Developmental Mathematics in 4-Year Institutions: Denying Access

By Irene M. Duranczyk and Jeanne L. Higbee

ABSTRACT: ***In this article we use two avenues to make a case for retaining developmental mathematics education at 4-year postsecondary educational institutions. First we review the literature surrounding inadequate preparation for college-level mathematics. Then we report results from a qualitative research study that examined students' perspectives on policies related to relegating all developmental mathematics course offerings to 2-year institutions. We conclude that both students and institutions benefit from making developmental mathematics available at 4-year institutions.***

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Many studies have demonstrated the effectiveness of developmental education through a variety of research methods (Boylan, Bliss, & Bohnam, 1997; Boylan, Bonham, Claxton, & Bliss, 1992; Roueche & Roueche, 1993; Thomas & Higbee, 1996; Waycaster, 2001), especially in terms of student retention (Durant, 1992; Lyons, 1994; Simmons, 1994; Umoh, Eddy, & Spaulding, 1994). This research has not provided sufficient rationale on a political level for higher education to embrace developmental education, particularly at 4-year colleges and research universities (Jenkins & Boswell, 2002).

Denying Access

Who are the students who would lose access to 4-year colleges and universities if developmental education is relegated to the community colleges? What effect would this decision have on underprepared students from traditionally underrepresented populations? What effect would this decision have on 4-year postsecondary institutions? American College Testing (ACT Newsroom, 2005) reported that only 41% of students graduating from high school in 2005 scored a 22 or higher on the ACT math test (ACT, 1959), indicating they had a high probability of succeeding in college algebra. That leaves a potential 59% majority pool of incoming high school graduates whose low ACT math scores indicate they could benefit from developmental mathematics services offered throughout postsecondary institutions. What will be the impact of denying these services at the 4-year college and university level?

Issues Relating to Transfer From 2-Year to 4-Year Institutions

We know from Pascarella and Terenzini's (1991) compilation of research that

> There is consistent evidence that initial attendance at a two-year rather than four-year college lowers the likelihood of one's attaining a bachelor's degree.... Baccalaureate aspirants who enter two-year colleges tend to have lower levels of educational and degree attainment than do comparable individuals who enter four-year institutions. (pp. 372-373)

Pascarella and Terenzini (2005) quantified this 4-year college advantage: "Studies continue to report that, net of other relevant factors, beginning pursuit of a bachelor's degree at a two-year rather than a four-year institution reduces by about 15 percentage points the chances of ever earning that degree" (p. 639). Thus, evidence emerging since 1990 has tended to support the proposition that even after adjusting for students' precollege characteristics, including degree plans, 2-year college enrollment may reduce students' degree aspirations. Initial attendance at a 2- versus 4-year college or university appears to decrease the likelihood that capable students from populations traditionally underserved by higher education in the U.S. will persist. As Boylan explained,

> Developmental education is best carried out in environments where students are also immersed in the culture of academe.
>
> At this point, the majority of those who start out at a two-year institution never receive a baccalaureate degree. Unless the resources and support are provided for community colleges to enhance their college transfer programs, forcing underprepared students to take remediation at two-year schools will probably reduce the number of university graduates in this country. It will particularly reduce the number of low-income and minority students who receive university degrees. (Stratton, 1998, pp. 27-28)

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Retention and Graduation as Measures of Success

Measures that developmental education programs often use to determine the degree of success or failure include successful developmental education course completion, developmental education course grades, subsequent grades in related coursework, grade point average (GPA), retention rates, and graduation rates (Boylan & Saxon, 1998). Although such measures do provide program success indices, they are incomplete. Statistics on course completion, grades, retention, and graduation serve the needs of programs more than the needs of individual students. Measures of higher education program success are modeled on serving the needs of traditional, adequately prepared students.

Nontraditional students—whether in terms of age, heritage, socioeconomic status, or educational history—often do not have the luxury of approaching higher education as full-time residential students, employed for fewer than 20 hours per week, supported primarily by their parents, and without the responsibility of caring for dependent family members. Program success measures based on completion rates, length of time needed for completion of an undergraduate degree, attendance rates, and academic and social integration may provide relevant success data for traditional students, but nontraditional students' goals in higher education may be impacted by barriers that make these indices inaccurate and irrelevant. Developmental education students from nontraditional, underprepared, and underrepresented populations do not mirror traditional college students' behaviors or needs. Collecting and comparing similar statistics for traditional and nontraditional students may not include or provide some important data on student success (Edu, 1997; Jalomo, 1995; Roueche & Roueche, 1993). Administrators question the viability and cost-effectiveness of developmental education programs when comparing postsecondary program outcomes for underprepared students to outcomes for academically proficient students (Lyons, 1994).

