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Comparison of Dual Enrollment Student Grades in Introductory Biology College Dual-Enrollment Courses Taken in Texas High Schools or Colleges for School Leaders

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Comparison of Dual Enrollment Student Grades in Introductory Biology College Dual-Enrollment Courses Taken in Texas High Schools or Colleges for School Leaders

Dual enrollment (DE) or dual credit (DC) programs enable students to earn both high school and college credit via collaboration between school districts, the high school, and institutions of higher education. Dual-enrollment programs have become more prevalent in the college and high school setting. These programs help students acquire a head start in earning college credit for post-secondary studies. According to Martinez et al. (2018), dual enrollment courses can be academic or career/technical and students can acquire credit for college by receiving a passing grade in the course. Moreover, "students may or may not simultaneously earn high school credit (i.e., dual credit), but their college performance is documented on a college transcript" (Martinez et al., 2018, p. 517). The number and percentage of high school students who take college courses while in high school is growing. However, little is known about how dual-enrolled students fare, especially when it comes to location of the courses such as courses taken at a high school campus or non-high school (i.e. college environment).

As per Martinez et al. (2018), dual enrollment programs in Texas public schools, it is noted that underrepresented students are acquiring both college credit and high school credit per dual credit course. As demonstrated by Hornbeck et al. (2023), the data demonstrates that student engaging in dual enrollment courses leads to higher success outcomes for higher education continuation, tenacity in college courses, better high school performance and increasing graduation rates. Research demonstrates that approximately 80% of students that take dual enrollment courses take it at their respective high schools, therefore high school leaders, such as principals, play an integral role in dual enrollment (Hornbeck et al., 2023).

This study is based upon a previous study that the researcher conducted in regard to looking at all courses for dual enrollment and location based on student performance. However, the researcher believed that more clarity should be considered in regard to Introductory Biology courses as they are an introduction to STEM courses that many students take while engaging in dual enrollment courses. This study will look at students taking introductory biology courses and their performance at both the high school and non-high school locations (i.e. college environment) in Texas. In addition, this study will provide recommendations to school leaders such as administrators or principals to ensure that high quality instruction and student achievement are in place in high school locations or in the college environment.

Literature Review

Role and Perceptions of School Leaders in Directing Dual Credit Programs

As mentioned, dual credit programs have gained prominence in education as effective pathways for high school students to earn college credits while completing their secondary education. These programs offer several benefits, such as increased academic rigor, enhanced college readiness, and cost savings for students and parents. However, the successful implementation and direction of dual credit programs rely heavily on the leadership of school administrators.

School leaders play a pivotal role in establishing a vision for dual credit programs. According to Adelman (1999), school leaders must articulate clear objectives and goals that align with the school's mission, vision, and needs of their student body. As per Troutman et al. (2018), by developing an integration strategic plan of dual credit offerings into the curriculum, school

leaders allow for effective program implementation and long-term success. In accordance with Adelman (2006), strategic planning allows for collaboration with faculty, staff, parents, and community stakeholders to garner support and resources for initiative. A primary responsibility of school leaders in directing dual credit programs is overseeing the development and alignment of curriculum standards. School administrators work closely with academic departments to identify college-level courses that meet rigorous academic standards which align with state and national educational requirements. Accordingly, school leaders ensure that dual credit courses maintain the corresponding level of quality and rigor as their college counterparts while also addressing the distinctive needs and interests of high school students.

Many dual enrollment courses are taught at the high school by qualified high school faculty who possess at least 18 hours of master level coursework hours to teach the dual enrollment courses (Hornbeck, 2023). Hence, school leaders are instrumental in providing faculty with the necessary training to effectively instruct dual credit courses. For example, they facilitate professional development opportunities, workshops, and seminars to enhance educators' pedagogical skills, content knowledge, and familiarity with college-level expectations. According to Mokher & Jacobson (2021), school leaders establish mentoring programs and peer collaboration networks to foster a culture of constant improvement and innovation among faculty teaching dual credit courses.

Accordingly, another key priority for school leaders is ensuring equitable access to dual credit programs. School leaders work to identify and address barriers to participation in dual credit programs, these include financial difficulties, academic preparedness, and transportation limitations (Duncheon & DeMatthews, 2018). Moreover, school leaders implement outreach and recruitment strategies to engage underrepresented student populations (Adelman, 2006). Strategies include providing students with the necessary support services, including academic advising, tutoring, and counseling. By promoting inclusivity and diversity within dual credit programs, school leaders strive to empower all students to pursue postsecondary education and career pathways.

According to Henig et al. (2016), School leaders recognize the importance of forming partnerships with intuitions of higher education offering dual credit courses. They establish memorandum of understanding (MOU), agreements, and dual enrollment partnerships to facilitate credit transfer processes and ensure adequate transitions for students (Hornbeck et al., 2023). Furthermore, school leaders also engage with business and industry partners to develop work-based learning opportunities and career pathways for students that align with workforce demands.

School leaders play a critical role in directing dual credit programs and shaping the educational experiences of high school students. Their visionary leadership, strategic planning, curriculum development, faculty support, student advocacy, and partnership building are essential for the success and sustainability of dual credit programs (Troutman et al., 2018). By utilizing their expertise and available resources, school leaders can create pathways to academic excellence, equity, and opportunity for dual enrollment students.

Impact on School Administrators and Dual Enrollment

According to Martinez et al. (2018), an enduring leadership quality found among many of the school leaders was their ability to be visionaries and see the long-term potential of dual enrollment opportunities at their intuitions and regions. Therefore, having a coherent vision is a pivotal component to transformation within a school or district (Hallinger, 2003). For example,

Martinez et al. (2018), stated that administrators' positive viewpoints on dual enrollment embodied a "college going culture" that would permeate to families and communities where dual enrollment was offered. For example, a South Texas administrator depicted in Martinez et al. (2018) studied, discussed, that his aim was to create a college-going culture throughout the district and this in turn would allow the community to place a strong value on higher education. Moreover, other administrators were aware that, in addition to parents and the community, all of their school and district employees were also embracing their vision of increasing dual enrollment opportunities for South Texas students (Martinez et al., 2018).

School Leaders and Instructional Leadership

School leaders play a central role in instructional leadership within their educational institutions. Instructional leadership enables the support and enhancement of teaching and learning processes. According to Martinez et al. (2018), this starts of with the school leaders establishing and having a vision for high quality instruction. School leaders must clearly articulate educational expectations for students, teachers, and all stakeholders. As denoted by Hallinger (2003), by instilling a clear vision students and teachers will be inspired and motivated to strive for excellence.

Secondly, school leaders create a culture of collaboration and professional learning where educators can engage in ongoing dialogue, reflection, and collaboration to improve upon their teaching skills (Martinez et al., 2018). School administrators facilitate and encourage opportunities for teachers to partake in professional development opportunities, workshops, peer observation, and collaborative groups that may focus on enhancing instructional effectiveness (Martinez et al., 2018). By fostering a culture of ongoing improvement, school leaders empower educators adapt instructional practices to meet the evolving needs of the student population (Hallinger, 2003).

