily a good signal of connectedness (Nasir, Jones, & McLaughlin, 2011). A student can feel connected to school, but have poor attendance or disciplinary infractions because of family or peer issues, or trouble with transportation. Disentangling connectedness from other factors is important given attendance rates, in combination with grades and credits earned during freshman year, are among the strongest predictors of high school completion (Allensworth & Easton, 2005; Gleason & Dynarski, 2002).

Self-regulation and control. Duckworth and colleagues' work focuses on self-regulation, which often proves necessary for students to realize the positive outcomes associated with growth mindsets and belonging (Duckworth, Grant, Loew, Oettingen, & Gollwitzer, 2011; Duckworth, Tsukayama, & May, 2010; Romer, Duckworth, Schnitman, & Park, 2010). Self-control (or -regulation) is important because it is among the "most robust predictors of consequential life outcomes" (Duckworth, Quinn, & Tsukayama, in press, p. 8). Self-regulation refers to the ability to reject temporary distractions and remain focused on extant tasks related to long-term achievement (Duckworth & Kern, 2011). Students who exhibit high self-regulation are more skilled than more impulsive peers at regulating behavioral impulses to achieve long-term goals. Specific to education, self-regulation means giving up short-term, distracting activities to focus on tasks that are important for long-term success in school (Duckworth, 2011).

Duckworth and Seligman (2005) piloted measures of self-control for eighth-grade students to predict academic achievement, and these measures grounded much of their subsequent research. They assessed students' self-control through parent-, teacher-, and self-report measures. For instance, all three groups rated students' impulsiveness (i.e., ability to inhibit behavior and follow rules) and reported the extent to which students prefer immediate rewards over bigger and later ones. The measures' composite average was highly predictive of final eighth-grade GPA, standardized achievement test scores, and admission to selective high schools, with highly self-disciplined youth out-performing more impulsive peers (Duckworth & Seligman, 2005). A follow-up study developed the Impulsivity Scale for Children (ISC), a questionnaire that lists eight behaviors identified by middle-school students and endorsed by public and private teachers as indicating lapses in self-control (Tsukayama, Duckworth, & Kim, 2011).

Based in part on these scales, low self-control has emerged as a significant risk factor for a variety of personal and interpersonal problems (Tangney, Baumeister, & Boone 2004). In education, higher scores on self-control measures correlate with a higher GPA, better adjustment (e.g., fewer reports of psychopathology, higher self-esteem), less binge eating and alcohol abuse, better relationships and interpersonal skills, and more optimal emotional responses to challenging situations (Tangney, Baumeister, & Boone 2004). A study that explored relationships between motivational orientation, self-regulated learning, and classroom academic performance for 173 seventh graders regressed achievement on self-reported measures of student self-efficacy, intrinsic value, test anxiety, self-regulation, and use of learning strategies (Pintrich & De Groot, 1990). Among these variables, self-regulation, self-efficacy, and test anxiety were the best predictors of performance and cognitive achievement (Pintrich & De Groot, 1990).

Many studies show that higher reported and observed levels of self-regulation correlate with improved long-term achievement well beyond high school (Butler & Winne, 1995; Dignath & Büttner, 2008; Lerner et al., 2011; McClelland & Cameron, 2011; Zimmerman & Schunk, 2001). There are, however, few explorations of classroom interventions that specifically target self-regulation. The Student Success Skills Program is one exception, showing how schools can provide supports that cultivate goal-setting and self-management strategies (Brigman & Webb, 2007). In the program, students monitored and recorded their success at achieving certain self-regulation goals, established on their own or with adult guidance. Over time, these interventions tended to improve self-reports of self-management (Brigman & Webb, 2007).

Paris and Paris (2001) created a framework for improving literacy through self-regulation by synthesizing three related studies. Strategies targeted students' reading and writing skills, cognitive task engagement, and self-assessment, with the ultimate goal of promoting independence, engagement, and deliberate planning in students' learning processes. The studies used by Paris and Paris (2001) found the following to be successful in promoting self-regulation: explicit and frequent feedback that explains to students why they are doing an activity and what learning value it has for them (thereby promoting academic tenacity); high levels of diversity, challenge, and "procedural complexity" in activities (rather than a focus on competition, routines, and disciplinary control); project- or problem-based learning; and regular self-assessment that entails internalizing standards and regulating one's learning.

