A Building Designed as a Catalyst for Project-Based Learning: A Case Study in America

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Higher education must adapt to a rapidly changing landscape of industries and knowledge. A university developing a new campus aims to transform education by designing its first academic building to promote active collaboration, project-based learning (PBL), and industry-relevant experiences, focusing on a student-centric approach. A well-designed facility is seen as crucial for success. The Active Learning Classroom has shown to positively impact students' perceptions of an inspiring environment, enhancing participation and idea generation (Park & Choi, 2014). PBL effectively connects academic knowledge with workplace experience (Guo et al., 2020).

A case study assessed the building's design for PBL during its first operational year. Findings evaluated the design's effectiveness and identified necessary changes. Both qualitative and quantitative data revealed limited use of collaborative spaces and technologies, as well as insufficient PBL integration in the curriculum. Recommendations include aligning faculty practices with program goals and engaging students more with available educational technologies in the learning spaces, both inside and outside the classroom.

Keywords: project-based learning, active learning environments, student-centered learning, classroom design, classroom types

INTRODUCTION

The current higher education landscape faces the impending demographic cliff in enrollment, significantly increased tuition costs, the rise of employer certifications and training options, and the contemporary political distrust of such institutions (Jdickler, 2024). Even the rise of online courses, if not handled carefully, threatens to reduce education to its lowest form further - knowledge transmission as opposed to value generation in the form of genuine essential skills development (Karna, 2021). The US once led the world in educational attainment. Still, among younger groups, this US lead has disappeared (Mettler, 2014), falling to 13th in the world for higher education attainment among 25 - 34-year-olds (Organisation for Economic Cooperation and Development, 2022). The ability to compete in an evolving, global marketplace is diminished if our college-capable youth are turning away from higher education attainment (The Advisory Committee on Student Financial Assistance, 2010).

The University of North Texas (UNT) sees a tremendous opportunity in these current conditions to lead innovatively at its new campus in Frisco, TX. One of the fastest-growing cities in America, Frisco, provides students and faculty at this campus with access to Fortune 500 and start-up companies and forward-thinking industries seeking students and a workforce with 21st-century skill sets. (Frisco Economic Development Corporation, 2024). To add value to education in the US, this university built a new academic building designed to challenge the notion of traditional educational delivery, creating a fundamentally different vision for how people learn, interact, and engage with faculty, partners, and fellow students while responding to a complex and advanced community of industries. A well-designed facility directly contributes to the success of a student-centric approach with PBL pedagogy as the foundation of learning. Wobbe & Stoddard (2023) suggest that open, decentered classrooms with moveable furniture contribute to PBL and engage learning success. An atypical academic building uniquely suited to educating the next generation of learners must focus on active, authentic educational environments and experiences that engage faculty, students, community, and industry partners. The university decided that a new kind of educational facility must eliminate the legacy of perceived barriers between the campus and community, the student and the "real world," education and employment, student services and academic affairs to recast "teaching students" as developing highly skilled human beings and thriving citizens who will thrive in a 21st-century world.

LITERATURE REVIEW

The Buck Institute for Education defines PBL as "a teaching method in which students learn by actively engaging in real-world and personally meaningful projects." It has also been described as an instructional model rooted in the constructivist approach to knowledge in which self-awareness of learning is gained from examining multiple views within a social activity. Teachers define PBL as a method that "supports, facilitates and improves the learning process" (Tamim & Grant, 2013). From a literature review of PBL, the findings suggest that work, family, and community life roles and responsibilities have changed through the years due to the acceleration of globalization, increased availability of technology, and changing population demographics. This demands that learning outcomes meet these changing roles and responsibilities, leading to new learning processes supporting these expectations (Wolff, 2003). PBL learning has a long history in education models. In the 1960s, medical schools were concerned that traditional science courses did not prepare students for problems that would arise in the real world as physicians (Bytyqi, 2022). Thus, some schools began using patient cases as problem-based learning, which is closely related to project-based learning, because it closes the gap between what students learn in school and what they need in the workplace (Savery & Duffy, 2001). Research suggests that a PBL pedagogical approach positively impacts students' academic achievement compared to direct instruction (Guo, et.al., 2020) and improves student learning concerning knowledge and skills (Grossman, et.al., 2021; Wobbe & Stoddard, 2019). While the literature review found that definitions of project-based learning vary, core elements include student engagement with an authentic project or problem, often addressed collaboratively through an iterative process with the benefit of faculty facilitation and feedback. Through sustained inquiry and revision, students develop a response to an industry problem or a wicked problem that they share publicly. They also develop resilience, interpersonal skills, creative thinking, and problem-solving functioning in the ambiguity of a real and messy problem. They develop iterative responses, leading to accepting and applying critical feedback. Encouraging active engagement through PBL builds relationships with an institution's community, engages and retains students, increases job placement, and develops strong alumni (Wobbe & Stoddard, 2019). The survey of the literature showed that PBL should be used because it engages students in deep, long-lasting learning and inspires a love of learning and a personal connection to their academic experience (The Buck Institute of Education, 2019). A PBL approach to active, engaged learning requires students to address authentic problems, acquire and apply knowledge in context in ways that support self-directed learning and initiative, tap into many of the "high impact practices" that George Kuh and the National Survey of Student Engagement identify as contributors to enhance student engagement, learning, and retention (Kuh, et.al., 2008). Multiple authors agree that PBL helps promote

