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Evaluating the Impact of STEM Academic Interventions on College Readiness for Rural Students

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Abstract: This study used a quasi-experimental cohort approach to investigate the impact of early academic interventions on rural students' academic college readiness as measured by indicators of science, mathematics, and English language proficiency in the United States. The program, delivered by a higher education institution, implemented a range of academic supports for students, including tutoring and in-class and after-school support by credentialed instructors, with the aim of preparing students for success in secondary and post-secondary educational experiences. The American College Testing (ACT) Aspire scores in science, mathematics, English language comprehension, and reading for a cohort of 8th-grade students in their second year of program participation (n = 100) were compared to the scores of a cohort of non-participants (n = 86) from the same school. Students who had participated in the program were significantly more likely than non-participants to meet college readiness benchmarks in all content areas and scored significantly higher than the non-program cohort in terms of their average percentile ranks. More research is needed to understand how particular interventions or combinations of interventions implemented in middle school impact students' college readiness.

Keywords: college readiness; early intervention; academic intervention; GEAR UP; middle school

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1. Introduction

Research indicates that the grades 6 through 8 years are a critical time for interventions to support students in the United States (U.S.) in becoming college ready by the time they complete their secondary studies [1,2]. The U.S. federal government has made considerable investments into early college readiness interventions delivered by institutions of higher education for at-risk students through the Gaining Early Awareness and Readiness for Undergraduate Programs (GEAR UP) initiative. In 2023, over USD 385 million was distributed to 160 GEAR UP sites in the U.S. with the aim of supporting students' readiness for higher education study [3]. GEAR UP is a discretionary grant program that provides funds to states and partnerships with the aim of increasing the number of students from lower socio-economic backgrounds (SES) who transition into and persist in higher education by implementing targeted interventions beginning during grades K–12 school in the U.S. Early interventions are particularly important to support students' college readiness, and evidence suggests that over half of variations in college readiness are attributable to academic and non-academic factors associated with students' middle (grades 6–8) school experiences [4]. In spite of the demonstrated importance of early interventions, the current evidence base for GEAR UP's impact on students' college readiness is limited.

The proportion of students from rural areas (not near a city or urban area) who pursue STEM degrees is low compared with their suburban peers [5]. Rural settings are a priority area for GEAR UP initiatives in the U.S. [6] since schools in remote rural settings generally serve more students living in poverty [7] and have disproportionately

lower college enrollment rates than schools in suburban settings [8,9], in addition to lower enrollment in STEM majors [5]. These phenomena have become more pronounced since the COVID-19 pandemic in the U.S., as evidenced by decreases in the number of rural students applying for federal financial aid and drops in first-time enrollments in rurally based universities [10]. These findings highlight the need to understand the effectiveness of college readiness initiatives delivered by institutions of higher education and to identify college readiness practices that are effective in rural areas.

This study aimed to examine early college interventions delivered through the GEAR UP program and associated impact on rural middle school students' college readiness. Our team conducted an investigation of one state-level GEAR UP (Statewide GEAR UP [SGU]) program that incorporated both in-school and out-of-school time (OST) activities that focused on STEM content and skills. Specifically, the study examined how students who had two years of participation in the SGU performed on college readiness indicators (American College Testing) compared to the performance of a cohort of students from the same school who had not participated in the SGU program. The findings from this study may be useful to policy makers seeking to invest strategically in college readiness, higher education administration, faculty, and staff, K–12 administrators and educators, and researchers interested in college readiness and post-secondary transitions.

1.1. College Readiness for Middle School Students in Rural School Settings

Although there is no single universally accepted definition of college readiness [11], definitions generally recognize that it is a construct that encompasses a complex interplay of academic and non-academic factors. There is widespread agreement that students who are college ready possess a combination of content knowledge, cognitive strategies, learning skills and strategies, and knowledge about post-secondary education [12]. This set of knowledge and skills includes those in the academic realm along with dispositions, behaviors, and knowledge about post-secondary transitions [13] that correlate with success in postsecondary study [14].

Research shows that 69% of variations in college readiness are attributable to academic and non-academic factors associated with students' middle school experiences [4], suggesting that college preparedness interventions in the middle school years can be particularly impactful in students' readiness for postsecondary studies. As [1] pointed out, middle school "is a time when they can close the achievement gaps and enter high school ready. . .Alternatively it is a time when students' achievement gaps widen" [1], p. 7. This is a particularly important finding for Black and Hispanic students since evidence indicates that in middle school these students tend to be proportionately less on track for college in terms of mathematics and reading college readiness benchmarks than their peers [15]. Moreover, research supports the notion that not only academic achievement but also post-secondary knowledge and information, students' aspirations and self-efficacy for college, and affective characteristics such as fortitude are crucial factors in college readiness that can be developed during the middle school years [16].

Approximately one-fifth of students in the US distributed over more than half of all school districts in the nation live in rural communities [7]. Research shows that these students enroll in post-secondary institutions at lower rates [5] and are less likely to persist in their post-secondary studies [17] than the overall population of students. Issues surrounding the impact of rural settings on student post-secondary matriculation are complex and intertwined. Schools in remote rural settings serve more students living in poverty than do suburban schools [7], and are often lower-resourced, experience difficulties in attracting highly qualified teachers, and provide fewer advanced classes than suburban schools [5,18]. The persistent achievement gap that exists between students from high versus low-income families regardless of demographic setting [19] and the related lower rates of post-secondary enrollment [20] are therefore mirrored in rural settings. These factors led Byun et al., 2015 to conclude that "efforts directed toward improving postsecondary attendance patterns should target youth from high-poverty rural backgrounds" [8], p. 277.

In addition to the pressing need for college readiness interventions for rural students generally, evidence indicates that the middle school years are a crucial time for interventions aimed at increasing high school graduation rates and preparing students for post-secondary experiences [1,14]

1.2. College Readiness Academic Intervention Strategies

In response to the findings presented above, a growing body of research seeks to understand interventions both in formal classroom and other learning settings that can increase post-secondary matriculation and success for rural students [8,21,22]. Evidence indicates that college readiness interventions should be age and ability appropriate [1,23], structured to provide supplemental academic assistance [1,24], and expose students to college and career information [24–26]. Evidence supports the use of these strategies both within the school day and in out-of-school-time (OST) settings [22,27].