Moreover, as stated in Education Trust (2020), school leaders provide instructional support and feedback to teachers through regular classroom observations, instructional rounds, and constructive feedback sessions. School leaders offer personalized coaching and mentoring to help teachers refine their instructional strategies, differentiate instruction, and address student learning needs effectively (Education Trust, 2020). By providing targeted support and feedback, school leaders help teachers grow professionally and improve student outcomes.

In addition, school leaders may provide opportunities for students and teachers that are culturally relevant to their region. According to Martinez et al. (2018), a district-level administrator spoke about an innovative approach that his district was advocating to increase dual enrollment opportunities that were culturally relevant to students in a South Texas region. The administrator stated that his district had recruited several chemistry and biology master-level degree teachers from Spain in preceding years (Martinez et al., 2018). The administrator explained that they were brought to his district to help with dual language, in English and Spanish. The administrator believed this was a good bilingual model to use with the students that was culturally relevant (Martinez et al., 2018).

According to Gardner (1993), school leaders allocate resources strategically to support effective instruction. For example, school leaders may invest in curriculum materials, instructional technology, and professional development opportunities (Martinez et al., 2018). School leaders advocate for equitable access to resources and opportunities for all students, regardless of their background or ability level (Hallinger, 2003). The equitable access to resources and opportunities ensure that every student receives a high-quality education (Gardner,

1993). School leaders play a critical role in promoting instructional leadership within their schools (Hallinger, 2003). School leaders engage in instructional leadership by having a coherent vision for high-quality instruction, articulating a culture of collaboration and professional learning, procuring instructional support and feedback to teachers, and allotting resources to support effective instruction (Hornbeck et al., 2023). By prioritizing instructional leadership, school leaders can formulate learning environments where students can thrive academically and advance the skills they need for success.

School Leaders and Monitoring Dual Enrollment

Gardner (1993) affirms that leaders who revolutionize their organization must think differently to move the organization forward. In the study conducted by Martinez et al. (2018), school leaders must apply leadership methods that broadened the traditional administrator role. For example, school leaders must approach dual enrollment programs with a futuristic vision for that region (Martinez et al., 2018). Furthermore, school leaders used their strategic leadership to develop partnerships from grade school to higher education, or also known as the P-20 pipeline (Martinez et al., 2018). These strategic leadership strategies enable school leaders to envision novel ways to help students acquire great access to dual enrollment opportunities that enable college readiness. Examples of college readiness opportunities created by school leaders in dual enrollment include creating a culture of college readiness such as early Texas Success Initiative Assessment (TSAI) testing, teacher hiring capacity, and attaining additional resources to advance dual enrollment opportunities in various regions (Martinez et al., 2018).

Gardner (1993) states that leaders need to utilize their leadership skills and ability to see opportunities to improve their organization. For example, in the study by Martinez et al. (2018), the administrator in the study recognized that the dual enrollment program also advanced the Latino population and this in turn may lead to long-term economic advancement in the South Texas Region. Therefore, partnerships and building networks among stakeholders is vital for continuous advancement of the region. School leaders must be transformative, innovative, and coherent when it comes to transforming secondary education with relevant dual enrollment pathways that align secondary, post-secondary, and workplace learning (Martinez et al., 2018).

School Leaders and Professional Development

Professional development for dual enrollment teachers is important for ensuring student and program success (Troutman et al., 2018). School administrators play an essential role in professional development for dual enrollment instructors as these opportunities ensure the success of the program and students involved. School leaders' positive perspectives on professional development enable for fundamentals of teacher training, curriculum alignment, and successful student outcomes (Education Trust, 2020).

For one thing, school administrators are aware that effective professional development provides instructors with the knowledge and skillset that is paramount to navigating dual enrollment program's unique challenges (Education Trust, 2020). According to Mthani & Msiza (2023), professional development sessions are recommended to focus on pedagogical strategies that are aligned for both the high school and college-learners, as dual enrollment students encompass both. Therefore, school leaders must encourage workshops, seminars, collaborative opportunities, that enable instructors to engage with a diverse student audience (Mthani & Msiza, 2023).

According to Fraire (2018), school administrators recognize the importance of aligning college and secondary schools' standards and expectations with dual enrollment school curricula. As a result, one of the goals of professional development is to aim to foster collaboration between high schools and partnering higher education institutions to provide students with a smooth transition (Mokher & Jacobson, 2021). Therefore, school leaders should aim to prioritize curriculum mapping sessions and subject-specific training to maintain rigor, relevance, and coherence across courses ((Mthani & Msiza, 2023).

School administrators highlight the importance of data-driven practices in evaluating the impact of professional development on student success and outcomes (Mthani & Msiza, 2023). School leaders may promote for the implementation of various assessment tools and progress monitoring mechanisms to track student growth (Mthani & Msiza, 2023). Therefore, school leaders support continuous training opportunities that will allow instructors to effectively analyze data and make informed instructional decisions.

Likewise, school leaders comprehend the importance of having a culture of ongoing improvement to maintain sustainability of dual enrollment programs (Mthani & Msiza, 2023). For example, school leaders encourage an open communication forum with feedback and input from instructors, students, and all stakeholders. School administrators leverage professional learning communities and peer mentoring initiatives to promote collaboration and innovation among dual enrollment faculty.

School administrators play an essential role in shaping the professional development arena for dual enrollment instructors (Mthani & Msiza, 2023). As stated, their views center around the importance of aligning curriculum, data-driven practices, and continous improvement. By keeping in mind these practices, administrators ensure that dual enrollment programs succeed and this in turn benefits students and the larger educational community.

School Leaders and STEM

School administrators serve as catalyst for advancing STEM (Science, Technology, Engineering, and Mathematics) education within dual enrollment programs. According to Gilson & Matthews (2019), through prioritizing and supporting STEM initiatives in dual enrollment programs, school leaders can help enrich students' educational experiences, prepare them for future careers, and contribute to building a prosperous STEM workforce in their communities.

There are several ways that school leaders can build collaboration among higher education stakeholders. According to Allen et al. (2019), school leaders can build a collaborative network with colleges and universities to develop a strong STEM dual enrollment curriculum course. According to Desy et al., (2018), to develop a robust STEM dual enrollment curriculum course, school leaders and higher education stakeholders must jointly work together to identify STEM disciplines, select course content, and ensure alignment with college standards. By offering a diverse range of STEM courses, school leaders attend to students' interest and enable passageways for student exploration and specialization (Desy et al., 2018).