autonomy and transfer of skills from the classroom to interpersonal life skills, developing a range of abilities and skills through various activities in various situations and increasing self-esteem and confidence (Bytyqi, 2022). Plus, learning how to manipulate technology fosters creativity and essential comprehension to link new knowledge to prior experiences or learning (Wolff, 2003). The Buck Institute of Education (2019) developed a model to aid teachers and schools in improving, calibrating and assessing their PBL practice with goal outcomes for students to build critical thinking, problem-solving, communication, collaboration, self-management and project management. Figure 1 outlines the seven essential elements of a project to help students reach their learning goals.

FIGURE 1
GOLD STANDARD PROJECT BASED LEARNING SEVEN ESSENTIAL PROJECT DESIGN ELEMENTS BY BUCK INSTITUTE FOR EDUCATION

The literature review further explores the connection between physical learning environments and PBL pedagogical approaches in contributing to student gains in knowledge. Research found that the architecture of a learning environment can have a psychological effect on learning. A typical classroom is often uninteresting and empties quickly after required use, whereas good design can foster engagement and extend our imagination about how we learn (Orr, 1993). One study emphasized the importance of spatial needs relating to behavioral objectives in a child's development. School settings should support activities that complement the users' needs and objectives (Amedeo & Dyck, 2003). One case study stressed the importance of flexibility in classroom layouts, changing the traditional views of a stagnate space to a space with multiple uses to support various group activities and acknowledging that learning can occur everywhere (O'Neill, 2009). A further case study found that activities within a setting can influence its specific spatial form, from a variety of orientations to movements of interaction, to allow the context of the activity to be workable. The spatial setting can impact the perceived value of the activity on teaching and learning perspectives for the users (Amedeo & Dyck, 2003). Findings from another study indicate that the quality of the teaching and learning experience hinges on the flexibility of the classroom, from reconfiguring furniture to ease of technology use, which provides a level of controllability essential to producing a successful experience (O'Neill, 2009). In opposition, a study found that the active learning environment had little influence on student achievements compared to active learning and teaching, which exhibited a positive impact. The pedagogical approach in PBL creates the actual difference. Thus, investing in development and training in pedagogy may be more beneficial than in the physical classroom (Brooks, 2011). Several studies note challenges in the PBL approach to teaching and learning and adaptation to the environment (Tamim & Grant, 2013).For example, one study notes that teachers face a conflict between balancing student control and teacher control over activities, often experiencing concern about being unable

to complete the required curriculum due to the necessary time spent on projects and apprehension about losing control of the topic and behavior of the students. In addition, the dynamic environment requires the teacher to be flexible and promote inquiry and challenge (Hertzog, 2007). The study concludes that motivation, adaptability to change and flexibility in planning aid in achieving the goals of PBL, but that belief in the importance of a student-centered project-based learning model enables teachers to maneuver the challenges successfully (Tamim & Grant, 2013).

Two key research questions guide the following exploration: 1) How do faculty and students interact and incorporate the physical elements of the building for PBL into their pedagogy and educational experiences, and 2) will the case study provide more knowledge about how the physical elements of the building relate to the dynamics of educational activities conducted in that setting? The paper navigates these questions through a case study, shedding light on evidence-based design and the realities of human integration and implementation.