Ensuring that students leave middle school with grade-appropriate academic knowledge and skills "is the single most important step that can be taken to improve their college and career readiness" [14], p. 36. Research indicates that tutoring is an effective intervention in supporting students' college readiness [26,28–30]. Academic tutoring can be especially effective in improving middle school students' mathematics achievement [31,32], English achievement [29], and academic confidence [31]. Academic assistance tied to current school learning content is particularly impactful [1,24]. Other evidence-based academic supports for college readiness include ACT and SAT preparation activities [30], and support in setting academic and career goals [22,33,34].

Although many states have adopted college and career readiness standards for K–12 schools [35], there is evidence that middle school educators struggle with implementing these standards and need additional resources and supports [36]. It is not surprising, therefore, that research findings also point to the value of teacher professional development for college and career readiness activities [34,37].

Research shows that OST activities incorporating the academic support strategies noted above can positively impact students' academic college readiness [22,27,38–40]. OST programs have been shown to reduce the achievement gap between high- and low-income learners and to contribute to student interest in STEM [41], and evidence indicates that students from underserved groups who participate in OST STEM activities enroll in post-secondary STEM majors at higher rates than non-participants [41]. In addition to these academic interventions, OST activities can also be a productive venue for career exploration activities [27] and provide opportunities for students to explore career information that they are able to translate to their own post-secondary and career goals [25,38].

1.3. GEAR UP

GEAR UP college readiness programs have been of particular research interest because of the scale of the federal investment in the program [3,42], GEAR UP's national reach, and the flexibility for GEAR UP sites to create programming tailored to community assets and challenges [43]. GEAR UP grants are aimed at creating innovative interventions that encompass a range of domains, including student academic support, mentoring, tutoring, college information, parental engagement, and educator professional development [43].

Because GEAR UP activities are customized at the local level, address multiple facets of college readiness (academic, social, and college and career planning), incorporate both OST and in-school interventions, and are intended to support students over multiple years, understanding the impact of GEAR UP programs is a complex task that requires both short-term and longitudinal perspectives and investigations. The flexibility in GEAR UP sites' activities adds to the complexity of teasing out program features that correlate with positive student outcomes. Although the evidence base regarding GEAR UP outcomes for students at the secondary level is comparatively robust, there has been less explicit attention paid in the research base to how GEAR UP impacts middle school students.

This is a particularly salient topic given evidence of the relationship between middle school experiences and post-secondary matriculation and success [1,14].

Direct evidence for GEAR UP's effectiveness in improving student outcomes is promising, but focuses primarily on short-term outcomes in highly contextualized settings. The most common approach to analyzing GEAR UP outcomes has been quasi-experimental, with comparisons of GEAR UP cohorts to control groups [42,44–49], or comparisons between groups with various intensities of participation in GEAR UP activities [50,51]. Studies have also drawn on survey data [37], quantitative analyses of the relationship between student standardized test scores and GEAR UP participation [29,40,52], analyses of GEAR UP students' post-secondary enrollment using National Student Clearinghouse data [30], and mixed methods approaches including student and parent interviews [50].

Studies of GEAR UP have provided some evidence for positive post-secondary student outcomes associated with program participation. For example, GEAR UP students in Rhode Island were 25% more likely to enroll in college than their peers in a matched comparison group [48], and research findings indicated that there was an increased likelihood of Texas GEAR UP students enrolling in post-secondary programs [37]. Once in college, evidence suggests that GEAR UP students can perform as well academically and persist at similar rates as their non-GEAR UP peers [42].

Short-term site-specific outcomes at the secondary level are often a focus of GEAR UP studies, and findings have shown that GEAR UP participants graduate at higher rates than the general population [50], have positive beliefs about their preparation for college [50], and have positive academic performance outcomes, particularly in mathematics and writing [40], and statistically significant increases in college readiness as measured by SAT, PSAT/NMSQT, and AP test scores [47]. One study also found that GEAR UP high school students had fewer disciplinary referrals than non-GEAR UP students [51].

Few studies focus explicitly on academic college readiness indicators specifically in middle school. Leuwerke et al. (2022) found that Iowa GEAR UP students in 7th–10th grades had, among other outcomes such as increased attendance, higher standardized test scores than students in a control group [52]. One of the first GEAR UP studies, conducted during the initiative's first years of implementation, found that GEAR UP participation was positively correlated with eighth grade participants' knowledge about college opportunities, their enrollment in above-grade level science courses, and parental involvement and understanding of post-secondary opportunities [49]. Although one study provided early evidence for the potential of GEAR UP to impact students at the middle school level, it did not include a direct measure of academic college readiness [49].

Some studies have attempted to identify specific GEAR UP interventions correlated to positive outcomes. Evidence suggests that college advising, campus visits, and providing college information through text and guest speakers positively impact rural students' college readiness [28]. Likewise, [30] examined a region that spanned urban, suburban, and rural areas and found that college visits, tutoring, assistance in understanding and applying for financial aid, and standardized test preparation were positively correlated with GEAR UP's students' college enrollment and persistence. In addition, [29] found that the intensity of English tutoring in GEAR UP correlated positively with increases in students' standardized test scores.

1.4. Purpose and Context of Study

The purpose of this study was to understand the impact of the SGU program on academic college readiness outcomes of students from one rural school (Johnsonville Middle School [JMS]) compared to a cohort of students from the same school prior to the start of the SGU program. The overarching research question that guided this study was: What is the impact of participation in the SGU on student academic college readiness outcomes? College readiness was measured by various 8th grade ACT Aspire indices (i.e., scaled scores, national percentile ranks, college readiness benchmarks), which are operationally defined in the data collection and instrumentation section.

Johnsonville Middle School is a rural middle school in the U.S. Midwest that serves slightly over 300 students in grades 6–8. On average, 59% of students are eligible for free and reduced-price lunch, and less than half (approximately 49%) have historically demonstrated proficiency or higher on state mathematics and reading tests.