The larger societal questions always remain. How does the developmental mathematics experience affect individual students' lives? How does the presence of developmental education students benefit the institution? What are the salient experiences that students take with them as they continue their journey through life? What are the short- and long-term effects of developmental education from the perspective of the students?

Issues Considered in Developmental Mathematics

Developmental education encompasses several academic disciplines, although developmental mathematics courses dominate, particularly at the university level (Parsad & Lewis, 2003). Developmental mathematics students often meet all other admission standards but have limited educational options because of their poor mathematics skills. Although only 14% of incoming college freshmen in the U.S. enrolled in developmental English courses in Fall 2000, 22% of them enrolled in developmental mathematics courses (Parsad & Lewis). ACT's (2005) college readiness benchmarks in English and mathematics showed an even larger disparity: 32% versus 59% of test takers scored below the college benchmarks in English and mathematics, respectively. Despite the educational needs demonstrated by incoming freshmen at universities, some state legislatures or boards of higher education would relegate all developmental education to community colleges (Jenkins & Boswell, 2002). The largest proportion of 1st-year college students taking a developmental course at public 4-year institutions in 2000 took developmental mathematics (80% of all remedial students) compared to developmental reading (30% of all remedial students) and developmental writing (45% of all remedial students). Eliminating developmental coursework beyond community colleges will impact at least 35% of 1st-year developmental students who only have deficits in mathematics (Parsad & Lewis). An examination of mathematics education in the U.S. identifies the continuing need for developmental mathematics services at all levels of the postsecondary education continuum.

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A Critical Framework for Examining Mathematics Education

Four critical issues foreshadow the need for developmental mathematics education: (a) elementary through secondary (K-12) educational systems that advantage some students and disadvantage others, (b) variations in mathematics standards, (c) tracking, and (d) affective barriers to mathematics achievement.

Educational disadvantages. There is a body of research showing that the American education system is differentially effective for students depending on their social class, race, ethnicity, language background, gender, and other demographic characteristics. It is clear from the "mathematics report card" that: (a) students with higher scale scores reported higher levels of parental education; (b) students eligible for free- or reduced-lunch programs scored lower than those not eligible; and (c) Black, Hispanic, and American Indian students' scores remained below the scale scores for White students (Reese, Miller, Mazzeo, & Dossey, 1997). Looking specifically at 12th-grade student performance, 38% of students nationally scored below the basic level in mathematics, which would indicate a need for developmental mathematics at the college level.

Gender is another factor related to mathematics achievement according to findings from U.S. participation in the Third International Mathematics and Science Study (TIMSS; U.S. Department of Education, 1998). This study looked at over 20 countries, assessing the general knowledge of mathematics attained by all students in their final year of secondary education and the achievement in mathematics of students taking advanced coursework in that subject. Twelfth graders in the United States scored below the international average and among the lowest of the 21 nations that participated in the assessment of general knowledge, scoring 61 points below the highest performing countries and 39 points below the average of all countries. A significant gender gap existed in advanced mathematics with males outperforming females (457 versus 426 average score in advanced mathematics). The U.S. was one of the 11 TIMSS countries having a significant gender gap

Variations in standards. Mathematics standards vary significantly from state to state and from elementary-secondary (K-12) school district to school district. Concomitantly, postsecondary mathematics requirements can also vary considerably from state to state or from institution to institution. For example, differences in high school graduation requirements explain further variance in mathematics proficiency in the U.S. In the TIMSS study, 35 out of 38 countries had national standards, policies, and requirements for high school mathematics education (U.S. Department of Education, 1998). There are no nationally established high school mathematics graduation requirements in the United States. Many states do not have standard high school mathematics graduation requirements. The North Central Association of Colleges and Schools, for example, does recommend that accredited high schools offer 4 years of mathematics but does not require that graduates take those courses, nor does it specify what courses might be included in those 4 years of