Next, school leaders can establish partnerships with local STEM organizations to help enrich the dual enrollment experiences. According to Guenther et al. (2019), these partnerships can provide students with access to various opportunities such as: internships, mentorships, guest speakers, and hands-on experiences in STEM fields. Students will build connections to real world professionals and experiences, through this opportunity school leaders enhance relevance and applicability of STEM education (Guenther et al., 2019).

Furthermore, school leaders play a key role in ensuring equity and access in dual enrollment programs and in turn STEM curricula. School leaders must actively recruit and support students from various backgrounds, assist with funding or providing financial assistance, have transportation options available, and provide academic support services to ensure that dual enrollment students can participate and succeed (Allen et al., 2019). According to Minaya (2021), through diversity and inclusion, school leaders cultivate a rich STEM pipeline that reflects the rich diversity of society.

Moreover, school leaders must provide and invest in professional development opportunities for dual enrollment teachers to strengthen their teaching practices, pedagogy, and content knowledge, especially in STEM curricula (Desy et al., 2018). When ongoing training is provided, mentorship, and resources to teachers, school administrators empower teachers to deliver high quality instruction that is engaging for students (Minaya, 2021).

Overall, school leaders play a monumental role in promoting STEM education within dual enrollment programs by developing a robust curriculum, fostering partnerships, ensuring equity and access, and supporting teacher professional development (Desy et al, 2018). Through their leadership and commitment to STEM initiatives, school leaders prepare students for success in college, careers, and the rapidly evolving STEM-driven world.

School Leaders In Building Teacher Capacity in Dual Enrollment

According to Martinez et al. (2018), dual enrollment leaders must approach the development of dual enrollment programs strategically in the case of building teacher capacity. This requires administrators to analyze current trends, determine institutional needs, and leverage resources (Martinez et al., 2018). Other examples, of how leaders strategized dual enrollment programs include maximizing roles for support staff such as counselors or college transition specialists to open communication between schools and higher education partners that may provide services for students (Martinez et al., 2018). Moreover, other school leaders considered school personnel such as teachers to build dual enrollment opportunities on their campus. This may include by hiring teachers with master's degrees to teach dual enrollment courses or having a school district provide funding for teachers to acquire their master's degree and in turn teach dual enrollment courses (Martinez et al., 2018). It is important to note that school administrators that are in charge dual enrollment programs must think in advance and create a "pipeline of qualified educators" that can service students pursuing dual enrollment courses (Martinez et al., 2018). Administrators understand that teachers not only are tasked with delivering of instruction for dual enrollment programs but also are a resource to collaborating universities. Moreover, administrators must work jointly with their school boards to support students through their dual enrollment journey. All in all, strategic planning is crucial for school administrators especially when it comes to thinking ahead, the implementation and working with dual enrollment stakeholders.

Dual Enrollment for Equity

Various studies have demonstrated how dual enrollment is a potential mechanism for equity as it also involves underrepresented and underprivileged students. Specifically, studies have been conducted for students taking science, technology, engineering, and math, or STEM, courses. According to Gilson & Matthews (2019), due to demands for students to engage in science, technology, engineering, and mathematics (STEM); specialized dual enrollment programs are opening in support of these fields. According to Chang (2016), STEM programs

are recruiting diverse students to engage in these fields. Currently, bringing in more technology to the classroom, student engagement, and directly connecting fundamental knowledge to applications that allow for real-world application are in place, so students succeed in these fields. (Chang, 2016). Specialized dual enrollment programs are successful due to smaller class sizes, fostering relationships, and student mentorship for future academic and career goals (Gilson & Matthews, 2019).

Moreover, studies have shown that minority students taking STEM courses follow a STEM pathway after high school graduation. For example, in a study by Allen et al. (2019), it was found that Latinx students who took engineering courses through dual enrollment followed a STEM pathway often enrollment in these courses during dual enrollment. In another study by Minaya (2021), there was a comparison of Florida students who took a dual enrollment algebra course with those who did not and the findings indicated that Black and Hispanic students who took dual enrollment algebra significantly persisted upon graduation in a college and STEM program. Therefore, it is important to note that school leader contributions are salient because they guide, promote, and assist student success in college and career readiness as they continue with higher education and future careers. (Malin & Hackmann, 2017).

Biology College Course

As part of a student's college major, students must take a STEM or a science course (Alaie, 2011). Among courses offered to dual-enrolled students are Biology Majors and for Non-Biology Majors. As per Cromley et al. (2021), introductory biology courses are exigent courses. According to Culver et al. (2019), biology courses require the use of deductive and inductive reasoning and inferences to study and learn the material. It is important for school leaders to look at STEM courses, such as Biology, and assess how faculty can best help and prepare students taking these courses to become college and career ready. Therefore, school leaders must prioritize instruction and student achievement by understanding, sharing, and promoting a clear definition of high-quality instruction based on best practices from recent research. Accordingly, administrators must oversee high quality instruction, implementation, and the use of research-based practices in these courses that will lead to student success.

College and Career Readiness

In current times, in the United States there is greater interconnectedness and interdependence in our society, therefore, high caliber education is crucial, both for the individual and the nation (Malin & Hackmann, 2017). To address the deficit in college and career readiness, "some high schools have created career pathways which implement rigorous curricular courses, partnerships with business and institutions of higher education, and work-based learning" (Malin & Hackmann, 2017, p. 607). The school leader plays a role in facilitating campus collaboration with stakeholders and higher education officials to promote student college and career readiness.

Moreover, tasks of the school leader include being accountable for student success, ensuring student's readiness for college and careers, and to bring stakeholders together when "considering, planning and implementing reforms" (Malin & Hackman, 2017, p. 607). As Malin and Hackman (2017), state, since PK-12 faculty members, post-secondary educators, and business/industry leaders have "invaluable curricular expertise and career experiences," these stakeholders should partake in "formal and informal leadership roles as they design and deliver college-and-career programming" (Malin & Hackman, 2017, p. 607).

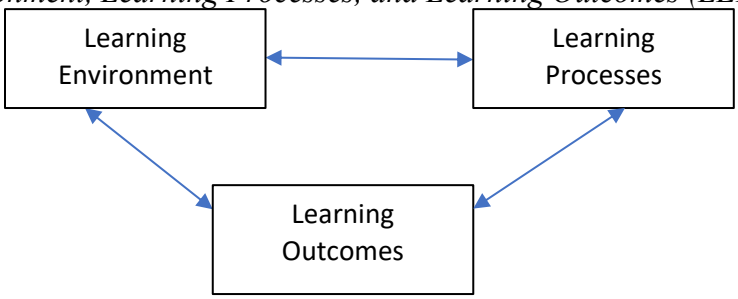
Research demonstrates that integrated instructional leadership, where leaders collaboratively and interactively work with colleagues to address a learning program, eases the transition to augmented student learning gains (Malin & Hackman, 2017). This study will fill the gap and look at students taking introductory biology courses and their performance at both the high school and non-high school locations in Texas. In addition, this study will provide recommendations to high school administrators to ensure that high quality instruction and student achievement are accomplished in dual enrollment courses.