Grit. Related to self-regulation is grit: "perseverance and passion for long-term goals" (Duckworth, Peterson, Matthews, & Kelly, 2007, p. 1087). Whereas self-control involves the ability to resist more immediate temptations, grit emphasizes sustained perseverance in the pursuit of long-term goals: "an individual high in self-control but moderate in grit may, for

example...resist the urge to surf the Internet at work – yet switch careers annually” (p. 1089). Since high levels of achievement require long-term effort on difficult tasks, grit is an important predictor of remaining and succeeding in school. Differences in grit were measured via level of agreement with statements like “I have achieved a goal that took years of work” (high) and “I become interested in new pursuits every few months” (low). Grit has been shown to predict educational attainment, students’ K-16 GPA, retention among West Point cadets, and children’s performance in the U.S. spelling bee (Duckworth & Quinn, 2009; Duckworth, Peterson, Matthews, & Kelly, 2007).

Setting and System Levels

A growing body of research links academic tenacity to K-12 achievement and, less directly, to postsecondary outcomes. Though we have already discussed several ways in which tenacity can be monitored and addressed at the classroom (setting) level, uncertainty remains about how to make these interventions more systemic, especially how to develop related indicators. This uncertainty stems from several factors. For one, many measures of tenacity either lack precision or agreement about their validity. For another, scholars disagree about the extent to which tenacity is an innate trait (particularly related to grit) versus one that policy and practice can influence (for an extensive discussion, see Farrington et al., 2012). Before establishing setting-level indicators, one must first establish if schools and districts can, as a system, generate classroom environments and promote teaching strategies that encourage tenacity. To date, this question about the system has not been explored.

This systems-level gap in the research also occurs because of practical challenges that confront schools and districts that attempt to measure tenacity broadly. As previously discussed, classroom interventions in high school and college settings can change students’ beliefs about

their intelligence, sense of belonging, self-control, and long-term persistence in challenging academic environments (Dweck & Leggett, 1988; Oyserman, Bybee, & Terry, 2006; Walton & Cohen, 2007). Yet, even in instances where teacher practice has been shown to influence students' tenacity, there are practical limitations to using these indicators in supporting action at the school and district levels. For instance, many tenacity interventions rely on teachers conducting time-consuming data collection related to student habits, which can make replication and scaling difficult. This practical consideration proves especially germane to secondary and postsecondary education, where, unlike elementary classrooms, teachers interact with students fleetingly and opportunities to collect data can prove more limited.

Instructional scaffolding, challenge, and support for student autonomy. Despite these gaps at the setting and system levels, research does show that certain classroom practices not only improve tenacity, but also can be implemented widely. In addition to classroom-specific interventions that target students' mindsets, long-term goals, and connectedness, there are other classroom practices that can promote tenacity and be brought to scale. Specifically, educators can impact motivation and engagement by appropriately scaffolding academic content. Scaffolding, in turn, helps teachers create challenging environments and develop student autonomy, both of which influence student achievement and growth mindsets (Ferguson, 2010). These supports can help students develop and maintain focus on mastery learning goals, effort, and achievement.

Scaffolding is a strategy that helps students complete challenging activities by ensuring they have the knowledge and skills necessary to succeed at a task before tackling it. As a result, scaffolding is important both to developing academic autonomy and challenging students. For example, the Tripod Project (Ferguson, 2010), which focuses on narrowing racial and

socioeconomic achievement gaps, used Dweck (2011) and colleagues' conceptions of instructional scaffolding, challenge, and support for student autonomy to foment tenacity. Specifically, the project fostered teacher behaviors that promote understanding, clear up confusion around difficult concepts, and assist students in persevering to achieve understanding. Teachers who were most successful in cultivating students' tenacity tended to focus their efforts on factors identified by the Tripod Project (Ferguson, 2010; Kern, 2006).

Instructional scaffolding helps teachers challenge students to work and think hard by ensuring students have the supports they need to succeed. Establishing a classroom environment that challenges students without making them feel threatened is, unsurprisingly, important to developing growth mindsets. Challenge goes hand in hand with scaffolding given students are likely to achieve high expectations if they receive a commensurate amount of assistance and feedback (Ferguson, 2008; Dweck et al., 2011). When teachers establish high expectations and standards that are non-threatening—sometimes higher than what students' prior records may warrant—achievement often increases (Walton & Cohen, 2011). This finding proves especially accurate for low-income and minority youth, who saw large gains in confidence and achievement during Walton and Cohen's study (2011).

