First-Year Seminars: An Effective Developmental Strategy for Remedial Mathematics?

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Many students who begin college do not persist to degree completion. The National Center for Education Statistics reports that 62 percent of students who enter college at a public four-year institution graduate within 6 years (Hussar et al., 2020). The challenges are even greater for those who come to college underprepared. Many are placed into remedial or developmental courses (Ganga, Mazzariello, & Edgecombe, 2018) and the success rates for these courses are low (Bahr, 2008; Bailey, Jeong, & Cho 2010). Of students placed into developmental mathematics, only half complete developmental course sequences (Chen, 2016). The low completion rates of developmental course sequences have both economic and social consequences for students.

Some have criticized approaches taken by post-secondary institutions to support underprepared students (Complete College America, 2012). These criticisms have resulted in a growing body of research on developmental education reforms. Much of this extant literature has focused on reforms such as remedial course placement (e.g. Hodara, Jaggars, & Karp, 2012; Hughes & Scott-Clayton, 2011; Ngo & Kwon, 2015), instructional delivery methods (emporium, face-to-face, and online; e.g. Bishop, Martirosyan, Saxon, & Lane, 2017; Zavarella, & Ignash, 2009), pathways (Rutschow & Diamond, 2015), and accelerated or co-requisite remediation models (Edgecombe, 2011; Jaggars, Hodara, Cho, & Xu, 2015). Evaluating the effectiveness of these reforms is important but may fail to consider the impact of developmental programs outside of placement and remedial curriculum (e.g., summer bridge, tutoring, advising). First-year seminars are an example of an initiative outside the traditional developmental core (mathematics, reading, writing) with purported value in the literature (Kuh, 2008; Mayhew et al, 2016). These seminars are also commonly available at most colleges and universities, which

make them ripe for intervention with special populations. The purpose of this study was to explore the effectiveness of first-year seminars for students placed into remedial mathematics. Findings from this study may help institutions identify more comprehensive developmental education strategies for those who come to college underprepared.

Literature Review

Developmental Education

Some students enter college lacking the necessary literary and mathematical skills to be successful at the post-secondary level. Chen (2016) reported that "68 percent of those who started at public 2-year institutions and 40 percent of those who started at public 4-year institutions took at least one remedial course during their postsecondary enrollment" (p. 15). Given that the National Center for Education Statistics projects that roughly 19.7 million students will enroll in U.S. colleges and universities in fall 2020, the potential impact of remedial course-taking is profound. The estimated costs of remediation may exceed $2 billion annually in the U.S. (Strong American Schools, 2008).

Despite the number of students placed into remedial courses, this phenomenon is not new (Chen, 2016). The percentage of students placed into remedial courses today are only marginally different from those reported in the early 1980s (Chen, 2016). The reasons for remediation are varied (Munsch et al., 2015). In some instances, remediation may improve access to post-secondary education within local communities. In other instances, remediation may be necessary to improve preparedness for those transitioning out of secondary schools. Regardless, remediation has been a part of our post-secondary system for much of its existence.

Various terms have been used to describe remediation in college. Developmental and remedial education are both used to refer to courses and programs that support underprepared

students. Although these terms are used interchangeably, contemporary literature differentiates remediation from developmental education. The National Organization for Student Success (formerly NADE) defines developmental education as programs and services that "includes, but is not limited to, tutoring, personal/career counseling, academic advisement and coursework" (NADE Executive Board, n.d.). It is suggested here that *developmental education* refers to the broader support structures and systems designed to aid student success, while *remediation* refers to specific coursework required to prepare students for college-level coursework.

Early remediation focused primarily on reading and study skills but have evolved into specific courses in reading, writing, and mathematics. For example, a remedial mathematics course today may include topics on algebraic concepts and notation, geometry, and linear and quadradic equations in order to prepare students for college-level pre-calculus or calculus courses. Students placed remedial courses must successfully pass them prior to enrollment in college-level courses. The concern is that students enrolled in remedial courses "are the most at-risk population for drop-out and stop-out" (Munsch et al., 2016). Additionally, a higher percentage of students requiring remediation are often placed into remedial mathematics. Bailey et al. (2010) reported that only 33 percent of students referred to remedial mathematics completed their remedial course sequence. Further, half of remedial course completers successfully passed the college-level course.