mathematics education. Often local school districts are able to set their own standards; high schools within the same district may even vary in expectations and standards. In states that have decentralized higher education systems, each public postsecondary institution may have its own standard for college mathematics preparation, necessitating local K-12 school districts to confer with college admissions officers to acquire college mathematics preparation guidelines or requirements. The National Assessment of Educational Progress (Hawkins, Stancavage, & Dossey, 1998) determined that in high schools requiring 2 years or less of mathematics for graduation, 35% of graduates have 1 year or less of algebra preparation. In high schools requiring 3 or 4 years of high school mathematics, 26% of graduates have 1 year or less of algebra preparation. Based on these statistics, one-fourth to one-third of all graduating high school students will need developmental math.

There is a dichotomy between policies and practices as operationalized in the U.S. and set forth in the guiding principles of equity and mathematics for all by the National Council of Teachers of Mathematics (NCTM; 2000) and the American Mathematical Association of Two-Year Colleges (Cohen, 1995). There are structural injustices in how opportunities are distributed (Oakes, 1990; Secada, 1992); developmental education students are aware of this dichotomy and are impacted by it.

Tracking. Beyond these variances, "tracking" is alive and well in the U.S. (Reese, Miller, Mazzeo, & Dossey, 1997). Mathematical proficiency is often used as a basis for decisions regarding further schooling and job opportunities. By the eighth grade, students have been tracked into distinct educational and vocational pathways. Some progress is occurring: 33% of eighth graders in 2004 reported taking eighth-grade mathematics compared to 61% in 1986. The other eighth-grade students in the 2004 cohort took more advanced mathematics courses: either prealgebra (32% in 2004) or algebra (29%). When asked about high school mathematics, 21% of the eighth graders were not planning to take algebra or a higher-level mathematics course (Reese et al., 1997).

The percentage of 17-year-olds in the U.S. having completed coursework beyond Algebra II was still only 17% in 2004. Only 8% of Black 17-year-olds and 14% of Hispanic 17-year-olds progressed beyond Algebra II compared to 19% of White students (Perie, Moran, Lutkus, & Tirre, 2005). Although 63% of high school graduates go to college, only 43% follow a college preparatory curriculum (Breneman & Haarlow, 1998).

Affective issues. Affective issues have been shown to play a central role in mathematics learning. Noncognitive factors impact student performance and interest in mathematics. Although the National Council of Teachers of Mathematics (2000) has adopted the philosophy that all students can learn mathematics, there is a widely held belief in the U.S. that only some students can succeed in mathematics. This belief is based on assumptions about innate ability: stereotypes that result in lower parent and teacher expectations for females, students who live in poverty, and non-Asian students of color (Oakes, 1990; Secada, 1992; Singham, 1998). These attitudes toward students as learners of mathematics can impact student achievement. Other affective variables, such as students' own confidence in their ability to learn mathematics, have also been shown to play a central role in mathematics learning in general (McLeod, 1993; U.S. Department of Education, 1998) and among developmental education mathematics students in particular (Bempechat, J., Nakkula, M. J., & Wu, J. T., 1996; Dwinell & Higbee, 1991; Goolsby, Dwinell, Higbee, & Bretscher, 1994; Higbee & Dwinell, 1995; Higbee & Thomas, 1999). In the TIMSS study, "There was a clear positive association between self-concept and mathematics achievement within every country and within every benchmarking jurisdiction" (Mullis et al., 2001, p. 129).

[Students] made very passionate statements about being accepted into a university that would allow them to take developmental mathematics on campus.

Method

In 2001, 54 individuals who completed their developmental coursework at Eastern Michigan University (EMU), a comprehensive, urban, public university in the Midwest, between 1994 and 1998 were invited to participate in this research study. Emphasis in student selection was placed on developing a purposive sample to capture maximum variation by age, gender, race, income, and college majors served by the program. The sample included first-generation college students and students who had transferred from a community college to the university. Of the 20 former students who agreed to participate and completed the initial survey form, 18 were interviewed. The group was made up of (a) 7 traditional age students and 13 nontraditional age students, (b) 5 male and 15 female students, (c) 2 minority and 18 nonminority students, (d) 7 first-generation college students, and (e) 5 economically disadvantaged students. This sample was statistically parallel to the student population at EMU.