NEW ACADEMIC BUILDING

Institutional Goals and Master Plan

In 2019, the university documented its comprehensive campus master plan and building program with the help of the architecture firm Ayers Saint Gross (2019), and the plan clarifies the design of the first academic building on the branch campus is centered around a project-based learning pedagogy. With this integration, the academic goals of the branch campus align with the university's vision to become globally known for collaborative and imaginative educational innovation and scholarly activity that transforms students and benefits the world around them. The critical goals established for this new building were to create environments that support active collaboration and project-based learning that mirror industry practices to foster understanding and prepare students for their careers, with flexible and adaptable spaces that can be utilized for multiple programs while maximizing efficiencies. The goal was a facility that makes the student experience central - inspiring innovation, connections, achievement, and a sense of belonging while maximizing transparency and visibility to facilitate engagement and interaction across the campus and with the community.

Building Utilization

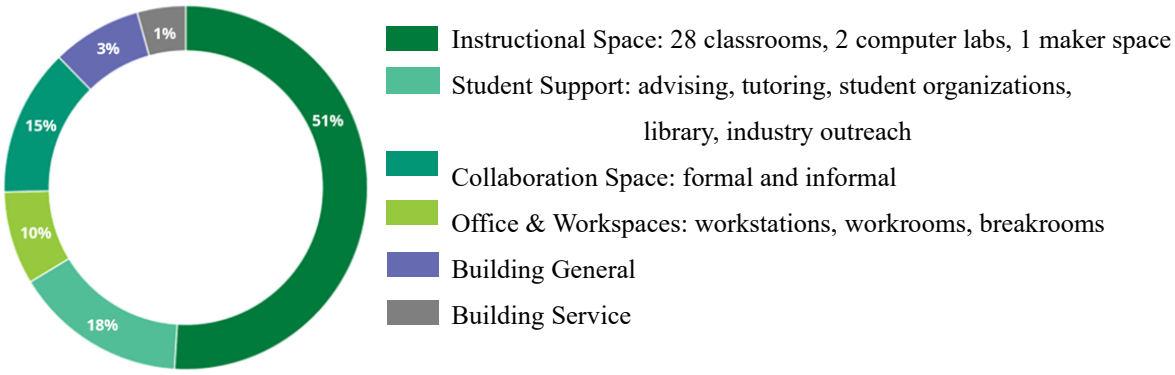
The Master Plan noted that since the new building design is centered around a project-based learning pedagogy, this would require a higher net assignable square footage (NASF) per student compared to traditional classroom models. The first building needed a multi-purpose academic facility incorporating teaching and learning spaces, offices, select student services, student support spaces, and other resources. The space needs assessment was tailored to consider UNT at Frisco's unique premise and approach and showed an expectation of 3,400 students and 208+ faculty and staff. Assumptions included that the ratio of upper-division undergraduates and graduate students would likely be higher than the university's typical population on their main campus, reflecting a focus on supporting student transfers and professionals continuing their education. One of the institution's newest colleges, the College of Applied and Collaborative Studies (CACS), created to develop and offer multidisciplinary, collaborative, 21st-century programs and educational experiences, would be housed at UNT at Frisco. Its programs include or are structured around project-based and partnership-based learning that engage students in collaborative, hands-on, real-world projects to prepare students better to succeed in professional environments. Often, these projects are facilitated attentively by members of local industry who work closely with faculty in the programs to identify projects that meet curricular outcomes. Partners thus far include but are not limited to Toyota, McKesson, Sam's Club, The City of Frisco, Samaritan Inn, Four Corners Brewing Co., and Voodoo Robotics, who are often in the facility, directly engaged with students, contributing to their education, skills, and professional growth, as shown in Figure 2.

FIGURE 2
STUDENTS PRESENTING FINDINGS FROM A PROJECT WORKING WITH THE CITY OF FRISCO, TEXAS

Building Design

Research shows that crucial design features supporting individuals and teams include formal and informal learning environments, adaptable spaces of various sizes, and versatile and ergonomic furniture. Considering these design elements and those addressing psychological and physiological needs significantly contributes to establishing a strong sense of belonging for college learners (Wolff, 2003). An architecture team was charged with designing a new academic facility centered around a project-based learning pedagogy emphasizing collaboration spaces to facilitate project-based and partnership-based learning, extending beyond formal instruction times and spaces. To meet the university goals, the program aimed to create a learning environment prioritizing face-to-face interaction, open discovery, and discourse. To achieve this, quantitative and qualitative criteria were collected from evidence-based research, the design team's previous project experience, surveys and interviews with university administration, faculty practicing PBL pedagogy and students in PBL courses. Data collected helped to establish a design centered around a pedagogical approach, curricular goals, flexible room configurations, technology integration, and collaboration with industry partners. Plus, the integration of independent controls for acoustics, lighting, and thermal comfort provides further opportunities to modify the space as needed (Ayers Saint Gross, 2019). As shown in Figure 3, 84% of the building comprises instructional, collaboration, and student support spaces, with the remaining allocated for faculty and staff workspaces and building general and service space.