Proposed Theoretical Framework of Study

The proposed theoretical framework of this study was the learning environment, process, and outcomes or LEPO framework (Figure 1). As per Wong et al. (2021), the learning environment pertains to the location of where the student is taking a specific course which facilitates learning. For example, in terms of location a student may be on campus, online, at home, or remotely. Another important element of the LEPO framework is learning activities. Learning activities enable students to engage in learning. Finally, learning outcomes are considered. Learning outcomes allow for students to emerge in their understanding because of the learning activities in their learning environment (Wong et al., 2021). In this study only environment and outcomes will be addressed. As per the Texas Higher Education Coordinating Board (2018), assuming that activities are similar because as per regional accreditors, such as SACSCOC, all learning activities are analogous in both high school and non-high school locations such as syllabus, materials, assignments, course content, and exams.

Figure 1

Learning Environment, Learning Processes, and Learning Outcomes (LEPO) Framework



Methods

The data was collected by census of Biology dual-credit courses offered in Texas colleges in 2019 which compiled and archived by the Texas Higher Education Coordinating Board for all colleges offering dual-enrollment courses. In the following section, the methods of this quantitative study are explained. The section will start with a restatement of the research question and associated hypothesis. Then the research methodology and procedures for data collection and analysis will be presented. Ethical protections are presented followed by a concluding summary.

Research Question and Hypotheses

One research question and associated null hypotheses guided the study:

Is there a difference between the proportion of 2019 Biology dual-enrolled students who earned an A, B, C, DF, or W (withdrew) for students who took the biology courses at their high school or other non-high school location?

Null and alternative hypotheses are presented:

$H_0$1: There is no statistically significant difference between the mean proportion of students earning an A, B, C, DF, or W (Withdrew) when taking a biology dual enrollment course in a high school or non-high school location.

H_a1: There is a statistically significant difference between the mean proportion of students earning an A, B, C, DF, or W when taking a biology dual enrollment course in a high school or non-high school location.

Research Design and Rationale

The approach taken to address the research question posed is a quantitative quasi-experimental comparative retrospective cross-sectional design.

In total, six variables were postulated in this study. The variables were as follows: one independent variable and five dependent variables. The independent variable was the location of the class, either at the high school environment or at another non-high school location. Location is coded dichotomously as 0 or 1 as a nominal variable. Student performance in terms of academic performance with grades A, B, C, DF, and W, was denoted as the dependent variables. Academic performance was designated by THECB's public data and was contained in the dataset.

Sampling

For this study, a census of Biology dual-credit courses offered in Texas colleges in 2019 was data used (Texas Higher Education Coordinating Board, 2022). Due to the COVID-19 pandemic during 2020-2021, 2019 data was the most available to study student performance, as measured by the proportion of grades earned in Biology Dual-credit courses. This data was compiled and archived by the Texas Higher Education Coordinating Board for all colleges offering dual-enrollment courses, and currently the 2019 data is the most up-to-date at the time of this study.

Instrumentation

The study used descriptive statistics available in IBM SPSS's, version 25, explore command (IBM Corp., 2018) to screen the date for correctness. Outlying cases are included in the analysis, which are $\pm$ 3 standard deviations from the mean.

Hypothesis testing was executed using Mann-Whitney U. The overall model was utilized for statistical significance of the differences between two groups. As per Penn State Eberly College of Science (2021a), the probability of F is interpreted using a .05 level of significance, as typical in the social sciences.

Partial eta-squared was used to interpret the effect size (Laerd Statistics, 2018). For partial eta, effect size values were as follows: 0.14 = large effect; .06 = medium effect; and .01 = small effect (Laerd Statistics, 2018). Partial eta-squared is the same as eta-squared for models with one independent variable (Laerd Statistics, 2018).

Internal validity was assumed since educational data reported to and housed at THECB is subject to audits and compliance standards as per the 2014 Texas Administrative Code 39 TexReg 1360. Moreover, content validity was assumed because dual enrollments courses are aligned to state learning outcomes. Lastly, external validity was strong by reason that a census was used to conduct the analysis.

Data Collection

Public data was retrieved from THECB. All academic performance dual-credit data for students are public information, and no names of students or colleges were collected to protect reputational and confidentiality risks.

Summary of Methodology

The purpose of this study was to compare student performance between Introduction to Biology dual college courses taken in high school and other non-high school locations (i.e. college environment) in Texas. One research question was posed to address the purpose. One independent variable and six dependent variables were measured to test the null hypothesis associated with the research question. The null hypothesis was tested using Mann-Whitney U. THECB 2019 archival data was collected. Appropriate descriptive and inferential statistics were calculated. Results and discussion will be presented in the following section.

Findings

Descriptives

Table 1 presents descriptive statistics of A, B, C, DF, and W grades in locations 0 and 1, which represent the high school and non-high school, Non-HS, environments respectively.

Table 1. Descriptive s*tatistics*.

Grade	Location	*M*	*Mdn*	*SD*	*Min*	*Max*	*SE*
A	High School	32.00	26.50	16.69	12.00	77.00	3.407
	Non-HS	25.88	24.00	14.71	3.00	71.00	3.000
B	High School	30.83	32.00	10.81	16.00	51.00	2.206
	Non-HS	22.25	21.00	8.872	6.00	39.00	1.811
C	High School	16.79	16.00	7.500	4.00	32.00	1.531
	Non-HS	19.00	18.00	13.108	0.00	54.00	2.676
DF	High School	5.79	2.50	8.335	0.00	38.00	1.701
	Non-HS	12.88	9.50	11.207	0.00	37.00	2.288
W	High School	1.92	2.00	1.742	0.00	5.00	0.356
	Non-HS	5.33	2.00	8.850	0.00	31.00	1.806

Mean A scores for high school were 6.12 marks (32.00 to 25.88) higher than mean A the Non-HS locations (non-high school, or college campus or online). Mean B scores for high school locations were 8.58 marks (30.83 to 22.25) higher than mean B for non-high school locations. Mean C scores for high school locations were 2.21 marks (16.79 to 19.00) lower than mean C for other locations. Mean DF scores for high school locations were 7.09 marks (5.79 to 12.88) lower than mean DF for non-high school locations. Mean W scores for high school locations were 3.41 marks (1.92 to 5.33) lower than mean W for non-high school locations.

Research Questions

One research question and associated null hypotheses guided the study:

Is there a difference between the proportion of 2019 Biology dual-enrolled students who earned an A, B, C, DF, or W (for Withdrew) for students who took the biology courses at their high school or other non-high school location?
Null and alternative hypotheses are presented:

$H_0$1: There is no statistically significant difference between the mean proportion of students earning an A, B, C, DF, or W (Withdrew) when taking a biology dual enrollment course in a high school or non-high school location.