The study applied critical ethnographic procedures to an outcomes data analysis relevant to a case study approach. Four general analytic strategies were used to complete the analysis of survey responses and interview transcriptions: analytic induction, constant comparison, typological analysis, and enumerations (McLaughlin & Tierney, 1993). The researcher and two peer examiners triangulated the emergent themes after multiple readings of the transcripts and reviews of survey documents submitted by the former students. These themes were embedded within students' descriptions of their experiences and woven into their answers to questions posed.

Discussion of Results and Implications

This article reports on the results of just one of the themes explored in this qualitative research study (Duranczyk, 2004), specifically students' attitudes about completing required developmental education courses at a community college rather than at the university at which they were enrolled. This practice is but one solution being used in states or public systems of higher education where developmental education has been banished from all 4-year institutions. Institutions must devise ways to serve students who, based on results of math placement tests, are not adequately prepared to enroll in the institution's lowest level of graduation-credit-bearing mathematics. For 4-year institutions situated in locations where a 2-year campus is nearby, one alternative has become joint enrollment, with university students completing their developmental education courses at the 2-year institution while taking their other courses at the university.

Student Perceptions of the Need for University-Level Developmental Mathematics

In this study (Duranczyk, 2004), 13 participants gave a clear picture of the importance of developmental mathematics at the university level. Five who were placed in developmental mathematics made very passionate statements about being accepted into a university that would allow them to take developmental mathematics on campus rather than requiring them to enroll in a community college mathematics course. Of the same 13 participants, 4 others elected to take the developmental courses even

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though they were not required. These students met the university placement guidelines necessary to enroll in a college-level mathematics course but elected to take a developmental course first because they felt inadequately prepared or because they attended a college-level course during the first few weeks of class and were overwhelmed. For them, taking developmental mathematics did not represent a stigma but an opportunity to overcome mathematical anxieties or lack of preparation and to develop mathematical proficiency to pursue a goal that they might otherwise have relinquished. Each of these four students ended up taking more than three mathematics courses beyond developmental mathematics. They discovered that mathematics no longer limited their options but could empower them. Developmental mathematics at the university opened that door.

The following statement comes from a nontraditional-age student who took more than nine mathematics courses beyond developmental mathematics, tutored mathematics, and was a Supplemental Instruction leader. When asked about how she would have reacted had she been required to take developmental mathematics in a community college instead of at the university she said,

> I would have been horrified. I would have thought that it was really unfair, and I would have been angry. Typical of me, I probably would have been angry, but I would have done it, too. I'm not one to really protest. I just silently bitch somewhere, but I think, I don't know, it doesn't seem like a good policy to me. (Duranczyk, 2004, p. 59)

A business major who also tutored mathematics shared her opinion:

> That's ridiculous. No, no, wrong, wrong, absolutely wrong. That's going to make me feel like I am the dummy. That's going to make me feel more demoralized. That's going to make me feel more like I can't do it, like I'm different, like, um, I'm lower, I'm a lower level. Because I wasn't a lower level at, at other things, at certain things. It was just this area where I hadn't gotten the support I needed in high school....But other classes that I was taking at the college level helped give me the momentum to work hard at just that one area and then get up to speed. (Duranczyk, 2004, p. 59)

From these statements one becomes aware of the underlying tensions experienced by some of the student participants, even years after completing many of the hurdles a college education demands. Students who are undereducated and from underrepresented populations exhibit many uncertain attitudes and behaviors and frequently relate thoughts of inadequacy based on their histories of academic failure. These students' potential will never be realized if institutional policies serve as a barrier to their persistence and retention at the institution.

