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Differential Benefits of Attending Supplemental Instruction for Introductory, Large-Section, University U.S. History Courses

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Abstract:

We investigated students' academic achievement in three high-enrollment, introductory-level history sections at a large, public, Hispanic-serving university. Using a conditional indirect-effects model, we analyzed supplemental instruction (SI) attendance and class absences as predictors of course success, after accounting for sex, ethnicity/race, and SAT/ACT scores. Results suggested a positive direct effect of SI attendance on course success and a negative direct effect of absences. A significant interaction effect between ethnicity/race and SI suggested that Hispanic students reaped stronger benefits from SI than Caucasian students, and that the course achievement gap between these groups was smaller when students attended more hours of SI. Our study contributes new findings to research supporting the effectiveness of SI by examining mediation and moderation effects and controlling for confounding variables.

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Headnote

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KEYWORDS supplemental instruction (SI), ethnicity/race, academic achievement, class attendance, gatekeeper college courses

Large-section introductory core courses that have low course success rates can be a major stumbling block for students. It is, therefore, critical to investigate interventions that can help students succeed in these courses. The particular introductory history course that was the focus of this study was a core curriculum course, had high enrollments, and had a history of high D, F, and W rates. The course was identified by the university as an intensive writing course, and students were restricted from enrolling in the course if they had not placed out of or passed their developmental education writing course. The combination of (a) complex course content, (b) a large-section format, (c) an intensive writing component, and (d) assignments that emphasized deep-level critical thinking and reasoning strategies all contributed to the challenging nature of this history course. Supplemental instruction (SI) was available to all students enrolled in this course to help support their learning and improve their course performance. Our primary objective was to examine relationships between students' participation in SI and their success in the course while taking into account students' sex, ethnicity/race, SAT/ACT concordant scores, and number of class absences. We were also interested in the relationship between class absences and course success, interactions with demographic variables, and indirect effects of

SAT/ACT scores on course success.

Retention of College Freshmen

According to data from the ACT Institutional Data Questionnaire, an annual survey of postsecondaiy institutions, the freshman-to-sophomore mean retention rate for two-year public institutions was 55.5% (American College Testing Service, 2012) . This rate was higher for four-year public institutions (72.2%), and the rate varied according to the highest degree offered by an institution: bachelor's degree (65.2%), master's degree (69.7%), and doctoral degree (76.7%). The rate also varied by institutional admissions selectivity. The average first-to-second year retention rate across all postsecondary institutions surveyed was 66.5%. In public four-year degree-granting institutions, only 57% of full-time, first-time students seeking a bachelor's degree graduated with a degree in six years (Aud, WilkinsonFlicker, Kristapovich, Rathbun, Wang, &Zhang, 2013); and the highest rate of student attrition has been found to occur between the first and second year of college (Bradburn &Carroll, 2002).

Students' academic performance during their first year of college is one factor that contributes to persistence. Bradburn &Carroll (2002) found that lower academic performance during the first year of college was associated with higher attrition in both two-year and four-year postsecondaiy institutions. From early childhood interventions through undergraduate programs, significant differences in educational achievement existed between Caucasian and African American students and between Caucasian and Hispanic students (Braswell, Lutkus, Grigg, Santapau, Tay-Lim, &Johnson, 2001). In 2011, Hispanic and African American students took fewer mathematics and science courses and scored lower on the mathematics scale of the National Assessment of Educational Progress compared to students who were Caucasian or Asian/Pacific Islander (Aud et al., 2013) . In addition, the high school freshman averaged graduation rate during the 2009-2010 school year was lower for Hispanic (71%) and African American (66%) students compared to Caucasian (83%) and Asian/Pacific Islander (93%) students. Closing the ethnicity/race achievement gap remains a national focus across all levels of education. Examining these gaps in the student population of an introductory college course was one focus of this study.