H_a1: There is a statistically significant difference between the mean proportion of students earning an A, B, C, DF, or W when taking a biology dual enrollment course in a high school or non-high school location.

Hypotheses for Testing with Mann-Whitney U

Five hypotheses were developed to align with the non-parametric Mann-Whitney U procedure which uses the mean rank to test for statistically significant difference. Five null and alternative hypotheses are presented next.

$H_0$1: There is no statistically significant difference between the mean rank of students earning an A when taking a dual enrollment Biology course in a high school or non-high school location.

*Ha*1: There is a statistically significant difference between the mean rank of students earning an A when taking a dual enrollment Biology course in a high school or non-high school location.

$H_0$2: There is no statistically significant difference between the mean rank of students earning a B when taking a dual enrollment Biology course in a high school or non-high school location.

H_a2: There is a statistically significant difference between the mean rank of students earning a B when taking a dual enrollment Biology course in a high school or non-high school location.

$H_0$3: There is no statistically significant difference between the mean rank of students earning a C when taking a dual enrollment Biology course in a high school or non-high school location.

H_a3: There is a statistically significant difference between the mean rank of students earning a C when taking a dual enrollment Biology course in a high school or non-high school location.

$H_0$4: There is no statistically significant difference between the mean rank of students earning a DF when taking a dual enrollment Biology course in a high school or non-high school location.

Ha4: There is a statistically significant difference between the mean rank of students earning a DF when taking a dual enrollment Biology course in a high school or non-high school location.

$H_0$5: There is no statistically significant difference between the mean rank of students earning a W when taking a dual enrollment Biology course in a high school or non-high school location.

H_a5: There is a statistically significant difference between the mean rank of students earning a W when taking a dual enrollment Biology course in a high school or non-high school location.

Statistical Assumptions Testing for Mann-Whitney U test

There are three assumptions in the Mann-Whitney *U* test (Morgan et al., 2018). The assumptions are: (a) the dependent variable should be measured at the ordinal or continuous level, (b) the independent variable should consist of two categorical groups, (c) there should have independence of observations, meaning that there is no relationship between the observations in each group or between the groups themselves. Statistical assumptions were met by design.

Results of Mann-Whitney U Test for grades A, B, C, DF, and W

Table 2. Results of Mann-Whitney U Test for Grades A, B, C, DF, and W.

Grade	Location	Mean Rank	*U*	*p*	*r*
A	High School	26.96	229.0	0.223	1
	Non-HS	22.04			
B	High School	29.77	161.5	0.009	0.093
	Non-HS	19.23			
C	High School	23.75	270.0	0.710	-0.328
	Non-HS	25.25			
DF	High School	19.79	175.0	0.019	-.167
	Non-HS	29.21			
W	High School	22.98	251.5	0.435	-.170
	Non-HS	26.02			

The mean and mean rank of the proportion of As, and Bs were higher at the high school locations. The mean and mean rank of the proportion of Cs, DFs, and Ws were higher at the non-high school locations. Results of individual hypothesis testing for each grade are presented in the following five sections.

Hypothesis 1: A grade by location

For letter grade A, the 24 schools for the high school location have higher mean ranks (26.96) than the 24 schools for the non-high school location (22.04), $U = 229.0$**,** $p = 0.223$, $r = 1$, which was not statistically significant. I retained the first null hypothesis of no difference between locations for the proportion of A grades earned. The difference was large in terms of effect size (Morgan et al., 2018).

Hypothesis 2: B grade by location

For letter grade B, the 24 schools for the high school location have higher mean ranks (29.77) than the 24 schools for the non-high school location (19.23), $U = 161.5$**,** $p = 0.009$, $r = 0.093$, which was statistically significant. I rejected the fourth null hypothesis of no difference between locations for the proportion of B grades earned. The difference was moderate in terms of effect size (Morgan et al., 2018).

Hypothesis 3: C grade by location

For letter grade C, the 24 schools for high school have lower mean ranks (19.79) than the 24 schools for the non-high school location (25.25), $U = 270.0$**,** $p = 0.710$, $r = -0.328$, which was not statistically significant. I retained the null hypothesis of no difference between locations for the proportion of C grades earned. The difference was large in terms of effect size (Morgan et al.,

2018).

Hypothesis 4: DF grade by location

For letter grade DF, the 24 schools for the high school location have lower mean ranks (19.79) than the 24 schools for the non-high school location (29.21), $U = 175.0$**,** $p = 0.019$, $r = -.167$, which is statistically significant. I rejected the fourth null hypothesis of no difference between locations for the proportion of DF grades earned. The difference was large in terms of effect size (Morgan et al., 2018).

Hypothesis 5: W grade by location

For letter grade W, the 24 schools for the high school location have lower mean ranks (22.98) than the 24 schools for non-high school location (26.01), $U = 251.5$**,** $p = 0.435$, $r = 0.347$, which is not statistically significant. I retained the null hypothesis of no difference between locations for the proportion of W grades earned. The difference was large in terms of effect size (Morgan et al., 2018).

Discussion

The purpose of this quantitative study compared dual college student performance between Biology college courses taken at high school and non-high school locations in Texas to provide recommendations to school leaders such as administrators and principals in terms of high-quality teaching and student achievement. The independent variable was the class environment, either the high school or non-high school environment. The dependent variable was the student course performance, measured by the proportion of students who earned an A, B, C, DF, or Withdrew. The data collected was compiled by the Texas Higher Education Coordinating Board for all colleges offering dual-enrollment courses in Texas in 2019 (Texas Higher Education Coordinating Board, 2022).

The mean and mean rank of the proportion of As, and Bs were higher at the high school locations. The mean and mean rank of the proportion of Cs, DFs, and Ws were higher at the non-high school locations. Differences were significant by location for B and DF grades but not for A, C, and W grades earned. The effect sizes ranged from moderate too large for significant differences.

Summary

In the following section, conclusion and final considerations will be stated. Moreover, further recommendations will be provided for administrators, stakeholders, and for researchers to expand upon the findings of this study.

Conclusion

Interpretation of Findings

As previously mentioned, regional accreditors such as the Southern Association of Colleges and Schools Commission on College (SACSCOC) call for dual credit college courses taught at the high school location and non-high school locations to use similar and comparable materials in both settings (Southern Association of Colleges and Schools on Commission on Colleges, 2018). The problem addressed in this study is that though there are many studies on dual enrollment courses there is no known study that has compared student performance in Biology courses based on location where the class was taken Location has been shown to influence learning and outcomes.

The theoretical framework of the current study was the Learning Environment, Learning Processes and Learning Outcomes (LEPO) framework. According to Msimanga (2020), the

LEPO framework has three parts: the learning environment or the location where learning takes place, the activities involved in learning, and the learning outcomes that can be demonstrated in student understanding. The LEPO framework reasoned that the learning environment has an impact on students' learning and performance (Msimanga, 2020). The focus of this study was on the environment and outcomes. Findings from the current study support that location/environment do make a difference in terms of passing and failure rates of biology dual enrollment courses.