At the core of scaffolding and challenge are strategies that facilitate students' sense of control over their learning, an autonomy that is necessary to success in postsecondary institutions where independence is high. When students feel they are required to engage in an activity, they may experience low autonomy, buy-in, and ownership. When they elect to engage, however, students prove more likely to be intrinsically motivated and report high levels of autonomy (Reeve, Jang, Carrell, Jeon, & Barch, 2004; Stefanou, Perencevich, DiCintio, & Turner, 2004). In Strobel's 2010 study, scaffolding challenging concepts was key to supporting students'

autonomy as learners because teachers knew when students could move ahead independently having mastered a topic (Strobel, 2010). Similar strategies can be used to support autonomy, including making subjects relevant and allowing students to learn experientially (Strobel, 2010).

College Knowledge

Academic preparedness and tenacity are key to college access and success, but they only form part of the equation. Also essential is a third component of college readiness: college knowledge (Conley, 2007a, 2007b), or the knowledge base, skills, and behaviors (apart from academic content knowledge) that allow students to successfully access and succeed in college. College knowledge includes identifying, gathering, understanding, and using the information necessary to apply for and finance a postsecondary education. First, we review research that examines what students know about the college application process, with a focus on financial aid, and how that knowledge affects their college-going behavior and outcomes. We conclude with a review of research on the development of a college-going culture and diagnostic tools for assessing and improving students' college knowledge.

Individual Level

College aspirations and attainment. Many students aspire to postsecondary schooling, but are under- or mis-informed about admission criteria, the application process, and financial requirements (Venezia & Kirst, 2005; Wimberly & Noeth, 2005). Through a national survey, Venezia and Kirst (2005) documented the aspiration-attainment gap, or the disparity between students' college goals and actual achievement. The authors examined 2,000 responses from ninth- and eleventh-grade students, their parents, and school staff from 23 schools in California, Illinois, Georgia, Maryland, Oregon, and Texas to determine what the students knew about application and financial requirements. Although students expressed an interest in attending

college, they knew and planned very little for it. While 88 percent of students reported wanting to attend college, “most” did not understand the application process and were not worried about college because it “is still years away.” Most students were unaware of course requirements for admission and only 12 percent knew all the requirements (Venezia & Kirst, 2005).

Related research on “college match” supports the finding that students are unaware of their college options. “College match” measures whether “students enrolled in a college with a selectivity rating at or above the types of colleges they would most likely be accepted” (Roderick, Coca, & Nagaoka, 2011, p. 187). Research demonstrates that Chicago Public Schools students tend to “undermatch”—that is, they attend a college that is less selective than their academic achievement might suggest. The rates at which students attended “undermatch” schools points to incomplete or misinformation about their college opportunities.

Although many students consider post-high-school plans, a majority reported not having thought about how they plan to pay for postsecondary education. Results produced by ACT (Wimberley & Noeth, 2005) support Venezia and Kirst’s (2005) findings regarding the divide between students’ postsecondary goals and knowledge. Their survey of almost 3,000 ninth-through eleventh-grade students in 15 schools in Chicago, Charleston, West Virginia, Denver, Los Angeles, New Orleans, and Oklahoma City found that one third of students had not thought about how to pay for college (Wimberley & Noeth, 2005).

Additional research supports some of the ACT report’s findings, in particular those related to college financial planning. These studies focus on questions of who completes the Free Application for Federal Student Aid (FAFSA) and what this means for college access. Using 1999-2000 National Postsecondary Student Aid Study data, which includes information on eight million undergraduates enrolled at institutions that participate in federal Title IV student aid

programs, the American Council on Education (ACE) conducted a correlational analysis to determine what type of students do not apply for financial aid (King, 2004). ACE found that community college students comprised 60 percent of students who do not apply for financial aid. Lower income students, who would benefit most because they are more likely to receive financial assistance, represented 21 percent of non-applicants. Moreover, 55 percent of students filed the FAFSA application after the March deadline, with low-income students less likely than their higher income peers to apply before the deadline (King, 2004). Identifying which students are not submitting the FAFSA application is the first step in understanding how to better educate and help students apply.