Introductory College Courses

Introductory courses with high enrollments, also known as gatekeeper courses, are a common experience for most first- and second-year college students, and failure in these courses can communicate to students whether they are "fit" for college, or for a particular major. As Eagan and Jaeger (2008) explained . . not succeeding in these gatekeeper courses may prompt students to change their major, transfer to a new institution, or drop out of higher education entirely" (p. 40). Adding to the academic pressure of these courses, many institutions bar students from enrolling in required introductory courses that are intensive in reading, writing, or mathematics until they pass any developmental education coursework that is required. Furthermore, it is common for instructors of gatekeeper courses to utilize weak pedagogical practices such as long lectures that precipitate passive learning and memorization rather than active learning and critical thinking (Eagan &Jaeger, 2008). It is, therefore, critical to investigate methods for increasing student success in high-risk, high enrollment, introductory courses.

Supplemental Instruction

Supplemental Instruction (SI), developed by Dr. Deanna Martin in 1973 at the University of Missouri at Kansas City (UMKC), has become a popular method of supporting students' learning and success in high-risk courses; that is, courses with DFW rates greater than 30%. As Arendale (2010) claimed, "supplemental instruction is used at more than 2,500 postsecondary institutions in forty-five countries to provide a study review session that integrates review of rigorous course material with modeling of appropriate learning strategies for students' adoption and independent use" (p. 72). SI programs typically provide learning support to students by having SI leaders (peers who previously succeeded in the course and received some form of SI training) attend class with students, take notes, complete readings, and hold group learning sessions outside of class multiple times per

week (Hurley, Jacobs, &Gilbert, 2006). There is a strong body of research supporting the effectiveness of SI at improving course grades (Fayowski &MacMillan, 2008; Martin &Arendale, 1992, 1994; Ning &Downing, 2010; University of Missouri - Kansas City, 2014; Zaritsky &Toce, 2006), and some studies have linked participation in SI to higher levels of semester-to-semester persistence (Malm, Bryngfors, &Momer, 2012; Ogden, Thompson, Russell, &Simons, 2003) and retention to graduation (Bowles, McCoy, &Bates, 2008; Martin &Arendale, 1992, 1994; Ramirez, 1997). Despite findings in favor of Si's relationship to both short-term and longterm academic outcomes, most studies on SI are correlational and cannot establish SI as the cause of improved success experimentally. This is because most all SI programs are voluntary. Accordingly, researchers have emphasized the importance of controlling for potentially confounding variables such as aptitude and motivation when examining the effects of SI on course success (Bowles et al., 2008; Parkinson, 2009).

Absences

Another focus of our research was on absences. Credé, Roch, &Kieszczynka (2010) conducted a meta-analysis suggesting that class attendance has a strong relationship with course grades and GPA, and they claimed "these relationships make class attendance a better predictor of college grades than any other known predictor of academic performance" (p. 272). Other researchers (Arulampalam, Naylor, &Smith, 2011; Lyubartseva &Mallik, 2012; Meulenbroek &van den Bogaard, 2013) made similar findings and found that attendance plays an important role in college students' success (defined by a grade of C or higher) in classes. In our study, we controlled for absences in addition to other more common control variables (e.g., sex, ethnicity/race, and SAT/ACT scores) because absences are an indicator of students' motivation and could, therefore, help us adjust our results for the self-selection bias that existed due to the voluntary nature of SI. Furthermore, we were interested in the relationship between absences and course success for students in our study.

Student Background Characteristics

In our study, we were interested in the student background characteristics of SAT /ACT scores, sex, and ethnicity. Some research has suggested that students with lower SAT/ACT scores might be more likely to participate in SI (Commander, Stratton, &Callahan, 1996; Ramirez, 1997), whereas other research has found null or mixed results (Congos &Mack, 2005; Congos &Schoeps, 1993); however, no studies, to our knowledge, have investigated SAT/ACT scores in a mediation model. To address this gap in the research, our study examined the indirect effect of SAT/ACT scores on course success through SI and through absences. We thought that students' level of proficiency on the SAT or ACT might influence their decisions to participate in SI and to attend class, which could then, in turn, affect their success in the course. Some studies on SI have also suggested that particular groups of students might benefit more from participating in SI than other groups. For example, Ramirez (1997) found that students who were identified as being underprepared for college-level work or at-risk for other reasons (e.g., socioeconomic status) reaped stronger benefits from participating in SI. Ogden et al. (2003) found that students who were conditionally admitted to a large Southern university and participated in SI were more likely to reenroll in college over one year and one quarter than those students who were traditionally admitted and participated in SI. In a study on SI in a calculus course, Fayowski and MacMillan (2008) found that males and females benefited equally from participating in SI. In a similar vein, we wanted to examine whether students would benefit differently from SI with respect to their sex or ethnicity/race. Given the lack of research in this area, we did not have specific hypotheses about which sex or which ethnicity/race groups might benefit differently.