Institutions need to develop more comprehensive strategies to address remedial course completion rates, particularly in mathematics. Recommended strategies include the use of freshman seminars, learning communities, and paired courses to support skill development (Boylan, 1999). It has also been suggested that "developmental education professionals must partner with those in academic advising roles, orientation and/or in the first-year experience

programs" to ensure students are familiar with the learning opportunities available to them (Munsch, 2016, p. 12).

First-Year Seminars

The term first-year experience refers to collective set of curricular and cocurricular initiatives designed to support students' first year in college. First-year seminars (a.k.a., first-year experience courses, student success courses, and frameworks courses) are a component of the first-year experience. The purpose of these seminars is to support the student transition into college by focusing on the needs of students and expectations of institutions (Hunter & Linder, 2005). The design and format of first-year seminars vary between institutions, but Barefoot (1992) offers a general typology of them. The types of first-year seminars include a) extended orientation seminars, b) academic seminars with generally uniform academic content, c) academic seminars on various topics, d) paraprofessional seminars, and e) basic study skills seminars. The most common type of seminars are extended orientations, although the use of more academically-focused seminars has grown in recent years according to national data (Young & Hopp, 2014).

First-year seminars (FYS) are one of several high-impact practices reported to enhance student engagement and increase student success (Kuh, 2008). They are also among the most commonly used student success strategies on college and university campuses. Young and Hopp (2014) reported that 86% of 2-year institutions and 91% of 4-year institutions offered a first-year seminar in 2012. Despite the widespread use of these first-year seminars, they are not always required of students in remedial courses. Further, research has produced mixed evidence regarding their effectiveness. Robbins et al. (2009) explored the effectiveness of various post-secondary strategies (academic skills, self-management, socialization, and first-year experience

programs) among a meta-analytic sample of 32 studies. Findings indicated only weak effects from first-year experience programs on student academic performance and retention. First-year experience programs were found to be meaningfully related to the study skills facet of motivational control. These study skills may be more relevant to underprepared students.

A separate meta-analysis conducted by Permzadian and Credé (2016) explored the effects of seminar type on academic performance and retention. First-year seminars had "only a very small positive effect on the first-year GPA and only a slightly stronger positive effect on the 1-year retention," but results were moderated by seminar type (p. 313). First-year seminars were more effective at increasing one-year retention rates when they were delivered as extended orientations, taught by full-time faculty and administrators, and targeted to all first-year students. When the aim was to increase academic performance, seminars with an academic component were more beneficial to students. Further, first-year seminars were more effective at 2-year institutions than at 4-year institutions, possibly because of the greater proportion of underprepared students and the open-access nature of these institutions. Some populations of students (i.e., underprepared students) are more likely to benefit from first-year seminars.

More recently, Culver and Bowman (2020) conducted a study using a multi-institutional sample to explore the impact of first-year seminar participation on GPA, satisfaction in the first and fourth years, retention, and four-year graduation rates. Only satisfaction in the first year was found to be statistically different between participants and non-participants, after controlling for non-random assignment through propensity score modeling. ACT scores were examined as a moderating variable in the analysis (low/high ACT) and satisfaction differed based on these scores (higher ACT or level of college preparation resulted in higher student satisfaction). The

problem is that standardized test scores alone do not fully capture the diversity of underprepared students or the reasons for their placement into remedial courses.

A comprehensive approach to developmental education must consider that not all students who leave high school go directly into college (Boylan & Bonham, 2011). Many of today's students return to college as adult learners (24 and older) to pursue new careers or to receive additional training and workplace development for career advancement. As more time elapses between their departure from the secondary level and admission at the post-secondary level, remediation maybe required to bridge gaps in learning. Of the adult learner population, 62% of students beginning at 2-year institutions and 66% of students beginning at 4-year institutions are placed into remedial courses (Chen, 2016). Further, non-traditional students are also reported to take a higher number of remedial courses compared to their traditional-aged peers (Chen, 2016). Adult learners may need developmental support to accommodate the constraints placed on them as they navigate demands of work and family, in addition to school. Digital technologies (e.g. online courses) may be an effective approach to support them. Some research suggests that those in online remedial courses have higher completion rates than those enrolled in traditional face-to-face classes (Ashby, Sadera, & McNary, 2011).