Other research examines how additional information on financial aid processes, and FAFSA in particular, might change which students seek financial support. Bettinger, Long, Oreopoulos, and Sanbonmatsu (2009) used Department of Education and National Student Clearinghouse databases to track FAFSA submission patterns among 70,000 H&R Block customers. The sample population consisted of low- to moderate-income families with college-age children in Ohio. Families were randomly assigned to treatment and control conditions. The first treatment group received a partially filled out FAFSA application using tax return information that participants had submitted through H&R Block. The second treatment group received a personalized Estimated Family Contribution (EFC) towards college, but did not receive application assistance. The control group only received a financial aid informational brochure. Those in the first treatment group were 16 percent more likely to submit the FAFSA and up to 30 percent more likely to enroll in college. Simply informing students about financial aid or their EFC had no significant effect on their application completion or college enrollment

rates. Bettinger et al.'s (2009) findings were consistent with Venezia and Kirst's (2005): students were more likely to apply for aid when they received guidance through the application process.

Setting and System Levels

What we understand from research on students' individual college knowledge is that students might be better informed and more likely to apply for financial aid when there are support systems in place to guide them through the process. Resources and expectations at the setting level—in classrooms and schools—figure prominently as factors affecting students' knowledge and aspirations about college.

College-going culture. Conley et al. (2010) define college-going culture as “an environment where adults intentionally emphasize the value and attainability of postsecondary education” (p. 19). This includes informing, encouraging, and assisting students through the process. A college-going culture is critical to increasing students' college readiness, as students who attend high schools where a postsecondary education is expected are more likely to enroll in and graduate from a four-year college (Conley et al., 2010; Corwin & Tierny, 2007; McClafferty, McDonough, & Nuñez, 2002; Perna et al., 2007).

Some evidence suggests that teachers play a significant role in the dissemination of college information. Students are more likely to enroll in college if school staff help them with college applications or entrance exam preparation (Choy, Horn, Nuñez, & Chen, 2000; Perna et al., 2007; Venezia & Kirst, 2005). For example, students across all states in the Venezia and Kirst (2005) study reported talking more with their teachers than their counselors about college plans. This finding underscores the importance of a college-going culture in the students' setting, specifically the role of all adults, not just counselors, in informing them about college options.

The ACT 2005 College Readiness report also corroborates the importance of a college-going culture. Although 84 percent of students surveyed indicated aspiring to attend a vocational school, community college, or four-year university, only two of three high school students considered their school college preparatory. Students primarily ranked non-school individuals (e.g., parents, guardians, friends) as being helpful in exploring post-high school plans (Wimberly & Noeth, 2005). Overall, these students described counselors and principals as offering “a little help,” with teachers being the most helpful among school faculty (31 percent described their teachers as “very helpful” and 43 percent as “a little helpful”). Yet, the same teachers who students relied on most for college information self-reported being unclear about college entrance requirements themselves (Wimberley & Noeth, 2005). The report suggests that schools face a dual challenge: informing teachers about college and financial aid application processes, and developing opportunities for transmitting college knowledge to students. How best to meet these challenges remains unclear.

Nonetheless, related literature suggests a college-going culture can be developed in various ways. The Texas Advanced Placement Incentive Program (APIP) offers one model. APIP paid eleventh and twelfth graders and their teachers for passing an AP exam. In stressing the importance of AP exams and sustaining college-level academic work, APIP provided incentives to promote a college-going culture through monetary rewards. Not controlling for other factors (such as achievement in other courses and GPA), findings suggested that APIP students had higher college enrollment, retention, and graduation rates (Jackson, 2009). Research in Dallas supported the finding that AP exams played a role in creating a college-going culture, at least for some students. A regression analysis suggested that AP course enrollment was a positive indicator that a student will enroll in college (Hall & Johnson, 2011).

Although the APIP study found that AP passage rates correlate with an increase in college enrollment in general, it did not find an effect on college enrollment in four-year institutions. This suggests that two-year college enrollment drove the increase in college enrollment. Results also suggest that Hispanic and black students are more likely to graduate from college. However, because college graduation rates for black students were already trending upwards, the correlation between APIP and college graduation remained unclear (Jackson, 2009).