Studies of the effects of absences for particular groups of students also found that some groups were affected more by absences than others. In a study on the effects of absences on economics students' performance in classes in the UK, Arulampalam et al. (2011) found that, after controlling for characteristics such as poor effort, the effects of absences was statistically significant for students who were higher performing. Other researchers have found statistically significant relationships between absences and students' performance, but these differences were not moderated by the students' sex (Halpem, 2007) or race (Cohn &Johnson 2006; Jones,

1984).

Our research could test whether these findings would extend to the context of an introductory history course. Moreover, we decided to examine the differential benefits of SI and absences for Hispanic students because we conducted our research at an Hispanic-serving institution and we had a sufficient sample size to investigate this question. In sum, our research could contribute to scholarly inquiry on SI and absences by investigating the effectiveness of these variables on course success within a conditional indirect-effects model that accounts for important student background characteristics and examines mediation and moderation effects involving participation in SI and class absences.

The Current Study

The present study is a correlation research study; however, it is more rigorous than many previous studies because we examined the relationship between SI and course success after accounting for a number of potentially confounding variables: students' sex, ethnicity/race, SAT/ACT concordant scores, and absences. In addition, we were interested in examining mediation and moderation effects that have not been addressed sufficiently in previous research on SI attendance and class absences in large-section introductory courses. We had five primary research questions:

(1) Were students who attended SI more likely to succeed in their introductory history course?

(2) Were students who missed class less likely to succeed in their introductory history course?

(3) Were student background characteristics (sex, ethnicity/race, and SAT/ACT scores) related to their success in the course?

(4) Was the direct effect of students' SAT/ACT scores on course success mediated by SI attendance and/or absences?

(a) Did students' level of proficiency on the SAT or ACT change the likelihood that they would attend SI, and thereby, in turn, influence their chances of succeeding in the course?

(b) Did students' level of proficiency on the SAT or ACT change the likelihood that they would miss class, and thereby, in turn, influence their chances of succeeding in the course?

(5) Was the strength of the indirect effect of SAT/ACT scores on course success through SI hours and/or absences moderated by students' sex or ethnicity/race?

(a) Did the effect of SI on course success change in magnitude or direction based on the sex or ethnicity/race of a student?

(b) Did the effect of absences on course success change in magnitude or direction based on students' sex or ethnicity/race?

METHODS

Participants

Our sample included 1014 participants enrolled in a multisection introductory history course at a large Hispanic-serving institution (public university) in the southwestern United States. Students enrolled in one of three sections of the course: section A (n = 350), section B (n = 342), section C (n = 322). Students' sex, ethnicity/race, SI attendance, class absences, and course success are presented in Table 1. The average age of students was 19.63 (SD = 2.53) and their average SAT/ACT concordant score was 1043.37 (SD = 128.07). This was an introductory course required of all first-year students, therefore, most students were freshman (n = 781; 77%); the sample sizes for other student classifications were: sophomore (n = 154; 15.2%), junior (n = 64; 6.3%), senior (n = 13; 1.3%), postbaccalaureate (n = 1; 0.1%), and master's (n = 1, 0.1%). We excluded students who (a) were repeating the course, (b) withdrew from the course by the 12th class day, or (c) had missing SAT and ACT scores (n = 3), earned a course grade of "Incomplete" (n = 2), or had not signed a consent form (< 1% of sample were excluded for reasons relating to "c").