SGU interventions were delivered during both in school and out-of-school hours. Academic interventions for the SGU cohort included after-school tutoring focusing predominantly on mathematics and English for 4–6 h each week, one-on-one instructional support by credentialed program instructors, whole-class instructional support provided by credentialed program instructors, STEM-focused summer camps for students, twice weekly after-school STEM educational programming for students, teacher professional development, informal mentoring for students, multiple speakers focused on career options, and mathematics and science coaching for classroom teachers provided by master teachers on staff with the program. Whole class supports included co-teaching and support for small group instruction with a focus on best-practice strategies in science and mathematics including inquiry-based learning and mastery-based instruction in mathematics. In addition to tutoring, after-school programming included engaging students in problem-based STEM projects and college and career readiness activities. Additional support was provided by the state higher education commission which included college/career readiness activities (in person and virtual), preparation for college entrance exams, and other mentoring sessions.

2. Materials and Methods

SGU programming met the specifications for comprehensive school reform (CSR) advanced by the U.S. Department of Education, including the use of evidence-based strategies to improve student achievement, support for educators and staff, involvement of families, and ongoing evaluation [53,54], allowing us to apply the methodological evidence base for CSR to the investigation of the SGU. CSR has the goal of improving student learning via a set of interventions targeted toward instructional practices, parental support, and management that draw on the scientific research base for effective practices [54], and encompasses a wide variety of programs that target student achievement [54].

A quasi-experimental cohort design was used to compare the impact of SGU programming (treatment or intervention) on college readiness outcomes (ACT Aspire indices) for students from different JMS 8th-grade cohorts (Pre-SGU vs. SGU). True experimental designs are rarely implemented in educational settings due to the need for random assignment of students [55,56], a practice that has ethical implications. As such, it is far more common for quasi-experimental studies to be designed and applied using students from intact groups for the intervention and comparison when conducting CSR impact studies [56]. Specifically, quasi-experimental cohort designs have been shown to be effective in studies of the impact of GEAR UP programming on student outcomes [44,45,57] because comparison and intervention groups of students come from the same community and are typically demographically similar. In this case, researchers did not have access to other schools within the geographic region, so students in the comparison group attended the same school as the intervention group. When cohorts of students are demographically similar (quasi-comparable), support for internal validity related to the intervention's impact can be assumed [58,59].

SGU programming was implemented with JMS students beginning in the 7th grade; the sample of SGU students participating in this study (n = 100) were those who had participated for both 7th and 8th grades while the control group was the one year ahead of the group that received the intervention. The literature indicates that demonstrating improved academic outcomes for students participating in CSRs requires students to be exposed to programming for extended periods of time [59–61]. The level and quality of program implementation are also dependent on time [61] since school reform initiatives are most successful when programming is implemented through cycles of development, implementation, refinement, and evaluation [59,62]. These findings were explicitly applied to the selection of JMS cohorts. The cohort of 8th grade students was selected to participate

in this study because they had been exposed to two full years of SGU programming when academic college readiness was assessed in the spring. In addition, teachers and support staff at JMS were in their second year of enacting GEAR UP activities and had been able to proceed through a full cycle of program implementation and refinement, suggesting that the quality of programming was stronger than in the first implementation year. The Pre-SGU comparison group was composed of students in the year immediately prior to the first year of SGU implementation (two years before the SGU cohort examined in this study).

A total of 186 JMS 8th grade students, including 86 from the Pre-SGU cohort (n = 86, 46.2%) and 100 from the SGU cohort (n = 100, 53.8%), participated in the study. Aggregate demographics for each cohort of JMS students are presented in Table 1. To evaluate for significant differences between cohorts, Chi-square tests of proportions were conducted; no statistical differences were found ($p > 0.05$). Gender representation was nearly equal in each cohort, with close to half females and males in each. Nearly all students (97%) were reported to be White across cohorts. Over half of students in each cohort were eligible for free and reduced-price lunch. Most students spoke English as their first language, although 14% of the Pre-SGU cohort and 19% of the SGU cohort were identified as speaking English as a second language. Due to a change in state assessments at the middle-school level between the time cohorts were in 6th and 8th grades at JMS, a comparison of student achievement prior to SGU intervention was impossible. This school, however, has historically underperformed in statewide achievement testing, and it is assumed that both cohorts of JMS students would have been at somewhat similar levels of underperformance if given the same state tests with no intervention.

Table 1. Aggregate demographics for JMS 8th-graders by cohort.

Student Demographic Values	**Johnsonville Middle School 8th-Grade Students**	
	Pre-SGU Cohort	**SGU Cohort**
Gender		
Female	47.7%	53.0%
Male	52.3%	47.0%
Race/Ethnicity		
American Indian/Alaska Native	0.0%	1.0%
Black or African American	3.5%	1.0%
Hispanic	0.0%	1.0%
White	96.5%	97.0%
Free and Reduced-Price Lunch Eligible		
Eligible	52.3%	55.0%
Not Eligible	47.7%	45.0%
English as a Second Language		
Yes	14.0%	19.0%
No	86.0%	81.0%

Both Pre-SGU and SGU cohort students were assessed using the ACT Aspire instrument in the spring of their respective 8th-grade years as part of the overall SGU evaluation. A district data manager sent the evaluation team Excel files with de-identified ACT Aspire outcomes by cohort. ACT Aspire is a system of standardized achievement tests that measure a student's progress towards college readiness by testing students' academic readiness in the areas of English, reading, mathematics, and science. Extensive validity studies have been conducted to support this purpose and have been documented in the ACT Aspire Summative Technical Manual [63]. Numerous student outcome indices are reported for each content area including scaled scores, college readiness benchmarks, and national percentile ranks. Since this study focuses on ACT Aspire 8th-grade findings, only reporting measures relevant to this grade will be described. All scaled scores have a lowest possible score of 400 and a highest possible score ranging from 440 to 456 depending on the content area. A composite score is calculated as a weighted average of scaled scores from English

(0.29 weight), reading (0.23 weight), mathematics (0.23 weight), and science (0.26 weight), and can range from 400 to 449.

College readiness benchmarks were established to categorize ACT Aspire scaled scores from content areas as either College Ready or Not College Ready. If a student earns the lowest score needed to pass a College Ready benchmark, they are predicted to receive a future ACT score "associated with a 50% chance of attaining a grade of B or higher or approximately a 75% chance of obtaining a C or higher in selected first-year credit-bearing college courses" [64], p. 162. For the 8th-grade ACT Aspire test, college readiness benchmark scaled sores for each content are as follows: English = 422, reading = 424, mathematics = 425, and science = 427.