Major themes in this qualitative study were related to (a) quitting, (b) reinforcing feelings of personal or educational inadequacy, (c) placing a stigma on top of the already present lack of self-esteem or positive academic self-concept (Higbee & Dwinell, 1996), and (d) not pursuing a career that demands mathematics proficiency. When asked about the possibility of being required to take developmental mathematics at the community college, one university student said,

> I probably wouldn't have gone back to college. Because you know what? If I thought that my whole placement—my whole chance of getting into college was based on a math test, I probably would have said, "You know what? This isn't for me." I was already thinking that way when I came out with my associate's degree. So, I probably would have been very discouraged, and I probably wouldn't have made it all the way through. For real! I would have been so intimidated by that. You know I might even have tried it, but I probably wouldn't have made it because where would I go, what would I do? I have this associate's degree and I've got to go back to the same college and take some classes to get into another college? I probably would have been very much discouraged. I think I would have thought of it as too much work. (Duranczyk, 2004, p. 60)

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Another student explained,

> I would have felt very inconvenienced. I would have had to go through the whole process of having to reapply at [community college's name deleted] and having to register at [community college's name deleted] and having to go back there instead of coming here... Yeah, I would not have liked that at all. (Duranczyk, p. 60)

A student commented,

> I think it would have been easier to feel that you were, kind of, stigmatized if I would have had to go to a different campus to—I mean it would have—maybe not me but other students could possibly feel that it's another way that you don't belong on the university campus. (Duranczyk, p. 60)

Finally, one student shared,

> I'd be kind of angry because if they were willing to accept me into the university I'd feel that I should be able to take my classes at the university. If they were telling me I have to go to another school because I was not ready for their classes, I'd be kind of mad. I'd feel really hurt by the school that they didn't want me at that point in time and that I needed to leave. So, I wouldn't like that at all. (Duranczyk, p. 60)

Another compelling reason students expressed that developmental education services are needed at the university level is embedded in the registration and add-drop process. When students register for a course and then believe or have evidence that they are underprepared within the first weeks of the semester, it is important for them to be able to correct the situation: to select a prerequisite course without undue financial and logistical complications. The institution where this research study was conducted is one of several now enabling students to drop and add, or even do a "section change" (Higbee, Dwinell, & Thomas, 2002) from a credit-bearing mathematics course to one that will help better prepare them to succeed. Without this type of system on campus, students either remain enrolled in a class in which they feel "lost" or withdraw from the course, only to reenroll the following term and find themselves in the exact same position. Thus, academic failure often results and student retention is affected.

> It would have screwed up things in a major way. First of all, we, I would have had to drop 104 [intermediate algebra], losing all that money. Okay? [Instructor's name deleted] [was] able to get me the transfer slips proper, to transfer the class from one class to the other class, without losing a single penny. . . . If that class [beginning algebra] had not been offered at EMU, I could've easily lost my financial aid.... My ex-husband would have been saying, "I told you so." My father would have been saying, "See? You shouldn't have even tried to do this." (Duranczyk, 2004, p. 61)

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Employment concerns, the length of time since their last mathematics course, and the demands of their newly chosen career paths made the option of pursuing developmental mathematics while taking university nonmathematics-based college coursework a necessity. The availability of this option enabled them to maintain their work, family, and student status without additional conflicts. They were nontraditional-age students with gaps in their educational pursuits. The one traditional-age student who transferred from a community college found that taking developmental mathematics during his first semester at the university enabled him to establish a sense of community and belonging. He had been an outsider throughout his elementary, secondary, and community college experiences. At the community college this student "avoided it [mathematics]. Well, I lucked out. It wasn't required, number one, and number two, because it wasn't required I could avoid it as long as possible" (Duranczyk, 2004, p. 62).

However, when entering the university, mathematics was one of the first classes he took:

> I didn't know if I would make it, to be honest with you. There again I didn't have the self-confidence. It wasn't just math. I didn't know if I could make it period. I took a light schedule that first year because I didn't know if I could cut the mustard. I felt a bit out of place. (Duranczyk, 2004, p. 62)

Later he stated, "Gaining more self-confidence which I gained from the developmental mathematics program has had a very positive impact on my life" (Duranczyk, p. 62).

Only 1 of the 13 student participants believed that taking developmental education courses at a community college while enrolled at the university would be acceptable. The considerably lower tuition costs at a community college compared to the university did not pose a major concern for participants. Time, transportation, and other logistical issues were the far more prevalent concerns. The participants in this study clearly appreciated and benefited from the incorporation of developmental mathematics at the university level.