TABLE 1. Course Success by Sex, Ethnicity/Race, Absences, and SI Hours

	Total Sample		Course Success	
	N	%	f	%
Sex				
Female	558	55.0	346	62.0
Male	456	45.0	237	52.0
Ethnicity/race				
White	653	64.4	405	62.0
Hispanic	270	26.6	125	46.3
Other[a]	91	9.0	53	58.2
Absences				
0	162	16.0	107	66.0
1–2	326	32.1	188	57.7
3–5	259	25.5	157	60.6
6+	267	26.3	131	49.1
SI Hours				
0	505	49.8	214	42.4
1–3.5	231	22.8	145	62.8
4+	278	27.4	224	80.6
Course Success				
Yes	583	57.5		
No	431	42.5		
Total	1014	100.0		

[a]Because ethnicity/race was dummy coded for the purpose of our analyses, Table 1 does not show the breakdown of ethnicity/race for students who were collapsed into the category "other," which included: American Indian/Alaskan ($n = 4$), Asian/Pacific Islander ($n = 17$), African American ($n = 64$), International ($n = 4$), and unknown ($n = 2$).

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Design and Procedures

We used a correlational research design to investigate student background characteristics (i.e., sex, ethnicity/race, and SAT/ACT concordant scores) and course behaviors (i.e., SI attendance and class absences) as predictors of students' success in their introductory history course. The study variables followed a temporal ordering. Student background characteristics were measured first as part of the university's admission process; SI attendance and course absences were collected during the semester students were enrolled in the course, and course grade was reported at the end of the semester.

Measures

Student Background Characteristics

We obtained information on students' sex, ethnicity/race, and SAT and/or ACT scores from the university's institutional research department. Sex was coded as: 0 = male, 1 = female. We dummy coded ethnicity/race into three categories: Hispanic, Other, and Caucasian (reference category). We used students' combined verbal and quantitative SAT scores; however, when only ACT scores were available, we computed concordant scores using the concordance tables developed by ACT and the College Board (ACT, 2013). The concordant scores read like SAT scores with a maximum possible score of 1600. We divided the SAT/ACT concordant scores by 100 so that the results or our analysis would be in a range that was easier to interpret.

SI Attendance

Students' attendance at SI sessions was collected by the SI program staff and then reported to us as the total number of hours (measured to a half hour) a student attended SI sessions for their history course throughout the entire semester. The distribution of these data was positively skewed with a mean of 2.28 hours (SD = 3.22), a median of one hour, and minimum of 0 and a maximum of 21 hours. For our analyses, we transformed this variable into ordinal categories (0, 1-3.5, 4-jhours).

Class Absences

Instructors collected and reported to us the number of times each student was absent from class. The distribution of these data was positively skewed with a mean of 4.47 absences (SD = 5.13), a median of three absences, and minimum of zero and a maximum of 26 absences. For our analyses, we transformed this variable into ordinal categories (0, 1-2, 3-5, 6+ absences).

Course Success

We obtained students' course grades from the university's institutional research department. The distribution of grades was as follows: A (n = 34, 3.4%), B (n = 223, 22.0%), C (n = 326, 32.1%), D (n = 205, 20.2%), F (n = 155, 15.3%), and W (n i = 71, 7.0%). Two students earned "Incomplete" and were excluded from the analyses. We then transformed these data into a dichotomous outcome variable called course success. Course success was defined as earning a course grade of A, B, or C; whereas lack of success was defined as earning a D, F, or W.

SI Program Description

The SI program at this university derives from the SI program developed at the University of Missouri - Kansas City (see Hurley et al., 2006). The SI program targets courses with a historically high percentage (at least 30%) of students who earned a D, withdrew from, or failed the course. Introductory history was one of the targeted courses of this SI program, and at least one SI Leader was assigned to this course for approximately every 120 students enrolled. Trained SI Leaders, student peers who were in good academic standing and demonstrated success in navigating the course (e.g., earned an A in the course or tested out of the course with AP credit), held three 1-hour SI study sessions per week. An SI session is an alternative form of tutoring that emphasizes collaborative learning, peer interaction, modeling, and use of study strategies. In addition to holding SI study sessions, SI Leaders were instructed to participate in the course as a model student (e.g., attend class, take notes, participate in in-class activities, and complete course requirements), engage with students, and hold office hours. Moreover, they were required to meet regularly with the instructor of the course, at least once every two weeks. There was also an SI Supervisor who helped direct, coordinate, and train SI Leaders as well as monitor and manage the program overall. Intensive training of new SI Leaders occurred at the beginning of the fall semester for approximately 16-18 hours, and experienced SI Leaders also attended parts of this training. In addition, ongoing training sessions were held monthly throughout the semester. Moreover, SI Leaders were observed during an SI session and later were provided with individualized feedback in regard to their strengths and areas to target for improvement. Student participation in SI for this course was voluntary, free of charge, and not incentivized with course points. The SI program was announced during the first day of class and a survey was administered to determine SI session times that would work well with students' schedules.