Purpose of the Study

Many students are placed into remedial courses, and the success rates in these courses are low, particularly in mathematics (Bahr, 2008; Bailey, et al., 2010; Chen, 2016). First-year seminars can support the student transition (Hunter & Linder, 2005; Kuh, 2008) and are commonly found on university campuses (Young & Hopp, 2014). Although the findings on the effectiveness of first-year seminars are mixed, literature suggests they are more effective in contexts where there exist greater gaps in preparedness (Permzadian & Crede, 2016) and paired

with other support services (Culver & Bowman, 2020; Mayhew et al., 2016). First-year seminars may be an effective strategy to support students placed into remedial mathematics because these additional support sources are often embedded within these seminars. The purpose of this study was to explore the effectiveness of first-year seminars for students placed into remedial mathematics. Two types of seminars were compared: a general first-year seminar and an online first-year seminar offered as a learning community for remedial mathematics students. It was hypothesized that students who enrolled in a first-year seminar would pass their remedial and college-level mathematics courses at higher rates and have a higher overall GPA. It was further hypothesized that students enrolled in the online learning community would perform better than those in the traditional first-year seminar.

Theoretical Framework

This study was grounded in college student identity development and retention literature. A great deal of higher education research has explored both the cognitive and psychosocial development of college students. Young adulthood is a time in which one begins to develop a sense of individuality and separation from parents (Chickering & Reisser, 1993). Those pursuing post-secondary education need to successfully transition into these new environments. Those with poor institutional attachment and integration are less likely to graduate from an institution. Transition to college is also a time of significant development with respect to students' values, attitudes, and behaviors (Mayhew, et al., 2016; Pascarella & Terenzini, 2005). This aligns with Bean and Eaton's (2000) psychological model of retention which suggests that characteristics such as motivation, expectancies, and self-efficacy beliefs impact student success. These noncognitive factors shape students' motivation to persist and are malleable by institutions

(Tinto, 2017, p. 255). First-year seminars are a strategy on college and university campuses that can positively impact study skills and student motivation.

Method

The effect of participation in a first-year seminar on student academic performance in remedial mathematics was explored using a quasi-experimental design. Specifically, students at an emerging four-year Hispanic Serving Institution (HSI) in Texas were recruited for this study. This institution was purposefully selected because students more closely resembled demographic characteristics of the state. Approximately 50.2% of undergraduate students at this institution identified as non-white and 51.9% identified as first-generation in fall 2018. Students at the institution were not required to enroll in a first-year seminar and thus participation was not random. Due to the potential bias associated with self-selection, inverse probability of treatment weighting (IPTW) was used to minimize confoundedness with other variables associated with students' decisions whether or not to enroll in a first-year seminar. Weighted groups were then compared on remedial and college-level mathematics course pass rates as well as students' overall GPA at the institution. The data were obtained from the institution's Office of Institutional Research. The study was approved by the university's Institutional Review Board.

Participants

The participants in this study were students at a 4-year public institution in Texas categorized as a "Doctoral Research University" by the Carnegie Commission on Higher Education. This university reported a fall 2018 undergraduate enrollment of 18,498. This sample was limited to undergraduate students who were classified as not ready for college-level mathematics. The state of Texas requires that students be assessed for college readiness in mathematics prior to enrolling in a college-level mathematics course. College readiness is

determined by the student's score on the ACT, SAT, or State of Texas Assessment of Academic Readiness (STAAR). Students who do not meet an institution's criteria for college-readiness may be required to take the Texas Success Initiative Assessment (TSI). At the institution in this study, those students who scored between 340 – 349 on the TSI were placed into corequisite remediation while those who scored below 340 were placed into a traditional remedial mathematics course. Corequisite remediation allows students to enroll in a college-level course while concurrently receiving remedial support. In contrast, students in the traditional remedial course must first past this course before they are permitted to enroll in the college-level mathematics course.