Students are assigned a national percentile rank that compares their scaled score in each content area to three-year rolling norms. Because JMS cohorts in this study happened to fall within the same ACT Aspire three-year norming period, their national percentile ranks are comparable. Further, because percentile ranks are norm-referenced scores, comparisons about student performance between content areas can be drawn. National norms were based on nearly 200,000 students across the country for each subject area [64].

To evaluate measures of college readiness by JMS cohort, appropriate inferential statistics were used in alignment with variables. For all statistical tests, the independent variable (JMS cohort) was dichotomous (Pre-SGU vs. SGU). College readiness ACT Aspire outcome variables (or dependent variables) were either continuous in nature (scaled scores and national percentile ranks) or dichotomous (college readiness benchmark—met or did not meet). Thus, to examine the data for JMS cohort differences in scaled scores and national percentile ranks, independent samples *t*-tests were conducted for each content area (English, mathematics, reading, science). Chi-square tests for each content area were run to investigate possible differences in college readiness benchmarks by cohort (Pre-SGU and SGU). Due to the well-documented challenge of achieving significant academic outcome improvement for students who have had limited exposure to CSR programming [59–61,64], one-tailed statistical tests were used to allow for greater power in identifying potentially significant differences in college readiness outcomes between JMS cohorts.

3. Results

3.1. Scaled Scores Comparisons

Results from independent samples *t*-tests showed a statistically significant difference in English ($p < 0.001$), mathematics ($p < 0.01$), reading ($p < 0.01$), science ($p < 0.001$), and composite ($p < 0.001$) ACT Aspire average scaled scores by JMS 8th-grade cohorts. The SGU cohort scored significantly higher than the Pre-SGU cohort in all instances. When relating average scaled scores to college readiness as defined by the ACT Aspire technical manual, the average English and mathematics scaled score for SGU students fell in the range of "college ready", while their reading and science scores were slightly below the college ready level (reading—1 point below; science—5 points below). For the Pre-SGU cohort, students' average scaled scores were all below college ready; the closest average scores were for English (1 point below) and mathematics (1 point below) followed by reading (5 points below) and science (9 points below). Table 2 provides complete descriptive and inferential results.

Table 2. Independent samples *t*-test results for average ACT Aspire scaled scores by JMS 8th-grade cohort.

	JMS 8th-Grade Cohort Average Scaled Score			
PSAT Scale	**Pre-SGU M (SD)**	**SGU M (SD)**	**t-Statistic**	**Cohen's d**
English	420.63 (10.69)	426.64 (8.88)	4.18 ***	0.616
Mathematics	423.59 (7.41)	426.45 (8.00)	2.50 **	0.368
Reading	419.31 (9.42)	422.99 (7.87)	2.90 **	0.717
Science	417.79 (7.69)	421.87 (8.83)	3.33 ***	0.490
Composite	420.42 (8.06)	424.79 (7.44)	3.84 ***	0.565

Note. ** = $p < 0.01$, *** = $p < 0.001$.

3.2. College Readiness Benchmark Comparisons

Significantly greater percentages of SGU cohort students met or exceeded college readiness benchmarks across ACT Aspire content areas in comparison to Pre-SGU cohort students (see Figure 1). Differences in the percentage of JMS cohort students meeting benchmarks were most pronounced for English (33 percentage points), followed by reading (19 percentage points), science (17 percentage points), and mathematics (15 percentage points). In all content areas, fewer than half of students in the Pre-SGU cohort met the college readiness benchmark (range of 16% for science to 43% for mathematics). In contrast, half or more of students in the SGU cohort met the college readiness benchmark in English (75% met benchmark), mathematics (58% met benchmark), and reading (54% met benchmark). The only content area in which less than half of SGU cohort students met the benchmark was science (33% met benchmark).

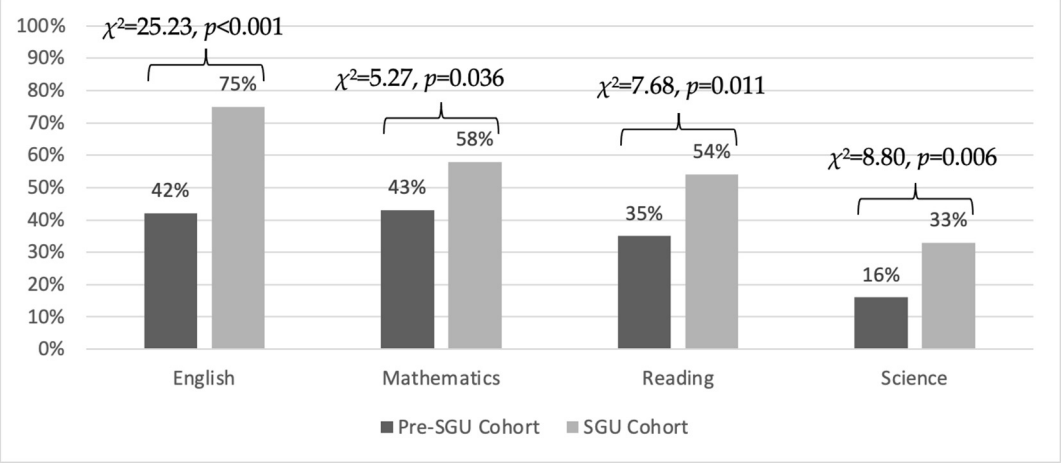

Figure 1. Percent met benchmark on ACT Aspire content areas by JMS 8th-grade cohort.

3.3. Percentile Ranks Comparisons

Independent samples *t*-tests findings demonstrated that SGU cohort students significantly outperformed Pre-SGU students in terms of their average percentile ranks across ACT Aspire content areas: English ($p < 0.001$), mathematics ($p < 0.05$), reading ($p < 0.01$), science ($p < 0.001$). The percentile ranks for the Pre-SGU cohort ranged from the 29.70th percentile in science to the 55.40th percentile in mathematics. These findings mean that the average Pre-SGU student scores better than 29.70% of the norm on the science ACT Aspire section and better than 55.40% of the norm on the mathematics section. For the SGU cohort, percentile ranks ranged from the 44.05th percentile (scoring higher than 44.05% of

the norm) in science to the 62.78th percentile (scoring higher than 62.78% of the norm) in mathematics. Descriptive and inferential statistics for these tests are shown in Table 3.