FIGURE 3
BUILDING PROGRAM SUMMARY



The physical design elements of spaces for an optimal PBL experience include a variety of classroom sizes, functions, adjacency, and furnishings. Critical for an optimal PBL experience, the facility was designed based on research by Wolff (2003), noting the importance of having a variety of room sizes that offer flexibility and adaptability to function how the faculty and students need it to, with classrooms that range to accommodate 20 to 80 students, along with collaborative huddle rooms and presentation spaces outside of the classroom, as shown in Figure 4. Figures 5, 6 and 7 picture the versatile furniture, technology, lighting, and tools for creation and documentation accessible to students and faculty. With transparent glazing in each area, the activities provide a visible connection to anyone in the facility, offering easy access to the other students, faculty, community, and industry. These elements help give the students and faculty a sense of control and ownership, contributing to a sense of belonging. Figure 8 indicates that the facility is comprised of four levels, and the program is spread throughout all levels (Vail, et.al., 2023). As faculty and staff travel throughout the building to reach their destinations, this dispersion of the program, which is transparent into spaces, aims to create opportunities to spark interest in seen activities and encourage collaboration.

FIGURE 4
A COLLABORATIVE HUDDLE ROOM OUTSIDE OF THE CLASSROOM IS AVAILABLE FOR ANY STUDENT OR FACULTY TO USE

Note. Photography by Gabe Border, 2023, reprinted with permission.

FIGURE 5
CLASSROOM WITH FLEXIBLE PHYSICAL DESIGN ELEMENTS

Note. Photography by Gabe Border, 2023, reprinted with permission.

FIGURE 6
CLASSROOM FEATURES WITH STUDENTS ENGAGED IN NON-TRADITIONAL MODES OF NOTE-TAKING AND COLLABORATION WITH WRITABLE TABLES AND GLAZING

FIGURE 7
CLASSROOM FEATURES WITH STUDENTS ENGAGED IN NON-TRADITIONAL MODES OF NOTE-TAKING AND COLLABORATION WITH WRITABLE TABLES AND GLAZING