Proportions of Biology dual-enrollment students earning A, B, C, DF, and W grades at high school and non-high school/college campus locations were compared. Results showed that students earn similar proportions of passing A, C, and W grades at high school and non-high school locations and are more likely to differ in B and DF grades at the high school and non-high school locations. Statistically significant differences were medium to large for B and DF grades but not for proportions of A, C, and W. Location did not matter for students who earned A, C, and W but it did for students earning B and DF grades. The current study's findings suggest that location matters in terms of passing and failing grades. This information is important for school leaders to consider as administrators must oversee high quality instruction, implementation, and the use of research-based practices in these courses that will lead to student success. Location matters and factors into instruction quality, implementation, and good research-based practices.

For this study, findings assert the LEPO framework for students who earned passing and failing grades. Location affects the learning environment, especially when students are engaging in a particular course (Wong et al., 2021). The LEPO model encourages education stakeholders such as administrators and educators to constitute a positive environment that will allow learners to perform and achieve outcomes. However, the LEPO framework does not specify the interactions with the environment, processes, and outcomes of learners and teachers (Msimanga, 2020). The LEPO framework also does not articulate the learner's preferences in terms of location or learners' inclination towards engaging in the learning process (Wong et al., 2021). Therefore, the findings of this study revealed that location may have an impact on passing and failure grades of Biology dually enrolled students. Moreover, this study demonstrated that the LEPO framework is advantageous for examining specific factors related to the learning environment, specifically in the case of this study, learning outcomes.

Conclusively, this research and further research on dual credit programs enables school leaders to make more informed decisions about the various facets of dual enrollment. Stakeholders from both the high school and college must collaborate interactively and interdependently for dual credit programs to thrive. According to Ferguson et al. (2015), location of courses, assignment of faculty, means of evaluation, and daily decisions require stakeholder knowledge, especially for school leaders. This study contributes to the scant research about how location impacts performance in dual credit Biology courses. This study was limited in several ways as discussed next.

Limitations of the Study

There were six limitations in the study. First, only students who took dual credit at the study sites and acquired a grade were included in this study. The study does not account for students who dropped before the census date. Next, course level records with low enrollment were removed by THECB for confidentiality. This decreased the number of students within the study who took dual enrollment courses at high school and non-high school locations in 2019. Third, previous learning of students who took dual college courses was not controlled for and may affect performance scores. Another limitation is that the study was limited in scope

geographically and in time. Only data from 2019 in the state of Texas was analyzed, as this is the most current up to date data available on the THECB website. Additionally, the study does not account for students who took previous or advanced placement biology courses. Moreover, another limitation would be perhaps there are differences in the institutions or instructors at those institutions that may account for the different grade distributions. Lastly, there may be different standards for grading in high schools versus college.

Recommendations for Future Research and Practice

Based on the findings of the research, the researcher presents the following recommendations for future studies and practice.

1. It is important to consider school leader's input regarding program quality, staff, faculty, costs, and student success (Ferguson et al, 2015). School leaders such as administrators and principals are important actors and key players that influence school settings (Hornbeck et al., 2023). Moreover, since most dual enrollment courses are taught at high schools, a qualitative study on how administrator's or principal's perceptions and actions are significant should be conducted.
2. It was noted in the study by Hornbeck et al. (2023), that school leaders such as administrators or principals have mixed perceptions in regard to rigor and quality of education. For example, some rigor concerns that administrators perceive is that they do not have control over who teaches the dual enrollment courses or the quality of the instruction (Hornbeck et al., 2023). A mixed methods study, using the repeated quantitative method in this study and a qualitative method portion on administrator or principal perspectives should be conducted to study their perceptions in regards to rigor and quality of education in dual credit courses and programs would be necessitated to address this concern.
3. Due to the manner of delivery of dual enrollment, most high schools and institutions of higher education share its governance. For example, in Texas school districts must enter a Memorandum of Understanding (MOU) with the institution of higher education to determine the logistics of the Dual Enrollment program (Hornbeck et al., 2023). Due to the nature of involvement of the high school, students, faculty and staff, school leaders such as administrators or principals believe that equal consideration in partnerships should be provided to both the high school and institutions of higher education (Hornbeck et al., 2023). An administrator and higher education administrator correlational study to measure the perceptions of high school and college campus involvement in partnership for dual credit programs is important to deduce further information.
4. As mentioned in one of the limitations, there may be different approved instructors teaching these courses at the high school and non-high school level, even if they may teach at the same institution. A teacher mixed-level methods study where quantitative methods similar to the ones stated in this study and qualitative methods using teacher perceptions, would address the question, what differences may account for different grading distributions? This would help administrators understand the perceived rigor and high-quality instruction.
5. As mentioned above in one of the limitations, addressed if there are different standards when it comes to grading at the high school and college level for dual enrollment. A comparative study would be useful to address this question

comparing grading standards in dual enrollment courses for the high school and college location.

6. A correlational study that measures the relationship between student post-secondary success with dual enrollment courses would reveal if and how much dual credit courses contribute to success in college. As Morgan et al. (2018) stated, academic rigor in high school prepares students for post-secondary education. Therefore, a study measuring how high school academic rigor, as measured by participating in dual-credit courses, correlates as a predictor of college success might be useful.

School Leaders in Support of Looking at Dual Enrollment Location

School leaders play an important role in advancing educational opportunities for dual enrollment programs, including the exploration of dual enrollment location options. Examining dual enrollment locations is essential for enabling access, equity, and effectiveness of dual enrollment programs (Allen & Roberts, 2019).

School leaders must comprehend the importance of location or geographical accessibility to ensure all students acquire equitable access to these programs. When school leaders explore different locations for dual enrollment, several barriers must be taken into account and reduced such as transportation and proximity, especially for students in remote or underserved areas (Allen & Roberts, 2019). School administrators must take this proactive approach which aligns with their commitment to promoting inclusion and expand educational access for various student populations.

School leaders understand the benefit of selecting an adequate location in order to optimize resource usage and program effectiveness. These venues include within or near schools, colleges, community center, these locations provide benefit to the program by providing full advantage of facilities, infrastructure and defraying costs and other challenges associated with the dual enrollment program (Allen & Roberts, 2019). This approach enables school leaders to demonstrate commitment and responsibility to cost and program management.

Moreover, school leaders can align the dual enrollment location with student academic and extracurricular schedules. When courses and dual enrollment opportunities are offered at convenient times and locations, this accommodates the diverse student population along with their needs and preferences (Allen & Roberts, 2019). This type of approach is student-centered and reflects the commitment and engage of school leaders to personalize and prioritize student learning experiences and student success.