Table 3. Independent samples *t*-test results for average ACT Aspire percentile ranks by 8th-grade JMS cohort.

	JMS 8th-Grade Cohort Average Percentile Rank			
PSAT Scale	**Pre-SGU M (SD)**	**SGU M (SD)**	**t-Statistic**	**Cohen's d**
English	32.14 (30.57)	49.55 (27.38)	4.09 ***	0.602
Mathematics	55.40 (26.86)	62.78 (27.34)	1.85 *	0.272
Reading	39.90 (34.12)	53.48 (30.79)	2.85 **	0.420
Science	29.70 (27.42)	44.05 (30.40)	3.35 ***	0.494

Note. * = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$.

3.4. College Readiness Outcome Differences

At the time of this study, the SGU initiative at JMS was a young program (only in its second year of implementation), yet it produced statistically and practically significant improvements in academic college readiness amongst 8th-grade SGU students as compared to Pre-SGU students. These results are especially promising given the fact that academic impact from programs like SGU are known to take time [59–61,64], suggesting that these impacts may become stronger in future implementation years. In relationship to past research, our findings accord with evidence for the effectiveness of tutoring to support students' academic performance in mathematics [31,32]. The positive outcomes for SGU students as compared to non-SGU students in meeting college-ready benchmarks also highlights and supports previous research findings regarding the effectiveness of leveraging both in-school hours [1,24] and OST [38,40] to support students' college readiness.

These findings suggest that the targeted academic support in mathematics and English incorporated into SGU were impactful for students' content knowledge and skills. We speculate that the comprehensive nature of supports that leveraged school hours, after-school hours, and summer camp programming provided students with consistent exposure and opportunities to engage with academic content that drove the achievement improvements relative to the non-SGU cohort. Although only 33% of SGU cohort students met the ACT Aspire college readiness benchmark for science, it is notable that these students were substantially more likely to meet the benchmark than pre-SGU students (16% met the benchmark), suggesting that with continued SGU academic supports increasing numbers of students may exhibit college-readiness in science.

4. Discussion

4.1. Broader Comparison

Percentile rank findings contextualize Pre-SGU and SGU cohort college readiness performance on a broader scale for comparison to national norms. A similar pattern of success was found across JMS cohorts with mathematics rankings being highest followed by reading, English, and science. However, the overall picture when comparing average cohort percentile ranks to the national norm sample of 8th graders completing the ACT Aspire was markedly different. With the exception of mathematics for the Pre-SGU cohort who averaged in the 55.40th percentile, Pre-SGU cohort JMS students performed on average substantially below typical 8th-grade performance on the ACT Aspire. In comparison, SGU cohort students from JMS performed, on average, better than nearly 50% of students completing the ACT Aspire in all areas except science (44.05th percentile).

Given the evidence of persistent achievement gaps for low-income students [19], it is especially noteworthy that GEAR UP students, who were more likely to qualify for free and reduced-price lunch than other students in their state and across the nation [65],

outperformed their peers nationally. This finding suggests that the GEAR UP model implemented at JMS is impactful and is achieving the desired GEAR UP outcomes. The evidence provided here of academic outcomes across a range of academic content areas contributes to the scant research base regarding the effectiveness of GEAR UP for middle-school students generally and provides a unique perspective on GEAR UP's impact on 8th graders' academic college readiness.

The use of the ACT Aspire, a nationally available instrument, provides opportunities for comparisons across rural middle school sites nationally. Likewise, the methodology used in this study may be useful in providing evidence of academic impact for relatively young GEAR UP programs. Using a common instrument such as the ACT Aspire provides opportunities to identify GEAR UP sites with particularly strong impact on rural middle school students. Further investigations of these sites can provide insights into the specific interventions that drive these results, and contribute to a compendium of best practices for college readiness interventions in rural middle school settings.

4.2. Methodological Considerations and Limitations

The complex nature of schools with numerous entwined programs and initiatives working together to support students in various ways creates substantial challenges for CSR research [66]. Quasi-experimental research plays an important role in this type of research [55,56]; however, it is important to further investigate such initiatives using qualitative and mixed-methods designs to garner a more complete picture of not only what occurred, but how and why changes took place as well [46]. Likewise, only academic achievement was examined in this study. No examination was made of the other supports (for example, college information, college visits, and mentoring) provided by SGU. While we can speculate as to why the SGU cohort significantly outperformed the Pre-SGU cohort across ACT Aspire college-readiness measures based on what we know about programming in JMS and from what the literature suggests, we cannot truly understand how and why the improvements were found without deeper qualitative or mixed-methods investigations.

Although quasi-experimental cohort designs are known to be robust and produce quasi-compatibility between cohorts with similar background demographics [59], there is always a possibility that groups may have been different in ways not assessed. Such differences are known as precursor confounding variables and often fall into the category of participant demographics [66]. Student-level variables available to this research team were examined for statistical differences, and none were found by gender, race/ethnicity, free/reduced-price lunch status, and ESL status. Nonetheless, findings must be interpreted with caution as all potential precursor confounding variables were unable to be checked for comparability. In addition, it should be noted that this study focused on only two cohorts of students at one school; the limited sample, therefore, presents constraints on the generalizability of findings.

5. Conclusions

Findings from the SGU program's first two years of operation are promising and suggest that the higher education-led program is producing robust academic college readiness outcomes for U.S. middle-school students. This evidence of positive return on the federal GEAR UP investment provides important information regarding higher education-led programming's effectiveness that can be useful to policy makers and college readiness educators, researchers, and advocates. It is important to note, however, that SGU was a relatively young program at the time of this study, and that there remains much work to be done in preparing these students for college and for understanding how the SGU program impacts college readiness. Although SGU-cohort students outperformed their non-SGU peers and their peers nationally, a large percentage of students did not meet college benchmarks in each academic area assessed, indicating the need for ongoing and possibly enhanced interventions and research studies to understand the impact of these interventions. In addition, student outcomes varied by academic subject area, a finding

that suggests that the comparative efficacy of various interventions on student outcomes in discrete subject areas could be investigated in future studies. Further studies that include qualitative and mixed methods and exam relationships between students' college readiness in domains other than the academic can provide a comprehensive understanding of the SGU program and its impacts. Likewise, longitudinal studies that follow the JMS cohorts through their secondary and post-secondary educational experiences could provide evidence of whether and how the early academic college readiness outcomes translate into high school achievement and post-secondary attendance and persistence.