The institution placed 1,730 students into remedial mathematics between the fall 2018 and spring 2020 semesters. Of these students, 905 required corequisite remediation while the remaining 825 students were placed into a traditional remedial mathematics course. Only those placed into the traditional remedial course were included in order to more narrowly focus this study on those least prepared for the college-level course. This sample was further restricted to only those who were first-time enrolled in college to minimize the issues associated with having previously taken a remedial course. The final sample included 757 students placed into remedial mathematics, of which 59.4% were female, 37.8% White, 33.7% African American or Black, 21.8% Hispanic, 3.6% multi-racial, 0.5% Asian, and 0.9% Native Hawaiian or Native American. Approximately 55.2% of the sample was reported to be Pell-eligible, 13.6% STEM majors, and 32.2% were concurrently enrolled in a first-year seminar. The average age of students in the sample was 19.7 years with an SAT score of 967 (Table 1-2).

Table 1

Demographic Characteristics of Students Enrolled in Remedial Mathematics (N = 845)

Variable	*N*	%
Male	307	40.6
Female	450	59.4
African American	255	33.7
Native American	8	0.8
Asian	4	0.5
Hispanic	165	21.8
International	7	0.9
Multiple Races	27	3.6
Native Hawaiian	1	0.1
Unknown	6	0.8
White	286	37.8
Pell Eligibility	418	55.2
STEM Major	103	13.6
Conditional Admission	165	25.6
First-Year Seminar	234	30.9

Table 2

Descriptive Statistics for Students Enrolled in Remedial Mathematics (N = 845)

Variable	*M*	*SD*
SAT	966.57	85.97
ACT	18.39	2.10
Age	19.69	c

Data

Outcome Measures. The outcome measures in this study included the student's performance in the remedial mathematics course, performance in the college-level mathematics course, and overall GPA at the institution. Performance in the remedial and college-level courses was recoded into a dichotomous variable separated by whether the student (a) passed with a grade of C or above or (b) did not pass by earning a grade of D or F, or withdrew from the course. GPA was calculated as the overall GPA at the institution and reported on a 4.0 scale.

Grouping Variable. The students placed into remedial mathematics were grouped into one of three categories for comparison. The categories included (a) participation in a general

first-year seminar (n = 217), (b) participation in first-year seminar offered as a learning community for remedial mathematics students (n = 20), or (c) no participation in a first-year seminar (n = 523). All entering students with fewer than 60 hours of college credit were eligible to participate in one of the first-year seminar sections offered at the institution. These seminars were offered as a three credit-hour elective and not included as part of the institution's general education core curriculum. First-year seminars at this institution were considered to be an academically oriented seminar with generally uniform academic content according to Barefoot's (1992) typology of first-year seminars. All seminars were also taught by full-time faculty or administrative staff. Some sections of these seminars were restricted to students in specific majors or academic programs. Some sections were also offered as an online learning community intentionally paired with remedial mathematics. Curriculum for the online learning community seminars were taught using an adapted version of the *Frameworks for Mathematics and Collegiate Learning* course developed by the Dana Center at the University of Texas at Austin (Charles A. Dana Center, 2014). Details about the development of the online learning community are reported in Lane (2019).

Covariates. Because students self-selected into first-year seminars, covariates related to their participation in these seminars were included in the study. The covariates included the student's gender, age, ethnicity, and Pell eligibility given their relevance to remedial course placement (Crisp & Nora, 2010; Kolajo, 2004; Wolfle & Williams, 2014). Race and ethnicity were collapsed into four categories (White, Black/African American, Hispanic, and other) to ensure the data were large enough for meaningful comparison. The study also considered the students' prior performance on standardized assessments (SAT and ACT) as well as their admission status into the institution (conditional admission vs. regular admission).