Data Analyses

When SI is voluntary, it could create a selection bias and result in applesto-oranges comparisons between SI participants and nonparticipants. For this reason, it was particularly important to control for potential confounds that might contribute to this selection bias. Therefore, when we examined the effect of SI on course success, we accounted for students' sex, ethnicity/race, SAT/ACT concordant score, and class absences.

We tested our hypotheses by running a conditional indirect-effects model using the statistical software program Mplus version 6.12 (Muthen &Muthen, 1998-2011). Following Preacher and Hayes (2004), we used a bootstrapping method with 5,000 samples to calculate confidence intervals. We also used a 95% confidence interval to determine the statistical significance of each effect. The model we tested consisted of one dichotomous dependent variable (course success); two ordinal mediator variables (SI hours and absences); one continuous independent variable (SAT/ACT concordant score) that was specified to work through both mediator variables; one dichotomous covariate (sex; coded 1 = female, 0 = male); one trichotomous co vari ate (ethnicity/race) that was dummy coded into two dichotomous variables (Hispanic and other ethnicity/race; the reference category was Caucasian); and six 2-way interaction terms (sex x SI hours, Hispanic x SI hours, other

ethnicity/race x SI hours, sex x absences, Hispanic x absences, and other ethnicity/race x absences).
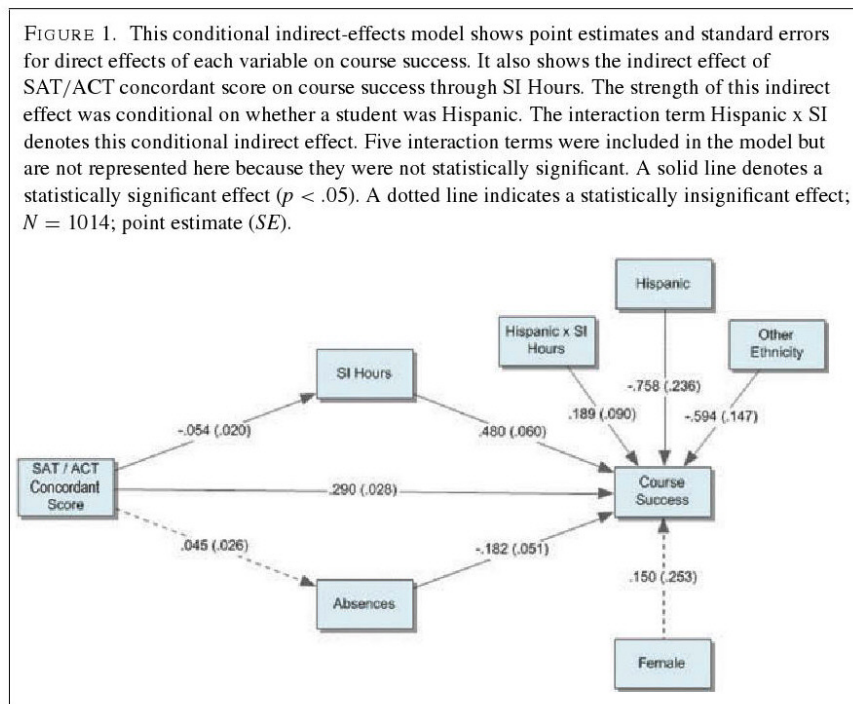
RESULTS

Of the 1,014 students in our study, 57.5% succeeded in their history course (earned a final course grade of A, B, or C), whereas 42.5% earned a final course grade of D, F, or W. Table 1 shows the frequency and percentage of students who did or did not succeed in the course by sex, ethnicity/race, number of absences, and number of SI hours. Trends in the descriptive data suggested that students who attended SI were more likely to succeed in the course. Of the students who never attended SI, 42.2% passed their history course with a C or better compared to 62.8% for students who attended between one and three-and-a-half hours of SI, and 80.6% for students who attended four hours or more of SI.