The SGU cohorts' relatively low scores in science reflect the trend in the low number of individuals from rural areas who pursue STEM degrees [5] and point to the ongoing need to support rural students in inquiry-based science learning. A focused examination of the science academic supports and STEM summer camp provided by SGU may provide more nuanced insight into students' academic achievement and barriers to that achievement. In addition, it may be useful to track the relationship between SGU students' mathematics and science scores over time to identify possible trailing effects in science achievement by investigating whether mathematics achievement gains correlate with subsequent gains in science achievement.

This study provided a limited, albeit encouraging and useful, snapshot of the impact of an SGU site's program on rural students' academic college readiness. College readiness is, however, a phenomena that requires sustained and persistent interventions. As Tillery and Duckor (2017) noted, "There remains a pressing need for comprehensive and longitudinal evaluations that follow GEAR UP students through the program and through college completion" [67], p. 122, as well as to understand the relationship between specific interventions and post-secondary-student outcomes.

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References

1. Balfanz, R. *Putting Middle Grades Students on the Graduation Path*; Everyone Graduates Center and Talent Development Middle Grades: Program Policy and Practice Brief; National Middle School Association: Westerville, OH, USA, 2009.
2. Glaser, E.; Warick, C. *What Does the Research Say About Early Awareness Strategies for College Access and Success?* National College Access Network: Washington, DC, USA, 2016. Available online: https://eric.ed.gov/?id=ED604082 (accessed on 5 August 2024).
3. National Council for Community and Education Partnerships. About GEAR UP. Available online: https://www.edpartnerships.org/about-gear-up (accessed on 21 October 2024).
4. Gaertner, M.N.; McClarty, K.L. Performance, perseverance, and the full picture of college readiness. *Educ. Meas. Issues Pract.* **2015**, *34*, 20–33. [CrossRef]
5. Saw, G.K.; Agger, C.A. STEM pathways of rural and small-town students: Opportunities to learn, aspirations, preparation, and college enrollment. *Educ. Res.* **2021**, *50*, 595–606. [CrossRef]
6. US Department of Education. Applications for New Awards; Gaining Early Awareness and Readiness for Undergraduate Programs (State Grants). *Fed. Regist.* **2023**, *88*, 35858–35863.
7. Johnson, A.; Kuhfeld, M.; Soland, J. The Forgotten 20 Percent: Achievement and Growth in Rural Schools Across the Nation. NWEA Center for School and Student Progress. 2022. Available online: https://www.nwea.org/content/uploads/2022/03/The-forgotten-20-percent-achievement-and-growth-in-rural-schools-across-the-nation_NWEA_research-brief.pdf (accessed on 5 August 2024).