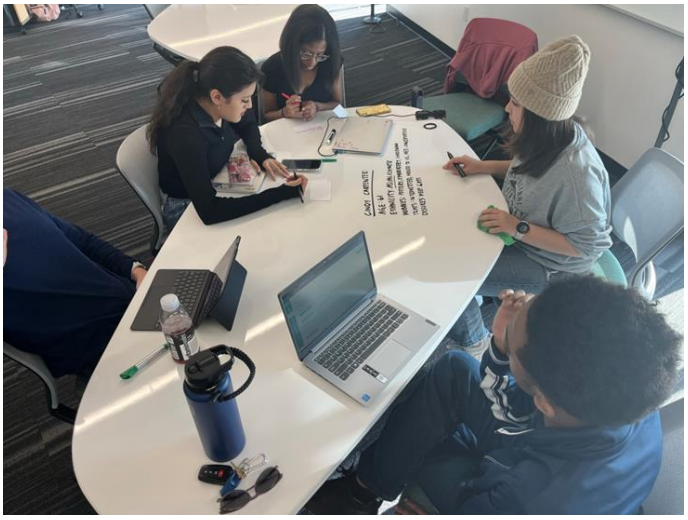
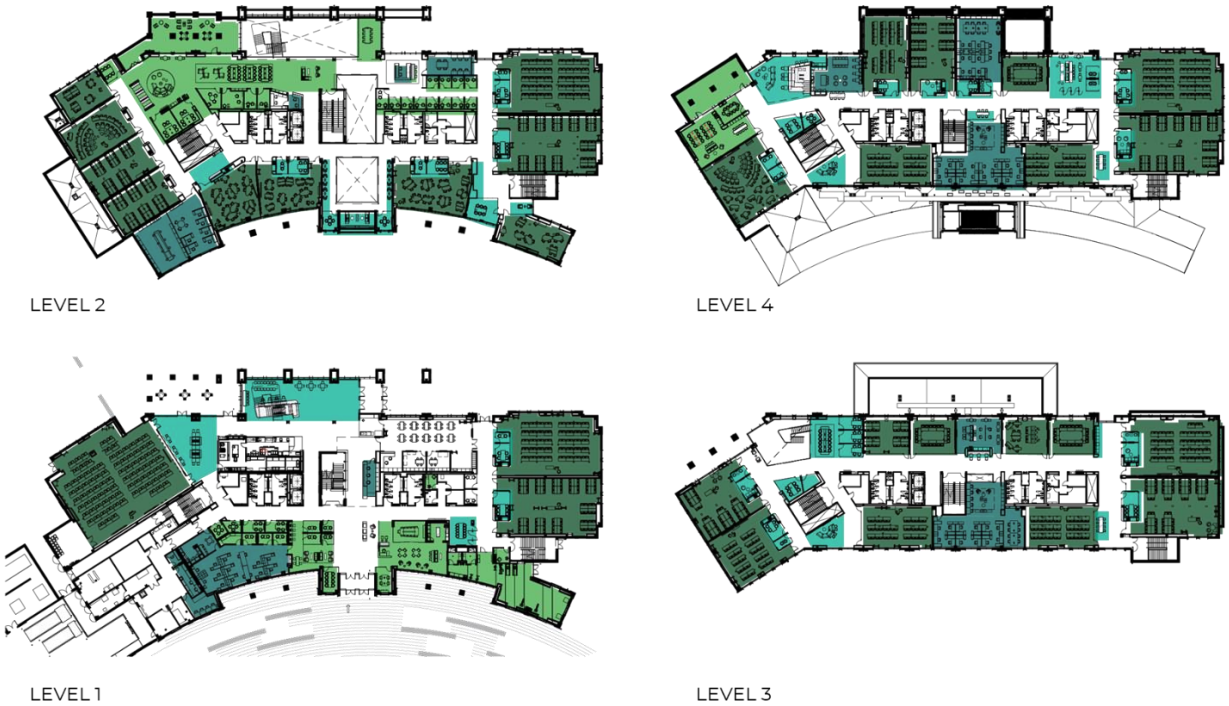
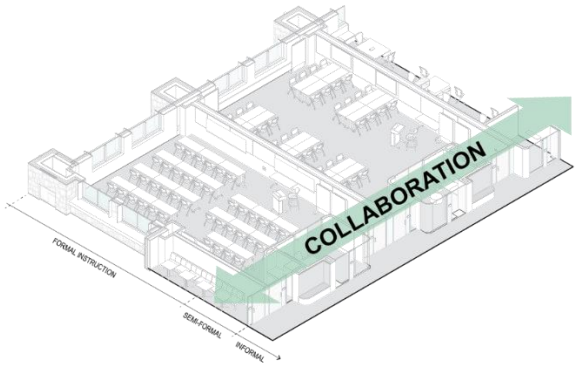


FIGURE 8
BUILDING FLOOR PLANS INDICATING PROGRAM LOCATIONS



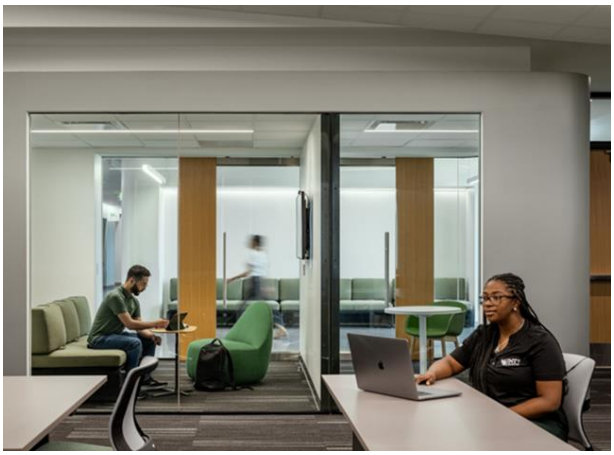
The division between classrooms and corridors was designed to blur the boundaries. Instructional spaces incorporate study rooms as an intermediate layer between the central circulation spine and formal instruction. As represented in Figure 9 and Figure 10, semi-formal pods create a space for collaboration and meetings for instructors and students outside of scheduled classes.