Research also points to the important role social norms play in how students select colleges (Manski & Wise, 1983; McDonough, 1997). Fletcher and Tienda (2009), in collaboration with the Texas Higher Education Opportunity Project, found that high school peers' perception of higher education institutions influenced students' college selection. Through the project, they surveyed seniors from 105 Texas public high schools in 2002. From a stratified random sample of 13,803 seniors, Fletcher and Tienda (2009) then re-interviewed a random sample of 5,836 high school seniors. Using students' self-reported college preferences, authors found that students were more likely to attend the college of their choice if their classmates preferred the same college. Students were also less likely to attend a college they preferred if their classmates did not prefer it. Students who engaged in informal conversations with their peers about college plans were generally more likely to attend college (Fletcher & Tienda, 2009). Fletcher and Tienda argued that there was suggestive evidence that students who received direct information from their counselors about college were more likely to attend college, but more specificity was required to make larger claims regarding counselors' roles in post-secondary enrollment.

At the system level, researchers like Conley and colleagues (2010) have begun to develop indicators that measure broad contextual factors affecting students' college knowledge. Based on data from 38 public high schools in the U.S. that demonstrated success in preparing underrepresented groups for postsecondary education, Conley et al. (2010) developed the College Career Ready School Diagnostic. This tool is empirically-based, with tests of its effectiveness in tracking college readiness of individual students currently underway. Using interviews, focus groups, online questionnaires, and school observations, Conley and colleagues (2010) identified the following strategies as supports for a college-going culture: 1) aligning high school curriculum with college standards, 2) aligning high school assignments and grading policies with college expectations, and 3) ensuring that high school seniors take a challenging course load. This last point is pivotal given twelfth graders who take easier courses needed remediation at higher rates in college. These numbers are higher for minority, low-income, and first-generation college-goers (Conley et al., 2010).

While Conley et al.'s work provides a conceptual frame to motivate further empirical study of setting-level factors influencing college readiness, research of college knowledge at the system level remains sparse at best. Beyond Conley's research, we found few rigorous studies examining how districts and states can monitor their own role in fostering college knowledge, an issue we raise in the next section of this review.

Directions for Future Research

We use this review of the literature to highlight several major gaps in existing studies on college readiness indicator systems. In particular, extant research typically fails to acknowledge that 1) high school graduation and college readiness are not the same, 2) early warning systems therefore tend to omit important factors other than academic preparedness that inform college

readiness, 3) predictive indicators are not the same as actionable indicators, and 4) the settings and systems in which students find themselves influence postsecondary access and outcomes. We address all of these shortcomings by examining indicators of college readiness that extend beyond academic preparedness to include academic tenacity and college knowledge, and by examining actionable indicators at three different organizational levels: individual, setting, and system. In total, this framework suggests opportunities for educators to address a much broader range of factors that influence college readiness, as well as to monitor their own role in producing college-ready graduates.

While our approach substantially shifts the conversation on college readiness indicators, it also only scratches the surface on what educators and researchers alike need to accomplish in order to truly produce indicator systems capable of disrupting the cycles of low college enrollment and readiness they predict. Our findings suggest several broad areas to which future research can contribute. First, studies could better show how indicators related to academic preparedness, academic tenacity, and college knowledge are interrelated and interdependent. Said differently, research could elucidate when these indicators measure the same thing, and when they capture unique facets of a student's college readiness. This contribution is especially important given research tends to suggest that, while each facet of college readiness is necessary, no one alone is sufficient to produce college-ready students. Current studies on the importance of GPA represent a case in point. Most early warning system research finds that GPA predicts college outcomes as strongly as virtually any other indicator. Yet, beyond a few hypotheses, no studies demonstrate whether GPA proves such a powerful indicator because it measures academic preparedness, tenacity, or college knowledge. For example, GPA may capture academic ability, but it likely also measures a student's motivation and knowledge of the school

norms that underlie high performance. Ultimately, just how connected are these different dimensions? Can academic performance be improved without also boosting academic tenacity and vice-versa? Knowing where these dimensions of college readiness do—and do not—overlap carries important implications for how indicator systems can be used to improve student outcomes. If these dimensions are distinct, then interventions and supports could be targeted to each. If, however, the dimensions are all part of a single construct that may loosely be called “college readiness,” then addressing them individually may be much less effective than addressing them in tandem. Though no single study addresses this interconnectedness, in the aggregate, related studies suggest college readiness combines academic preparedness, tenacity, and college knowledge in ways that cannot (and perhaps should not) always be disentangled.