Propensity Score Analysis

The effect of participation in a first-year seminar was tested using propensity score analysis (PSA). Propensity score analysis is grounded in the work of Rosenbaum and Rubin (1983) and was developed as a mathematical approach to mitigate bias due to self-selection. The analysis includes the estimation of propensity scores, which are then used as a variable in covariate adjustment, stratification, matching, and inverse probability of treatment weighting. Inverse probably of treatment weighting (IPTW) was used in this study over other approaches to maximize sample retention. Further, the use of IPTW is suggested to be comparably effective at removing systematic differences between groups (Austin, 2011).

Propensity scores were estimated through logistic regression to predict participation in a first-year seminar. Covariates discussed earlier in the method were included in the estimation of propensity scores. The effects from participation in a first-year seminar were then computed using the approach discussed in Lunceford and Davidian (2004). The average treatment effect (ATE) was estimated as $\frac{1}{n}\sum_{i=1}^{n} \frac{Z_i Y_i}{e_i} - \frac{1}{n}\sum_{i=1}^{n} \frac{(1-Z_i)Y_i}{1-e_i}$, where Z denotes treatment assignment, e is the propensity score, and Y is the outcome variable. The effect of the weighting on sample size was adjusted through generalized estimation equation approach.

Results

Overall, 67.6% of students in the sample successfully passed the remedial mathematics course. The percentage of students who earned a grade of C or better are reported by group in Table 3. The passing rates in remedial mathematics were highest for those students who enrolled in a general first-year seminar (72.1%), followed by the learning community (61.5%) and non-participants (52.6%). There were no statistical differences in remedial mathematics course pass rates between those enrolled in the online learning community and non-participants ($\chi^2[1] =$

$0.19, p = .62$). In contrast, those who participated in a general first-year seminar passed their remedial mathematics course at a statistically higher rate than non-participants ($\chi^2[1] = 5.00, p = .03$). These students were 2.33 times more likely to pass the remedial mathematics course.

Table 3

Summary of Statistical Tests and Odds Ratios for Remedial Mathematics Pass Rates

	% Passing	*B*	*SE*	χ^2	*df*	*p*	Odds
FYS	72.10	0.84	0.38	5.00	1	.03	2.33
FYS – Online LC	61.50	0.38	0.86	0.19	1	.62	1.46
No FYS	52.60	--	--	--	--	--	--

Note: No FYS was the reference group.

Of the 503 students (67.6%) who successfully passed the remedial mathematics course and initially enrolled in a college-level mathematics course, grades were reported for only 425 of these students. Policies at the institution allowed students to drop courses prior to the 12th class day without a grade of Q reflected in their transcript. Students for which no grade was reflected in their transcript were assumed to have dropped the college-level mathematics course prior to the Q-drop date. Those who dropped the college-level mathematics course comprised 15.5% of the sample.

For the sample in which grades were available ($N = 425$), passing rates in the college-level mathematics course were compared based on their first-year seminar participation. The percentage of students who earned a grade of C or better are reported by group in Table 4. The passing rates in remedial mathematics were again highest for those students enrolled in a general first-year seminar (64.4%), followed by the learning community (53.3%) and non-participants (42.4%). Those who participated in a general first-year seminar passed their remedial mathematics course at a statistically higher rate than non-participants ($\chi^2[1] = 6.05, p = .01$). These students were also 2.55 times more likely to pass the remedial mathematics course. The

effect sizes were slightly larger among the comparison of pass rates in the college-level mathematics course than the remedial mathematics course. There were no statistical differences in remedial mathematics course pass rates between those enrolled in the online learning community and non-participants ($\chi^2[1] = 0.19, p = .62$).

Table 4

Summary of Statistical Tests and Odds Ratios for College-Level Mathematics Pass Rates

	% Passing	*B*	*SE*	χ^2	*df*	*p*	Odds
FYS	64.40	.94	0.38	6.05	1	1	2.55
FYS – Online LC	53.30	0.39	0.89	0.19	1	1	1.47
No FYS	42.40	--	--	--	--	--	--

Note: No FYS was the reference group.