FIGURE 9
CLASSROOM, STUDY SPACE, AND CIRCULATION LAYERED IN THE FLOOR PLAN



Note. Floor Plan (Vail, et.al., 2023)

FIGURE 10
CLASSROOM, STUDY SPACE, AND CIRCULATION LAYERED IN THE FLOOR PLAN



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METHODOLOGY

The case study involved a quantitative and qualitative approach, using participant surveys, observation, and data collection from internal institutional sources to examine the relationship between the new learning environments and student and faculty success concerning PBL. This first academic building is on 100 acres set aside for a new branch campus and is located 40 kilometers from UNT's main campus. It opened for classes in January 2023, so it is in its infancy, with a 50-year master plan for development. After the facility had been operational for eight months, research was collected during the 16-week fall 2023 academic semester, with 3,148 students enrolled, 59% of whom attended full-time, 41% attended part-time, and 161 faculty teaching in the building. At the time of the case study, the branch campus offered 20 undergraduate degree programs, 6 master's degree programs, 3 doctoral degree programs, 14 minors, 4 undergraduate-level certificates, and 2 graduate-level certificates. In week three of the semester, all students and faculty could take an online survey, which remained available through week eight. Two surveys were designed, varying slightly: one for faculty and one for students. Observations were conducted during the semester's mid-term and the week before final exams when students and faculty were heavily involved in course assignments. The students and faculty were observed during classroom instruction and working in private

and open collaboration learning spaces outside the classroom. Furthermore, occupancy load and schedule tracking were collected from institutional sources utilizing enrollment data and wireless access devices.

FINDINGS

Qualitative Analysis

Participant Observation

Through the building's design, all program offerings and courses at UNT at Frisco are actively and passively encouraged to embrace engaging, collaborative instructional approaches with team-based activities, fostering interactions among students and faculty.

Classroom Observations

Three classes, each from a different degree program, were observed once during classroom instruction: a Project Design and Analysis course, a Business course, and a Computer Science Computer Engineering course.

+ CACS, Project Design Analysis Course: The class consisted of nine undergraduate students and one faculty member. The faculty member moved the tables and chairs before class began in preparation for the lesson. Throughout the lesson, the students were instructed to move to different locations depending on the activity. Activities involved both individual and group interaction. One monitor was used and controlled through the faculty's cell phone. The students adjusted the window shades to prevent glare on their computer screens. The writable surfaces or speakers in the classroom were not used. The overhead lighting remained the same throughout the class. Students appeared to be engaged and not distracted throughout the lesson.
+ Business Course: The class consisted of 36 undergraduate students, one faculty member and a guest speaker who presented for the entire class period. The students were spread evenly throughout the room using the mixed seating types: individual lounge chairs with 30", 36" and 42" high desks. The furniture was arranged in a tiered setting. The floor space of the classroom was maximized with furniture, making it difficult to move the furniture into a new configuration during class time. Natural light filled the room, window shades were pulled halfway down, and overhead lights were not required to see sufficiently. The faculty had music playing through the overhead speakers as the students arrived and settled in for the class to begin. The projector was used during the guest speaker's presentation on "Networking." There was no group collaboration during the presentation. Students engaged in a question-and-answer session with the speaker during and after the presentation.
+ Computer Science Computer Engineering Course: The class consisted of five graduate students and one faculty member in a mediascape classroom setup, with several monitors along two walls, allowing the students and faculty the option to connect with the monitors and share their computer screens. Four 30" high classroom tables were grouped next to each wall monitor. The students appeared focused throughout the class, working on their projects collaboratively with the other students in their table groups on their laptops. The instructor could quickly join each group at the tables to review and discuss their project. The wall monitors were not used, and when asked, neither the students nor the faculty understood how to use them for collaborative work.

In summary, the level of collaboration with faculty and students, plus engagement with the building features, varied depending on the class and the activity for the period. The movable tables and chairs proved readily adaptable to the needs of the activity. Variable seating height to create a tiered seating configuration worked well for a quest speaker, allowing clear lines of sight for students and instructors. The use of audio-visual equipment and writable surfaces was low during the observations, and if used, it was only by the instructor. Students and faculty noted that they were unaware of how to use the equipment to its full potential.