Second and related, better measures of each construct—and academic tenacity in particular—could be developed, especially measures that can be used on a sufficient scale to improve college readiness for more than a handful of students. Though research documents that some districts currently try to measure academic tenacity and college knowledge, the tools at their disposal remain limited. For instance, many schools and districts rely on self-report questionnaires to determine whether students evince tenacity and an understanding of the college processes, like enrolling and securing financial aid. In addition to being costly and time consuming, these surveys do not necessarily provide teachers with the information they need to conduct successful interventions related to tenacity and college knowledge. As previously discussed, successful tenacity-based interventions tend to rely on teachers conducting individualized data collection related to student habits, a different process than asking hundreds or thousands of students a standard battery of questions. Ultimately, research has yet to show whether dimensions of college readiness other than academic preparedness can be measured in

standardized ways and, if so, whether these measures can be used to produce the small-scale interventions in the tenacity- and college-knowledge literature at a much broader level.

Third, research could help draw a clearer distinction between predictive indicators and actionable indicators. As previously discussed, an indicator may forecast college outcomes with some precision, yet still constitute a measure that cannot or should not be acted upon. An indicator may be predictive but not actionable for a variety of reasons. For one, research begins to show that setting targets on particular measures can produce unintended consequences. As an example, Conley (2007a) demonstrates that efforts to raise GPA (whether organized or informal) have produced grade inflation without any commensurate improvement in students' academic skills. Broadly, educators need a better sense of when trying to move a given measure produces more harm than good. Another reason an indicator may not be actionable is that the construct it measures proves much less malleable than for other indicators. For instance, research has yet to prove whether grit represents an innate student trait or a pliable state of mind. If the former, then significant efforts to improve a student's grit may prove ineffectual. Regardless of the specific reason an educator may not wish to build supports around a given indicator, research can help show when a particular indicator-based support is likely to prove futile or, even worse, counterproductive.

Fourth, in the rare cases research demonstrates that an indicator can be tied to an effective intervention, few if any studies compare the cost effectiveness of these interventions. In an era of severe resource constraints, educators could benefit from knowing not only what works, but how to maximize efficient use of their funding and personnel in the process. As an example, Bettinger, Long, Oreopoulos, and Sanbonmatsu (2009) showed that providing basic support filling out the FAFSA can significantly increase the number of students enrolling in college, a

relatively cost-effective intervention. While one might assume that helping parents complete the FAFSA proves more cost-effective than trying to improve SAT performance or generate increased academic tenacity, no research documents as much. Given this void in the literature, practitioners are left to make fairly uninformed guesses about which intervention will produce the greatest results for each dollar spent.

Finally, on all fronts, additional research is needed on what setting- and system-level indicators educators should use to monitor their own role in producing college-ready students. While we suggest a variety of these indicators in this review of the literature, most of these indicators were identified by aggregating individual measures up to the school, district, or state level. For instance, districts can monitor whether increasing numbers of students take and pass AP tests. Research shows these aggregate measures provide valid indicators at the setting and system levels, yet studies identify few if any indicators tied to specific school, district, or state practices that influence college readiness in less direct ways, like generating a college-going culture. Such indicators may relate to policies around educational atmosphere, resource allocation, professional development, and data use.

Notes

1. See: The Consortium on Chicago School Research's follow-up on their student on-track metric (Allensworth & Easton, 2007) and New Visions for Public Schools' Tracker (<https://knowledgebase.newvisions.org/resource/loadresource.aspx?ArtifactId=3298>).
2. "Postsecondary outcomes" refers to these three outcomes in the remainder of the paper.
3. Research labels non-cognitive factors as such, since they are typically not measured by pervasive cognitive tests, like high school exit and college entry examinations, which tend to focus purely on academics.
4. Dweck (1999) measured intelligence mindsets using a "Theory of Intelligence Questionnaire," which had students rate six items on a six-point Likert-like scale.

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