Conditional Indirect-Effects Model

Our model is in Figure 1. It consists of direct effects, indirect effects, and conditional indirect effects on course success. Accordingly, we divided our results into these three areas.

Direct Effects

We hypothesized that greater usage of SI would increase students' chances of succeeding in their introductory history course. Furthermore, we expected this effect to be significant even after accounting for the variance explained by other variables in the model. The data supported our hypothesis and suggested that students who attended more hours of SI were significantly more likely to succeed in the course ($b = 0.480$, $SE = 0.060$, 95% CI [0.362, 0.598]).

FIGURE 1. This conditional indirect-effects model shows point estimates and standard errors for direct effects of each variable on course success. It also shows the indirect effect of SAT/ACT concordant score on course success through SI Hours. The strength of this indirect effect was conditional on whether a student was Hispanic. The interaction term Hispanic x SI denotes this conditional indirect effect. Five interaction terms were included in the model but are not represented here because they were not statistically significant. A solid line denotes a statistically significant effect ($p < .05$). A dotted line indicates a statistically insignificant effect; $N = 1014$; point estimate (SE).

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As hypothesized, we found that absences had a statistically significant negative effect on course success ($b = -.182$, $SE = .051$, 95% CI [-.282, -.082]). That is, students with fewer absences were more likely to succeed in the course.

We entered sex and ethnicity/race as covariates in our model. Sex was not found to have a statistically significant relationship with course success, whereas ethnicity/race was found to have a statistically significant relationship. Hispanic students were less likely to succeed in the course than Caucasian students ($b = -.758$, $SE = .236$, 95% CI [-1.220, -.296]). Also, students who listed an ethnicity/race other than Hispanic or Caucasian were less likely to succeed in the course compared to Caucasian students ($b = -.594$, $SE = .147$, 95% CI [-.882, -.307]).

As hypothesized, we found that SAT/ACT scores had a positive direct effect on course success (b = .290, SE = .028, 95% CI [.235, .345]). Students with higher SAT/ACT scores were more likely to succeed in the course.

Indirect Effects

Even though SAT/ACT scores had a positive direct effect on course success, they had a negative indirect effect on course success through SI hours (b = -.026, SE = .010, 95% CI [-.046, -.006]). The effect of SAT/ACT scores on SI Hours was negative (b = -.054, SE = .020, 95% CI [-.094, - .014]) and the effect of SI Hours on course success was positive. Students with lower SAT /ACT scores were more likely to use SI, and this, in turn, increased their chances of succeeding in the course, whereas, students with higher SAT/ACT scores were less likely to use SI, which, in turn, decreased their chances of succeeding in the course. We also examined the indirect effect of SAT/ACT scores on course success through absences. However, this indirect effect was not statistically significant.

Conditional Indirect Effects

We tested whether the indirect effect of SAT /ACT scores on course success through SI hours was conditional on students' sex and ethnicity/race. To test these effects, we entered the following interaction terms into our model: sex x SI hours, Hispanic x SI hours, and other ethnicity/race x SI hours. We found one statistically significant conditional indirect effect for the interaction term Hispanic x SI hours (b = . 189, SE = .090, 95% CI [.012, .366]). This finding suggested that the indirect effect of SAT/ACT scores on course success through SI hours was stronger for Hispanic students (b = -.036, SE = .015, 95% CI [-.065, -.007]) than it was for Caucasian students (b = -.026, SE = .010, 95% CI [-.046, -.006]). Even though SI had a positive direct effect on course success across ethnicity/race groups, Hispanic students were found to benefit relatively more from SI compared to Caucasian students (see Figure 2). The gap in course success between Hispanic and Caucasian students is larger when students' usage of SI is low (i.e., one SD below the mean) and this gap shrinks as students participate in more SI and all but disappears when students' usage of SI is high (i.e., one SD above the mean). Moderation of the indirect effect of SAT/ACT scores through absences was not explored further because this indirect effect was not statistically significant.