Lastly, students' overall GPA at the institution was also compared between the groups. Students who did not participate in a first-year seminar (non-participants) were used as the reference group in the analysis. The weighted overall mean GPA at the institution was highest for those students enrolled in a general first-year seminar ($\underline{x}_{gpa}$ = 2.55, *SD* = 0.88), followed by the learning community ($\underline{x}_{gpa}$ = 2.32, *SD* = 0.60) and the non-participants ($\underline{x}_{gpa}$ = 1.97, *SD* = 1.17). The model η^2 effect size was .0759 which indicated that group membership explained approximately 7.6% of the variance in overall mean GPA. Most of this variance was attributed to differences between participation in the general first-year seminar and non-participants. There were no statistical differences between those in the online learning community and non-participants.

Table 5

Summary of Regression Weights

	B	*SE*	β	*t*	*p*
Intercept	1.97	0.15			
FYS	0.57	0.17	.28	9.80	<.01
MFLC - FYS	0.24	0.26	.04	1.49	.14

Discussion

As the percentage of students placed into remedial coursework remains high and pass rates in these courses low (Bailey et al, 2010; Chen, 2016), there is a need for developmental approaches that better support underprepared students. First-year seminars are commonly offered at most colleges and universities (Young & Hopp, 2014). The curriculum for these seminars is intended to support the development of study skills and improve awareness of student support services on campus. Literature suggests that when these seminars are purposefully paired in this way, they can be an effective strategy to support student success (Culver & Bowman, 2020; Mayhew et al., 2016). Despite these claims, the empirical evidence for their success is mixed and the literature that exists fails to explore the effectiveness of these seminars within specific populations, such as those placed into remedial courses. The current study compared the effectiveness of two types of first-year seminars on remedial and college-level mathematics pass rates as well as students' overall GPA. These results have potential to inform strategies for developmental education reforms.

Students placed into remedial mathematics and who enrolled in a first-year seminar passed their remedial mathematics course at a higher rate than other students in this study. The pass rates among those students were also higher than those reported nationally. For example, students enrolled in a first-year seminar had a passing rate of 72% in this study compared to the 45% of students placed into one level of remediation in Bailey et al. (2010). Further, those enrolled in a first-year seminar had an overall GPA that was nearly half a point higher than non-participants. Permzadian and Crede (2016) also reported small positive effects on first-year GPA based on enrollment in academically oriented first-year seminars. Findings from this study support those conclusions and that enrollment in a first-year seminar was a significant benefit to students placed in remedial courses.

In contrast to what was hypothesized, the first-year seminar offered as an online learning community was not more effective at improving remedial or college-level mathematics pass rates. Many students placed into remedial courses are adult learners who may require greater flexibility in their courses (e.g., online). Although these needs may be real, the data from this study contrasted with the benefits of online courses reported in Ashby et al. (2011). It may be that *remedial courses* are more effectively delivered online than *developmental education* supports, such as first-year seminars, which seek to connect students to resources that are not always available remotely. The COVID-19 pandemic has accelerated digital changes that were already occurring at the post-secondary level (Kim, 2021). Unfortunately, much of the data in this study was collected prior to the COVID-19 pandemic. As more student support services are shifted online in the coming years, the effectiveness of this modality may improve for these students.

Despite the lack of statistical differences, the use of online first-year seminars should not be abandoned as a developmental education strategy. Students in the online learning community were still 1.5 times more likely to pass the remedial and college-level mathematics courses than non-participants, which was an improvement over no intervention at all. It is possible that these differences were due to chance, but the pattern in the data may better reflect a lack of power to detect statistical differences than the absence of an effect in the population. As the tools to support online instruction and remote access to student services improve, the use of online first-year seminars may be a reasonable strategy for adult learners navigating work-life-school balance. A less effective online first-year seminar may still be preferable to no support at all.

Approximately 15.5% of students in this study failed to enroll in the college-level mathematics course despite having successfully passed the remedial course. Similar patterns

have been reported in the developmental education literature (Bailey et al., 2010; Zientek et al., 2020). The consequences of delaying enrollment in a college-level mathematics course are high. Students who do often fail to persist, not because of an inability to successfully complete the college-level mathematics course, but because they never attempt it (Lane et al., 2020; Zientek et al., 2020). As Bailey et al. (2020) suggest, "failure to enroll is a greater barrier than course failure or withdrawal" in developmental education (p. 260).