School leaders play a pivotal role in advocating and in finding options for dual enrollment locations. In turn, dual enrollment location options allow for enhancement of student success, equity, and effectiveness. Moreover, school administrators are in support of location or geographical accessibility, utilizing available resources, community partnerships, and working with student scheduling allows for demonstration of commitment to dual enrollment excellent and student achievement.

School Leaders Recommendations for a Successful Dual Enrollment Program Implementation and Supervision

According to Education Trust (2020), school leaders are key individuals in establishing protocols, recommendations, and initiatives for dual enrollment programs. School leaders must consider open communication, transparency, and collaboration with all stakeholders (Henig et

al., 2016). School leaders engage in this approach through consistent meetings and open dialogue among college partners, students, and parents to ensure alignment of goals, assets, and program expectations (Education Trust, 2020). Through transparency and cooperation, school leaders allow for a cohesive, well-coordinated, and adjusted dual-enrollment program (Duncheon & DeMatthews, 2018).

Next, school leaders must have inclusive and comprehensive student support services to address the various needs of participants. Examples of student support services include: academic advising, counseling, mentoring, tutoring, and financial aid to help students navigate the dual enrollment experience prosperously (Martinez et al., 2018). Furthermore, school leaders must advocate for access to resources such as technology, textbooks, school supplies, and transporation assistance to may help in reducing barriers for an equitable dual enrollment experience (Hornbeck et al, 2023).

According to Fraire (2018), school leaders must understand the importance of high academic expectations for students and must ensure that there are quality measures in dual enrollment courses. They must understand the importance of alignment between high school and college standards. Moreover, school leaders advocate for professional development for instructors to maintain academic rigor to ensure credibility of the courses (Culver et al, 2021). By having high standards of excellence, school administrators uphold dual enrollment program values of integrity and being reputable.

Furthermore, school leaders understand the merit of data-driven decision making in program evaluation and enhancement (Fraire, 2018). For example, they advocate the application of data collection systems to progress monitor students, track their outcomes, and identify improvement and strength areas. By evaluating quantitative and qualitative data, school leaders can determine trends, address academic challenges, and analyze program strengths and weaknesses to better meet the needs of the program, students, and stakeholders.

School leaders play an important role in the shaping of dual enrollment programs. School leaders shape dual enrollment program by having clear lines of communication among all stakeholders, comprehensive student support services, and through data-driven decision making (Hornbeck et al, 2023). School leaders' recommendations make a difference in the programs journey to excellence, equity, and continuous improvement. Therefore, with strong and strategic leadership and guidance, dual enrollment programs serve as a catalyst for student preparation and academic success in secondary and post-secondary institutions.

School Leaders Recommendations for Support of STEM Courses for Dual Enrollment Programs

School leaders are responsible for advocating and supporting STEM (Science, Technology, Engineering, Mathematics) courses in dual enrollment programs. Their recommendations and support to several core aspects of STEM education is important in dual enrollment program implementation.

Next, educational leaders understand the importance of rigorous course implementation that must align with high school, college standards, and industry expectations to promote student excellence (Culver et al., 2021). School leaders advocate for STEM courses to provide students with a solid foundation on the various concepts and skills to ensure that they are prepared for higher education and STEM careers (Allen et al., 2019). By making sure that there is STEM course alignment with academia and industry trends, school leaders make sure that STEM

courses for dual enrollment programs remain relevant, rigorous, and invaluable to students pursuing STEM higher education or industry jobs.

Also, school leaders must recognize the importance of recruiting, hiring, and retaining highly qualified STEM instructors (Allen et al., 2019). STEM instructors play a critical role as they are knowledgeable and guide students towards STEM fields (Cromley et al., 2021). School leaders support initiatives to attract highly quality STEM experienced professionals and instructors with expertise and therefore must provide ongoing professional development opportunities so these instructors may enhance their teaching skills and content knowledge.

Moreover, school leaders encourage access to modern STEM resources, facilities, and technologies to support hands-on and experiential learning in STEM dual enrollment courses (Allen et al., 2019). For example, school leaders must support investments such as STEM laboratories, equipment, instructional materials, and educational trips to further create stimulating learning environments that encourage inquiry, exploration, and innovation for students.

In addition, school administrators must advance partnerships with STEM industry partners and institutions of higher education to enhance STEM courses in dual enrollment. These partnerships ease opportunities for students to partake in research experiences, projects, internships, that enable learning outside the classroom and provide real-world application in STEM fields (Chang, 2016).

Furthermore, school leaders promote equity and inclusion in STEM dual enrollment courses that provide opportunities of diverse backgrounds. School leaders support recruiting, retaining, and attracting a diverse array of students and faculty. A diverse cohort of students and faculty will provide for a more inclusive and supportive learning environment that enourages varying perspectives and experiences in STEM (Chang, 2016).

In closing, school administrators can support STEM courses in dual enrollment programs by aligning the curriculum, ensuring instructor quality, allocating resources, forming partnerships, and having diverse initiatives to attact an array of students and faculty (Desy et al., 2018). By putting into action these recommendations, school leaders can equip students with knowledge, skills, and epxeriences to excel in STEM fields.

School Leaders and College and Career Readiness for Dual Enrollment Recommendations

According to Education Trust (2020), school leaders promote college and career readiness through dual enrollment programs and offer recommendations for students to be higher education and workforce ready. Through dual enrollment opportunities, leaders highlight the importance of early exposure to college-level work (Hornbeck et al., 2023). They recommend students enroll in dual enrollment courses to improve their higher education outcomes and to pursue interests and career aspirations (Hornbeck et al., 2023). School leaders, by providing students with opportunities to earn college credits while still in high school, enable a culture of academic excellence and lay the groundwork for future success.

Next, school leaders understand the importance of providing college and career support services in order for students to navigate dual enrollment pathways (Martinez et al., 2018). For example, school leaders must advocate for personalized student guidance and support to help students in their academic and career journey (Martinez et al., 2018). Through dual enrollment programs as a stepping-stone, school leaders have the ability to empower students to make educational and career informed decisions about their educational and career pathways (Duncheon & DeMatthews, 2018).

School leaders promote essential college and career readiness skills into dual enrollment curriculum. For example, they spotlight the development of critical thinking skills, problem solving skills, collaboration, communication, and exposure to real-world experience for students through dual enrollment programs (Culver et al., 2019). These skills will prepare students for academic success but also for challenges and opportunities in their academic and professional lives (Culver et al., 2019).

As previously stated, school leaders form partnerships with high education institutions and industry partners to enhance the impact of dual enrollment programs (Duncheon & DeMatthews, 2023). As mentioned previously, these partnerships students are able to acquire mentorship, internships, shadowing, and engage in valuable learning opportunities and skills (Martinez et al., 2018).

Conclusively, school leaders promote college and career readiness through dual enrollment programs by expanding access, encouraging individualized counseling and support services, integrating essential skills for education and the workforce, and fostering partnerships. By implementing these recommendations, school leaders will prepare students to actively engage in their education and workforce.