DISCUSSION

One of the major purposes of SI has been to provide learning assistance to students in gatekeeper courses. The undergraduate introductory history course in this study had high enrollments and high D, F, and W rates above 30%. Our findings supported the effectiveness of the SI program in this course, because students who attended more hours of SI had significantly higher chances of succeeding in the course even after controlling for variables known to be problematic in research on SI, such as measures of student motivation and aptitude (Parkinson, 2009). Even though attending SI related to higher course success on average for all students, we found that Hispanic students reaped greater benefits from participating in SI than Caucasian students. As a result, the gap in course success between Hispanic and Caucasian students shrunk as they participated in more hours of SI. In addition, we found that students with lower SAT /ACT scores, students who potentially had a relatively greater need for learning assistance, were more likely to use SI, and this was, in turn, associated with higher chances of succeeding in the course. Furthermore, this indirect effect contributed to weakened differences in course success between students with higher and lower SAT/ACT scores. This finding helps combat the notion that the only reason SI shows positive effects is because students with higher aptitude are more likely to attend SI.

FIGURE 2. This figure shows the interaction effect of SI Hours x Hispanic on course success for each sex at mean levels of absences and SAT/ACT scores. The probability of course success is shown for each ethnicity/race grouping at three levels of SI Hours (at the mean and one *SD* above and below the mean). Across both sexes, Hispanics had stronger gains in course success from greater usage of SI compared to Caucasians. As a result, the course success gap between Hispanic and Caucasian students shrunk as students participated in more hours of SI; $N = 1014$.
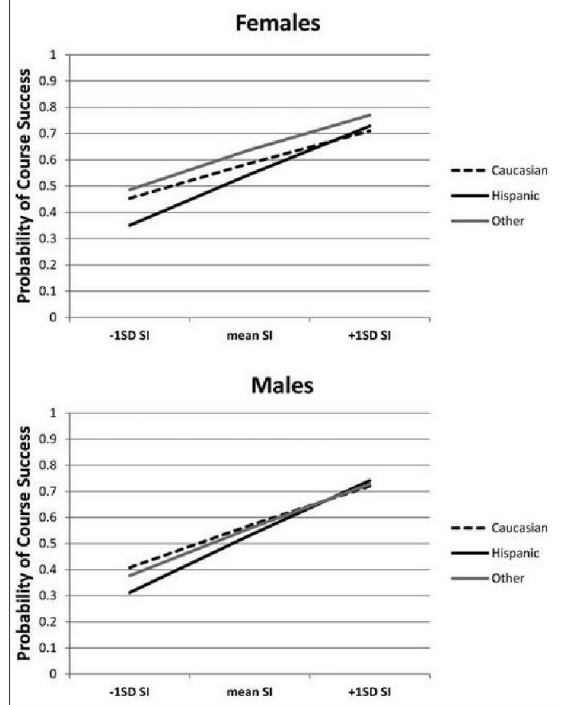
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help-seeking. The findings from this study suggest that student aptitude as measured by SAT/ACT scores might be an important individual difference variable to examine in research on help-seeking because SAT/ACT scores predicted students' use of academic resources. Studies on help-seeking have considered important psychological predictors and correlations of help-seeking such as achievement goal orientation (Karabenik, 2004), expectancy for success and task value (Zusho &Barnett, 2011); however, SAT/ACT scores might also be an important variable associated with college students' decisions to seek help, because students with lower SAT/ACT scores might have a stronger need for academic support.