Criticisms surrounding the low completion rates of remedial course sequences have resulted is growing calls to reduce the number of remediation levels and increase the use of corequisite approaches. The institution in this study recently shifted from a multi-tiered sequence of remediation to one level of remediation. Although the remedial mathematics completion rates in this study were higher than those referred to multiple levels of remediation in Bailey et al. (2010), this same pattern could not be said for the college-level mathematics course. The pass rates for remedial completers who enrolled in the college-level course were 78-81% in Bailey et al. (2010) but only 42-64% in this study. Its not clear if this was the result of differences in sample characteristics, state and institutional policies, or instructional practices. Regardless, remedial course completers in this study were less successful in the college-level course than in other published studies.

Limitations and Recommendations

A limitation of the study was the number of students who participated in the online learning community. Although the study contained a sufficiently large sample of students generally (first-year seminars and non-participants), a smaller group of students chose to participate in the online version of the first-year seminar. This reduced the statistical power to detect differences among this specific intervention. Several factors likely contributed to this

limitation, including the non-mandatory requirement to enroll in a first-year seminar, rapidly changing policies at the state level regarding placement into developmental education, and student perceptions in general about online courses. For example, the state of Texas shifted from no policy on co-requisite remediation prior to 2018 to an expectation that 75% of students who failed to meet college-level placement criteria be placed into corequisite remediation by 2020. This shift likely created challenges for students and institutions. In addition, collection of data in this study was completed immediately prior to the COVID-19 pandemic in which many institutions shifted their instruction online. As a result, some of the barriers and perceptions that existed prior to the pandemic have been removed for online programs and services. As a result, this study has the potential to inform post-pandemic strategies for supporting students.

Institutions should consider requiring those placed into remedial mathematics to concurrently enroll in a first-year seminar. Because first-year seminars are so widely available on most campuses, the institutional costs of requiring them for certain populations (i.e., underprepared students) may be less expensive than other approaches. They can also be adapted to multiple modalities. The problem is that remedial courses do not typically count toward required credit hours for the degree. Placing additional requirements on these same students could create even further financial hardships and extend time to degree. One approach may be to include first-year seminars as part of the co-requisite remediation strategy. For example, a one-hour first-year seminar course and two-hour developmental mathematics course could be combined into a single three-credit hour corequisite course. Such a strategy may better address both content and study skill development, while reducing the overall non-credit bearing courses a student is required to take.

This study explored the effectiveness of first-year seminars at one institution using an academically oriented seminar type, but other seminar types exist. Despite the volume of literature on first-year seminars generally, very few published studies exist regarding the differences in seminar type and how those differences moderate existing relationships in the literature. The research by Permzadian and Crede (2016) is a significant step in this regard, but much more research is needed to fully understand these differences. Unlike remedial courses, there is greater variability in the ways that first-year seminars are offered across institutions. First-year seminars range between 1-3 credit hours and may or may not be part of the institution's general education core curriculum. There is also a need to explore how these differences affect remedial course-taking and how they might be integrated in ways that do not create additional barriers for underprepared students.

Conclusion

Students placed into remedial courses face significant barriers to their academic success in college. Many of these students fail to complete developmental course sequences and persist through the college-level course. Although much has been written about various developmental education reforms (e.g., remedial course placement, instructional delivery methods, pathways, accelerated or co-requisite remediation models), less has been written about the relationship between enrollment in first-year seminars for these students. First-year seminars are intended to support student transition to college by focusing on the needs of students and expectations of institutions. As such, these seminars have potential to serve as a developmental education approach. Findings from this study suggest enrollment in a first-year seminar was related to higher pass rates in both the remedial and college-level mathematics course. Despite the flexibility that online courses can provide for adult learners, first-year seminars were more

effective in this study when offered in the traditional face-to-face delivery format. However, recent trends and changes in digital learning may provide enhanced opportunities for online approaches to be successful and should not be abandoned.

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