Role of School Leaders in Dual Enrollment Planning Recommendations

According to Duncheon & DeMatthews (2023), cross-sector partnerships among school administrators, stakeholders, and higher educational entities are an important factor when it comes to successful dual enrollment programs. Practices for school administrators to form successful cross-sector partnerships include: “shared vision, mutual decision, and trust building” (Duncheon & DeMatthews, 2023, p. 2). Inquiry into how principals navigate secondary-postsecondary partnerships is needed to support policy and practice around school leadership, principal preparation, and cross-sector P-20 reform (Duncheon & DeMatthews, 2023). In a case study of a successful and accoladed South Texas School Principal, Duncheon & DeMatthews (2023), it was revealed that this principal made sense of dual enrollment program reform by the process of negation among partners with distinct but legitimate needs and goals. The principal focused on understanding different stakeholder viewpoints which strengthened the ability to meet vision and goals for the dual enrollment program.

Moreover, it was noted that secondary-postsecondary partnerships can improve teaching, learning, align high school and higher education standards. Secondary-postsecondary partnerships can prepare students for the workforce, increase college preparation, and smooth student’s transitions. Moreover, other best practices for administrators include creating structures to support shared learning and collaboration, negotiating shared-resource distribution, using data to guide decisions, and cultivating stakeholder buy-in (Duncheon & DeMatthews, 2023). Moreover, effective, and consistent leadership is important.

Two key contributions of principals include relationship building and optimization of resources across sectors. It is important to understand that principals serve as key liaisons between internal and external stakeholders in the implementation of career academies or dual enrollment programs (Martinez et al, 2018). Duncheon and DeMatthews (2018) found that dual enrollment program principals enable student success by targeting interventions, embedding supports, and creating opportunities for enrichment for students through working with various stakeholders.

School Administrator Instructional Philosophy to Ensure Student Success and Impact on Research

As per Duncheon & DeMatthews (2023), at the school level, the principal is responsible for using their sensemaking skills or translating state and district policy into practice. Therefore, principal sensemaking is an important skill as this enables the principal to apply instructional and coaching models, accountability systems, and educator evaluations, special education and inclusive reforms, school marketing, responses to COVID-19, and race and demographic shifts within school community (Duncheon & DeMatthews, 2023). Moreover, principals bring their personal and professional experience, values, and vision for their school based on implementation and their sensemaking skills.

Next, principal sensemaking is shaped by their social context. Social context broadly refers to the facilitators and constraints of their school context, such as budget, enrollment, and resources; social and political influences, and relationships and professional networks (Duncheon & DeMatthews, 2023). A key takeaway is that, although principals exercise agency to implement reform in ways that align with their vision for their school and students, principal agency is influenced and often constrained by their social context. Through the implementation process, principals are constantly making sense and remaking sense, strategizing and restrategizing.

Moreover, principals need to appease diverse audiences, particularly when working in cross-sector partnerships such as with dual enrollment. Influence strategies can be formal or information. For example, school districts and higher education partners are required to jointly determine dual enrollment locations, cost-allocation, decision-making procedures, and processes for sharing and monitoring student data (Duncheon & DeMatthews, 2023).

As noted in an example by Martinez et al. (2018), an acclaimed principal saw dual enrollment programs as an opportunity to set high expectations for first generation students and to succeed at any higher education setting, all while supporting their social and emotional growth. The principal also prioritize high quality instruction (Martinez et al., 2023).

Conclusion and Impact on Research

A principal's perception is vital within the realm of context of college-and-career readiness because they must make certain that the curriculum is at equilibrium with core academic courses, that include STEM and science courses. Therefore, principals must ensure that students have access to a vast assortment of additional learning opportunities that are indispensable for students' postsecondary success (Malin & Hackman, 2017).

For principals and administrators to provide and prioritize high quality instruction, especially in the STEM or sciences courses, it is important that they promote the best practices from current research to promote college and career readiness. Biology instructors have a variety of teaching methods to help students reach academic outcomes. For example, a teaching method used in the STEM and science courses, as Alaie (2011) stated, es is exemplified by a concept called memorable exemplification. In memorable exemplification, students are taught the subject in a memorable manner that appeals to student learning and memory. Studies by Grosholz et al. (2020), stated that in science, specifically biology, it is recommended that instructors use a method of teaching called memorable exemplification that allows for students to remember different concepts and terms based on examples, visuals, stories, and strategies employed by college professors. Therefore, biology should be a hands-on subject where students not only learn the content of the classroom but also through reasoning, observation, field experience, and lab (Grosholz et al., 2020). This resonates with the idea that biology is a hands-on topic and as such students, both college and early college students, learn by incorporating both lecture and lab into the study of science (Desy et al., 2018). Additionally, it is important for students that are

majoring in STEM fields, such as biology, to be able to use critical reasoning to draw conclusions from material that is presented in the course whereas all material is not explicitly stated (Bauer et al., 2020). Hence, students must be able to draw inferences and conclusions to fully understand the material presented in the course (Cromley et al., 2021).

It is important for administrators to note that the quality of teaching is a significant factor in students' attitudes towards science (Desy et al., 2018). For example, as per Desy (2018), studies have reported that inquiry-based and undergraduate research experiences in sciences have documented benefits for students. Moreover, in addition to firsthand experiences with methods and processes of scientific inquiry, authentic research experiences may hold widespread benefits. Consequently, firsthand research opportunities enable students to experience the undertakings of science through curiosity stimulation, augmentation of critical thinking skills, and therefore increasing confidence and motivation. On that account, studies have demonstrated that student-researcher-mentor interaction is an important component in helping students think like a scientist and increasing student interest in STEM careers (Desy et al., 2018).

As Guenther et al. (2019) stated, contextual comprehension of subjects is shown to be of significance to be able to deduce inferences and conclusions that assist students when pursuing a STEM field. As a result, higher level thinking strategies such as" outlining, drawing/sketching, noticing text structures such as headings and bolded words, summarizing, and note-taking are important skills" for students to be successful in their introductory biology courses (Cromley et al., 2021, p. 150).

Interestingly, genuine research experiences are imperative for students taking dual enrollment (Desy et al, 2018). As per research, high school is a time when 15-24% of students shift their interest into or away from potential STEM careers, so it is of utmost importance that students' experiences with STEM draws them in for future STEM careers (Desy et al., 2018).

This study found that location matters in terms of passing or failing rates in dual enrollment courses. This study contributed to the scant research on comparing student performance between Biology dual college courses taken at the high school and other non-high school locations in Texas. Support networks and mentoring also play a role in student success. Implications of results are that the student success rate of Biology dual-enrollment college courses is comparable upon location. Location should be considered by school principals and other stakeholders such as policy and standards makers, dual credit partnerships, and the field of education in regard to student performance.

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