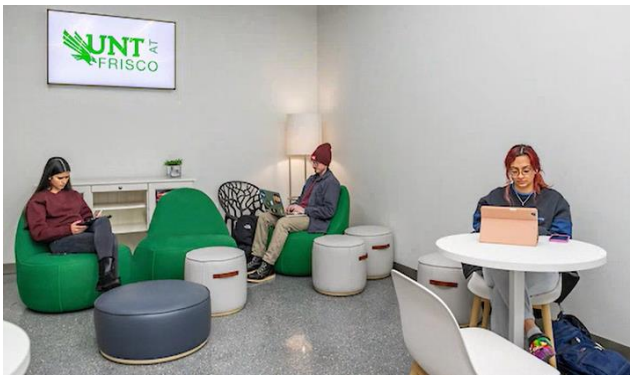
Observations Outside the Classroom

Participant observations recorded hourly between 9:00 a.m. and 6:00 p.m. on a weekday, once during the middle of the semester and again a week before final exams, documented the utilization of collaborative learning spaces located outside the classroom, in semi-private huddle rooms, open collaboration areas, and specialized spaces like the maker space and one-button studio.

1. Of the 3,148 students and 161 faculty, 205 (7%) used collaborative learning spaces outside the classroom.
2. Of these 205 occupants, 76% preferred the semi-private huddle rooms over the open learning spaces.
3. Of these 205 occupants, 81% worked independently rather than collaboratively.
4. On average, 96% of the occupants used only a laptop versus connecting to the facility technology available, such as wall monitors.

In summary, the huddle rooms, open collaboration areas, and specialized spaces like the maker space and one-button studio saw low usage for team-based engagement.

FIGURE 11
OBSERVATIONS OF STUDENTS USING COLLABORATIVE SPACES BUT WORKING IN SOLITUDE



Note. Photography by Gabe Border, 2023, reprinted with permission.

FIGURE 12
OBSERVATIONS OF STUDENTS USING COLLABORATIVE SPACES BUT WORKING IN SOLITUDE

Note. Photography by Gabe Border, 2023, reprinted with permission.

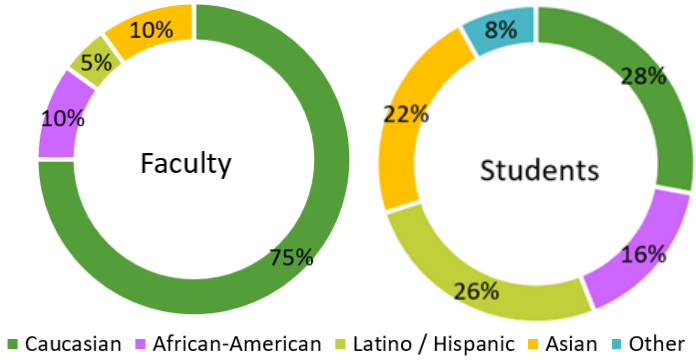
Campus Leadership Observations

Classes in this new building are scheduled manually by a small team that interacts with faculty and academic units directly to ensure that scheduling supports timely progress toward degree completion in Frisco. During the case study, campus leadership experienced a number of emails and in-person conversations that revealed faculty concerns and complaints about classroom layouts and technology issues. While following PBL techniques of movable podiums and wireless AV controls to encourage direct engagement with students and circulation of faculty around the classroom, faculty questioned the scheduling team about why the classroom layouts are so unusual, specifically voicing frustration at the decentered space in the classrooms. Some faculty and unit administrators even wondered aloud why the university bothered building a facility and scheduling courses in person rather than online.

Survey

An online, anonymous survey was conducted as part of the case study. Open to all students and faculty over the age of 18, of those who responded to the survey, 22 participants were faculty—8 Males, 13 Females—and 65 students—14 Males, 41 Females, 3 Non-Binary / Third Genders, and 7 Prefer Not To Say. The circle graphic in Figure 13 below represents the ethnicity of the faculty and student survey participants.