In our study, the achievement gap between Hispanic and Caucasian students shrunk when students attended more hours of SI; however, it is not clear why Hispanic students would have benefited more from participating in SI. To explain reduced achievement gaps between ethnicity/race groups, other researchers have pointed to social-psychological variables in their intervention research. Studies on these interventions reported reducing achievement gaps between ethnicity/race groups using a series of brief writing exercises designed to help students affirm their values (Cohen, Garcia, Apfel, &Master, 2006; Hanselman, Bruch, Gamoran, &Borman, 2014) and feel a stronger sense of belonging (Shnabel, Purdie-Vaughns, Cook, Garcia, &Cohen, 2013). Though speculative, it seems plausible that SI might contribute to students' sense of belonging, because SI provides opportunities for students to work collaboratively in small groups and interact with a peer model (i.e., the SI leader). Future research on SI should examine the role SI might play in closing achievement gaps between ethnicity/race groups and measure variables, such as social belonging and the race/ethnicity of the SI leader, which might help explain interaction effects between SI and ethnicity/race.

Limitations

A major complication in studying the effects of SI on course performance is that the SI model emphasizes the importance of voluntary participation. Staying true to this aspect of the SI model provides challenges to

conducting true experimental research on SI. To help address problems with the self-selection bias inherent to most research on SI, researchers have argued for controlling for variables such as students' motivation and aptitude. In our study, we followed these recommendations and found positive effects of SI on course success after controlling for differences in students' SAT/ACT scores, class absences, sex, and ethnicity/race. Although controlling for confounding variables might have helped weaken alternative explanations, doing so did not rule them out or help establish causality as a true experiment could. In future studies, researchers might consider randomly assigning students to lab sections with and without an SI available, randomly assigning lab instructors to these sections, and using multilevel modeling to examine intervention effects at the section level. Although this approach has methodological limitations (e.g., treatment diffusion), as well as logistical complications (e.g., access to numerous sections), and ethical issues (e.g., not making SI available to some students) that would warrant deep consideration, it could help strengthen causal inferences with regard to the effects of SI on course success.

Future Research

SI researchers should consider help-seeking variables in their studies, because these variables could potentially influence whether students attend SI and how much they benefit from SI. A growing body of research on help-seeking has shown that instrumental help-seeking (seeking assistance to develop mastery, knowledge, and skills) is associated with adaptive patterns of achievement behavior such as mastery goal orientations and use of deeper-level learning strategies (Karabenick, 2003, 2004; Zusho &Barnett, 2011). However, executive help seeking (seeking assistance to finish quickly, avoid work, and get the correct answer without regard to learning) and avoidance help-seeking (not wanting to seek help because of negative views on seeking assistance, such as threatened sense of selfworth) have been associated with maladaptive patterns of achievement behavior such as performance goal orientations and use of surface-level strategies. These three types of help-seeking could potentially be important to control for in studies on SI, in addition to measures of motivation and aptitude. Furthermore, a stronger understanding of the help-seeking process could help inform practitioners and researchers about why students do and do not seek help and ways to help students generate adaptive approaches to using SI. From our review of the literature, there is a gap in research connecting SI and help-seeking. In a special issue on help-seeking published in Learning and Instruction, Karabenick (2011) called for a "convergence of classroom and technology-supported help-seeking research paradigms" and a "reconsideration of help-seeking as a social-interactive strategy" (p. 290). SI is a ripe context for studying help-seeking.

CONCLUSION

Since the development of supplemental instruction in 1973 at the University of Missouri at Kansas City (UMKC), SI programs have spread to more than 2,500 postsecondary institutions in numerous countries across the globe (Arendale, 2010). Our study contributes to the substantial body of research supporting the effectiveness of SI by testing the relationship between SI on course success after controlling for measures of students' aptitude and motivation. Additionally, we contribute new findings that SAT/ACT scores had an indirect effect on course success through SI and that attending more hours of SI related to a reduction in the achievement gap between Hispanic and Caucasian students. Our research could provide a framework of important variables and relationships among variables that practitioners could use to help make decisions about their SI programs. In addition, this study could provide practitioners ideas about how to conduct their own studies on the effectiveness of their SI programs and ways to discuss evidence with administrators who decide on funding for their programs. Funding for SI programs is not a certainty, and rigorous research demonstrating its effectiveness is often necessary to keep an SI program running and adequately funded. There are many active SI programs collecting data on students' success. We encourage those involved with SI to conduct and share research on their SI programs.

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