8. Wells, R.S.; Chen, L.; Bettencourt, G.M.; Haas, S. Reconsidering rural-nonrural college enrollment gaps: The role of socioeconomic status in geographies of opportunity. *Res. High Educ.* **2023**, *64*, 1089–1112. [CrossRef]
9. Tieken, M.C. College talk and the rural economy: Shaping the educational aspirations of rural, first-generation students. *Peabody J. Educ.* **2016**, *91*, 203–223. [CrossRef]
10. Besas, M.; COVID Forces Number of Rural Students Attending College to Plummet. The College Post, 5 January 2021. Available online: https://thecollegepost.com/covid-rural-student-enrollment/ (accessed on 21 July 2024).
11. Green, S.; Sanczyk, A.; Chambers, C.; Mraz, M.; Polly, D. College and Career Readiness: A Literature Synthesis. *J. Educ.* **2023**, *203*, 222–229. [CrossRef]
12. Gee, K.A.; Beno, C.; Lindstrom, L.; Lind, J.; Post, C.; Hirano, K. Enhancing college and career readiness programs for underserved adolescents. *J. Youth Dev.* **2020**, *15*, 222–251. [CrossRef]
13. Camara, W.; O'Connor, R.; Mattern, K.; Hanson, M.A. *Beyond Academics: A holistic Framework for Enhancing Education and Workplace Success*; ACT Research Report Series; ACT Inc.: Iowa City, IA, USA, 2015.
14. ACT. The Forgotten Middle: Ensuring that All Students Are on Target for College and Career Readiness Before High School. 2008. Available online: https://www.act.org/content/dam/act/unsecured/documents/ForgottenMiddle.pdf (accessed on 5 August 2024).
15. Johnson, A.; Kuhfeld, M.; King, G. Measuring middle school achievement trajectories for college readiness. *Educ. Policy* **2022**, *36*, 1702–1730. [CrossRef]
16. Kurlaender, M.; Reed, S.; Hurtt, A. Improving College Readiness: A Research Summary and Implications for Practice. In *Policy Analysis for California Education*; PACE: Stanford, CA, USA, 2019.
17. Chen, X.; Soldner, M. *STEM Attrition: College Students' Paths into and Out of STEM Fields*; U.S. Department of Education Institute of Education Sciences, NCES: Washington, DC, USA, 2013; p. 2014-001. Available online: https://nces.ed.gov/pubs2014/2014001rev.pdf (accessed on 18 July 2024).
18. Peterson, B.; Bornemann, G.; Lydon, C.; West, K. Rural students in Washington State: STEM as a strategy for building rigor, postsecondary aspirations, and relevant career opportunities. *Peabody J. Educ.* **2015**, *90*, 280–293. [CrossRef]
19. Reardon, S.F. The widening academic achievement gap between the rich and the poor: New evidence and possible explanations. In *Whither Opportunity? Rising Inequality, Schools, and Children's Life Chances*; Duncan, G.J., Murnane, R.J., Eds.; Russell Sage Foundation: New York, NY, USA, 2011; pp. 91–116.
20. National Academies of Sciences, Engineering, and Medicine. *Barriers and Opportunities for 2-Year and 4-Year STEM Degrees: Systemic Change to Support Students' Diverse pathways*; National Academies Press: Washington, DC, USA, 2016.
21. Ehlert, M.; Finger, C.; Rusconi, A.; Solga, H. Applying to college: Do information deficits lower the likelihood of college-eligible students from less-privileged families to pursue their college intentions?: Evidence from a field experiment. *Soc. Sci. Res.* **2017**, *67*, 193–212. [CrossRef]
22. Gibbons, M.M.; Hardin, E.E.; Taylor, A.L.; Brown, E.; Graham, D. Evaluation of an SCCT-based intervention to increase postsecondary awareness in rural Appalachian youth. *J. Career Dev.* **2020**, *47*, 424–439. [CrossRef] [PubMed]
23. Grigal, M.; Cooney, L.; Hart, D. Promoting college and career readiness with middle school youth with disabilities: Lessons learned from a curriculum development project. *Career Dev. Transit. Except. Individ.* **2019**, *42*, 64–71. [CrossRef]
24. Albritton, K.; Cureton, J.L.; Byrd, J.A.; Storlie, C.A. Exploring perceptions of the path to work/life success among middle school students of color. *J. Career Dev.* **2020**, *47*, 440–453. [CrossRef]
25. Babarović, T.; Dević, I.; Blažev, M. The effects of middle-school career intervention on students' career readiness. *Int. J. Educ. Vocat. Guid.* **2020**, *20*, 429–450. [CrossRef]
26. Radcliffe, R.A.; Bos, B. Strategies to prepare middle school and high school students for college and career readiness. *Clear. House: A J. Educ. Strateg. Issues Ideas* **2013**, *86*, 136–141. [CrossRef]
27. Cohen, M.D.; Therriault, S.; Scala, J.; Lavinson, R.; Brand, B. *Afterschool Programming as a Lever to Enhance and Provide Career Readiness Opportunities*; College and Career Readiness and Success Center, American Institute for Research: Arlington, TX, USA, 2019.
28. Cates, J.T.; Schaefle, S.E. The relationship between a college preparation program and at-risk students' college readiness. *J. Lat. Educ.* **2011**, *10*, 320–334. [CrossRef]
29. Kennedy, R.F. Exploring the Relationship Between Student Involvement in GEAR UP and Academic Achievement. Ph.D. Thesis, Northern Arizona University, Flagstaff, AZ, USA, 2016.
30. Kim, S.; Bowman, N.A.; Ingleby, L.; Ford, D.C.; Sibaouih, C. Promoting educational success: Which GEAR UP services lead to postsecondary enrollment and persistence? *Educ. Policy* **2021**, *35*, 101–130. [CrossRef]
31. Alegre, F.; Moliner, L.; Maroto, A.; Lorenzo-Valentin, G. Peer tutoring in algebra: A study in Middle school. *J. Educ. Res.* **2019**, *112*, 693–699. [CrossRef]
32. Chappell, S.; Arnold, P.; Nunnery, J.; Grant, M. An examination of an online tutoring program's impact on low-achieving middle school students' mathematics achievement. *Online Learn.* **2015**, *19*, 37–53. [CrossRef]
33. Falco, L.D.; Steen, S. Using school-based career development to support college and career readiness: An integrative review. *J. Sch. Based Couns. Policy Eval.* **2018**, *1*, 51–67. [CrossRef]
34. Pak, K.; Desimone, L.M.; Parsons, A. An integrative approach to professional development to support college-and career-readiness standards. *Educ. Policy Anal. Arch.* **2020**, *28*, n111. [CrossRef]