Developmental Mathematics Students' Contributions to the University

When considering the elimination of the developmental education mathematics curriculum at 4-year institutions, it is important to look beyond how we serve students to consider the contributions these students make to our colleges and universities as well. How does the institution benefit? The nontraditional-age students who participated in this research offered a college-peer yet adult-parent figure to the traditional-age students. The nontraditional-age students became counselors, tutors, Supplemental Instruction leaders, and mentors to the traditional-age students within the developmental education mathematics program and across the university. The involvement of nontraditional-age students in instructional support roles impacted the developmental mathematics program and the overall university community. Throughout this qualitative research study, many students related stories of how they counseled, tutored, and mentored traditional-age students because of the footing they found within the developmental mathematics program. One commented, "And I've always said to the young people, 'If it needs a prerequisite, do it. I know it's going to delay you, but in the end you're going to be so much better off because you'll enjoy the class'" (Duranczyk, 2004, p. 63).

The university student who is taking the mathematics class at a community college on a part-time basis may not qualify for any counseling and learning support services.

Impact of the Developmental Education Mathematics Program on Retention

Finally, the number of participants who attributed attaining a sense of belonging at the university to their involvement in the developmental education program and the impact of that connection cannot be minimized. Participation in smaller classes, development of a sense of community, and opportunities to interact with faculty both within and outside the classroom are all factors that influence college student development and retention (Astin, 1993; Chickering & Reisser, 1993). As illustrated in some of the student quotations, students whose affiliation with the university might otherwise have been tenuous at best found their niche within the institution's developmental education mathematics program, in spite of their initial lack of preparation or confidence in their ability in the subject matter. Taking developmental mathematics at a community college instead would have interfered with, rather than heightened, this sense of community.

Conclusion

Through both a thorough review of the literature and student testimony, we have attempted in this article to establish an argument for retaining developmental education, and particularly developmental mathematics courses, at 4-year postsecondary educational institutions. There are many students who are otherwise well qualified to attend 4-year colleges and universities who need further preparation in mathematics to be successful and meet their educational and career goals. When developmental education is banished from these institutions, students who are underprepared in mathematics are generally forced into one of three situations: They are either (a) unable to gain admission to the institution, (b) admitted but required to complete one or more precollege-level mathematics courses elsewhere, or (c) put into a "sink or swim" situation in a college-level mathematics course for which they are not adequately prepared and in which they are likely to fail. None of these scenarios is in the best interest of the student *or the institution.*

Given the variation in mathematics standards from state to state and among local school districts, as well as the systemic differentiation in mathematics preparation at the K-12 level on the basis of race, culture, gender, and socioeconomic status, refusing to admit students who need additional preparation in mathematics deprives the institution of the opportunity to enhance the educational experiences of all students in a diverse community of learners (Antonio, 2001; Blimling, 2001; Gurin, Dey, Hurtado, & Gurin, 2002; Milem & Hakuta, 2000; Smith & Schonfeld, 2000). Admitting students but requiring them to enroll simultaneously in a mathematics course elsewhere limits students' sense of connection to the institution, and is likely to have an adverse impact on retention and graduation rates (Pascarella & Terenzini, 1991, 2005). In addition, for the student who is impacted by affective barriers to mathematics achievement, a lack of coordination of services—such as counseling for mathematics anxiety—between the student's "home" institution and the 2-year college where such issues might first be recognized or "diagnosed" may well result in the student never receiving appropriate help. Thus, even if the developmental mathematics faculty member of the community college notes the role of affective factors related to the student's performance, that faculty member is not likely to be well acquainted with services available at the 4-year institution. Meanwhile, the university student who is taking the mathematics class at the community

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college on a part-time basis may not qualify for any counseling and learning support services at that institution. Similarly, placing students in classes for which they do not have the "building blocks" to be successful will only lead to dissatisfaction with the college experience and a greater likelihood of either being dismissed for academic reasons or choosing to leave. Even for students who are retained at the institution, any policy that limits students' opportunities to interact with mathematics faculty at their own institution also reduces the likelihood that those students will be advised and mentored to pursue collegiate majors and careers that require mathematical proficiency (Pascarella & Terenzini, 1991, 2005).

The costs of banning developmental mathematics from 4-year institutions certainly outweigh any benefits from the perspective of prestige or other intangible supposed gains. Individual institutions, as well as state systems of higher education, should take the time to weigh the costs and benefits before making policy decisions that can affect the institution, as well as having a serious negative impact on the educational goals of individual students.

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