35. Klein, A.; How are States Measuring College-and-Career Readiness? It's a Hodge-Podge. Education Week, 22 January 2019. Available online: https://www.edweek.org/policy-politics/how-are-states-measuring-college-and-career-readiness-its-a-hodge-podge/2019/01 (accessed on 5 August 2024).
36. Walters, J.A. College and Career Readiness in Rural Idaho: A Mixed-Methods Study of the Current Culture, Struggles, and Successes in Middle Schools. Ph.D. Thesis, Northwest Nazarene University, Nampa, ID, USA, 2022.
37. Weiher, G.R.; Hughes, C.; Kaplan, N.; Howard, J.Y. Hispanic college attendance and the state of Texas GEAR UP program. *Rev. Policy Res.* **2016**, *23*, 1035–1051. [CrossRef]
38. Gutierrez, K.S.; Blanchard, M.R.; Busch, K.C. What effective design strategies do rural, underserved students in STEM clubs value while learning about climate change? *Environ. Educ. Res.* **2022**, *28*, 1043–1069. [CrossRef]
39. Hooker, S.; Brand, B. College knowledge: A critical component of college and career readiness. *New Dir. Youth Dev.* **2010**, *127*, 75–85. [CrossRef] [PubMed]
40. Schaefle, S. The relationship between GEAR UP program involvement and Latina/o students' performance on high-stakes tests. *J. Lat. Educ.* **2018**, *17*, 201–214. [CrossRef]
41. National Research Council. *Identifying and Supporting Productive STEM Programs in Out-of-School Settings*; The National Academies Press: Washington, DC, USA, 2015. [CrossRef]
42. Sanchez, J.E.; Lowman, J.L.; Hill, K.A. Performance and persistence outcomes of GEAR UP students: Leveling the playing field in higher education. *J. Coll. Stud. Retent. Res. Theory Pract.* **2018**, *20*, 328–349. [CrossRef]
43. National Council for Community and Education Partnerships. College and Career Readiness Evaluation Consortium: Data, Research, Evaluation. Available online: https://www.edpartnerships.org/ccrecup (accessed on 26 August 2023).
44. Lunceford, C.J.; Sondergeld, T.A.; Stretavski, E.L. A comparative case study of student preparation for postsecondary education: How GEAR UP, socioeconomic status, and race influence academic and non-academic factors. *J. Educ. Stud. Placed Risk (JESPAR)* **2017**, *22*, 185–199. [CrossRef]
45. Sondergeld, T.A.; Fischer, J.M.; Samel, A.N.; Knaggs, C.M. Evaluating the influence of an urban high school reform effort on college readiness and access outcomes: A quasiexperimental cohort study. *J. Educ. Stud. Placed Risk (JESPAR)* **2013**, *18*, 212–232. [CrossRef]
46. Samel, A.N.; Sondergeld, T.A.; Fischer, J.M.; Patterson, N.C. The secondary school pipeline: Longitudinal indicators of resilience and resistance in urban schools under reform. *High Sch. J.* **2011**, *94*, 95–118. [CrossRef]
47. Bausmith, J.M.; France, M. The impact of GEAR UP on college readiness for students in low income schools. *J. Educ. Stud. Placed Risk (JESPAR)* **2012**, *17*, 234–246. [CrossRef]
48. Fogg, N.P.; Harrington, P.E. Evidence-Based Research: The Impact of the College Crusade GEAR UP Program in RI. New England Board of Higher Education, Boston, MA, USA. 2015. Available online: https://nebhe.org/journal/evidence-based-research-the-impact-of-the-college-crusade-gear-up-program-in-rhode-island/ (accessed on 18 July 2024).
49. Standing, K.; Judkins, D.; Keller, B.; Shimshak, A. *Early Outcomes of the GEAR UP Program: Final Report*; US Department of Education: Washington, DC, USA, 2008. Available online: https://www2.ed.gov/rschstat/eval/highered/gearup/early-outcomes.pdf (accessed on 12 July 2024).
50. Morgan, Y.; Sinatra, R.; Eschenauer, R. A comprehensive partnership approach increasing high school graduation rates and college enrollment of urban economically disadvantaged youth. *Educ. Urban Soc.* **2014**, *47*, 596–620. [CrossRef]
51. Yampolskaya, S.; Massey, O.T.; Greenbaum, P.E. At-risk high school students in the "Gaining Early Awareness and Readiness" Program (GEAR UP): Academic and behavioral outcomes. *J. Prim. Prev.* **2006**, *27*, 457–475. [CrossRef]
52. Leuwerke, W.C.; Ingleby, L.D.; Tillery, C.Y.; Cech, T.G.; Sibaouih, C.M. Narrowing the college readiness gap: Assessing GEAR UP Iowa's intermediate impact on underserved students. *J. Educ. Stud. Placed Risk (JESPAR)* **2021**, *26*, 352–370. [CrossRef]
53. US Department of Education. Scientifically Based Research and the Comprehensive School Reform (CSR) Program. Comprehensive School Reform Program Office. 2002. Available online: https://www2.ed.gov/programs/compreform/guidance/appendc.pdf (accessed on 12 August 2024).
54. Borman, G.D.; Hewes, G.M.; Overman, L.T.; Brown, S. (Comprehensive school reform and achievement: A meta-analysis. *Rev. Educ. Res.* **2002**, *73*, 125–230. [CrossRef]
55. Creswell, J.W. *Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research*, 3rd ed.; Pearson Education, Inc.: Upper Saddle River, NJ, USA, 2008.
56. Crowley, J.; Hauser, A. Evaluating whole school improvement models: Creating meaningful and reasonable standards for review. *J. Educ. Stud. Placed Risk* **2007**, *12*, 37–60. [CrossRef]
57. Cook, T.; Campbell, D. *Quasi-Experimental Design and Analysis Issues for Field Settings*; Rand McNally College Publishing Company: Chicago, IL, USA, 1979.
58. Knaggs, C.M.; Sondergeld, T.A.; Schardt, B. Overcoming barriers to college enrollment, persistence, and perceptions for urban high school students in a college preparatory program. *J. Mix. Methods Res.* **2015**, *9*, 7–30. [CrossRef]
59. Sondergeld, T.A.; Stone, G.E.; Kruse, L.M. Objective standard setting in educational assessment and decision making. *Educ. Policy* **2020**, *34*, 735–759. [CrossRef]
60. Datnow, A.; Stringfield, S. Working together for reliable school reform. *J. Educ. Stud. Placed Risk (JESPAR)* **2000**, *5*, 183–204. [CrossRef]

61. Taylor, J.E. The struggle to survive: Examining the sustainability of schools' comprehensive school reform efforts. *J. Educ. Stud. Placed Risk* **2006**, *11*, 331–352. [CrossRef]
62. Aladjem, D.K.; LeFloch, K.C.; Zhang, Y.; Kurki, A.; Boyle, A.; Taylor, J.E.; Herrmann, S.; Uekawa, K.; Thomsen, K.; Fashola, O. *Models Matter: The Final Report of the National Longitudinal Evaluation of Comprehensive School Reform*; American Institutes for Research: Arlington, TX, USA, 2006. Available online: https://files.eric.ed.gov/fulltext/ED499198.pdf (accessed on 18 July 2024).
63. ACT. *ACT Aspire Summative Technical Manual*; ACT: Tokyo, Japan, 2020; Available online: https://actinc.my.salesforce.com/sfc/p/#300000000Wu5/a/4v0000005fHp/SLZ26Xzhfml8ibKP_Ca5G94_T3HuveFbNgFmfcRaHoY (accessed on 18 July 2024).
64. Kretovics, J.; Farber, K.; Armaline, W. Reform from the bottom up: Empowering teachers to transform schools. *Phi Delta Kappan* **1991**, *73*, 295–299.
65. National Center for Education Statistics. Digest of Education Statistics: 2021 Tables and Figures. Institute of Educational Sciences. 2021. Available online: https://nces.ed.gov/programs/digest/d21/tables/dt21_204.10.asp (accessed on 12 August 2024).
66. Provinzano, K.; Sondergeld, T. Community schools: A comprehensive and human-centric approach to school reform. In *The Personal, Place, and Context in Pedagogy: An Activist Stance for Our Uncertain Educational Future*; Springer International Publishing: Cham, Switzerland, 2021; pp. 103–132.
67. Tillery, C.; Duckor, B. Early intervention in college and career readiness: The GEAR UP model and its implications for 21st-century education policy. In *Preparing Students for College and Careers*; McClarty, K.L., Mattern, K.D., Gaertner, M.N., Eds.; Routledge: London, UK, 2017; pp. 119–129.