FIGURE 13
FACULTY AND STUDENT DEMOGRAPHICS OF SURVEY PARTICIPANTS

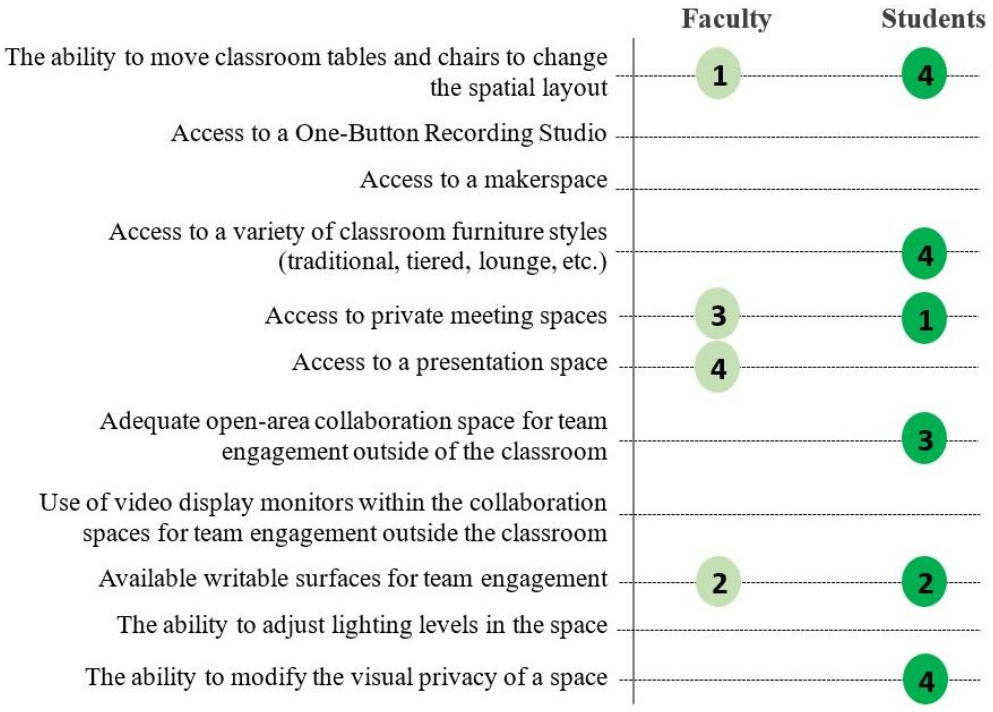


Faculty and students were asked about their awareness and understanding of how to utilize the learning environments within the facility as it pertains to the project-based learning pedagogy. A summary of the results in Table 1 highlights that over 95% of the faculty and 50% of the students were aware of the flexibility, technology and features of the classrooms and huddle rooms. This number reduced significantly to under 20% when asked if they knew how to use the technical features of the specialized areas – the maker space and the one-button studio. Only 9% of faculty and 14% of students knew how to access Industry Outreach resources within the building. When asked about PBL pedagogy, the survey results indicated that 95% of faculty were aware of it, but only 50% chose to teach a course utilizing it. Students were much less aware, 38%, of PBL pedagogy, and the majority were unaware if they were in a course that used it. As noted in Table 2, when asked about their favorite building features that best facilitate their learning, private meeting spaces, writable surfaces, and flexibility of furniture were among the top four for faculty and students.

TABLE 1
SUMMARY OF SURVEY RESULTS

Survey questions regarding the awareness or use of PBL and related elements in the building	Faculty response "Yes"	Student response "Yes"
Furniture flexibility in the classrooms	100%	69%
Shared huddle rooms	95%	46%
Classroom availability outside of classes	91%	59%
Specialty space: the makerspace	18%	23%
Specialty space: the one-button studio	0%	8%
Resources from the Industry Outreach Department	9%	14%
How to operate the technology in the classroom and study rooms (faculty only)	76%	Not asked
What project-based learning is	95%	38%
Are you currently teaching a course using PBL practices? (faculty only)	50%	Not asked
Are you currently enrolled in a course using PBL practices? (students only)	Not asked	10%

TABLE 2
TOP 4 RANKED BUILDING FEATURES OF IMPORTANCE IN AN ACADEMIC SPACE TO BEST FACILITATE SUCCESS IN A PROJECT-BASED LEARNING COURSE



The qualitative data helped to answer the research questions regarding how faculty and students interact and incorporate the physical elements of a building designed for PBL into their pedagogy and educational experiences and how these physical elements relate to the dynamics of educational activities conducted in that setting. The results indicate that even with some awareness that the facility was designed for project-based learning activities, the faculty integration of the physical elements into pedagogy is limited. A small

percentage of faculty are fully engaged in PBL. Information collected from building administration suggests that faculty prefer to teach in traditional, instructor-centered settings and are even frustrated by features such as decentered classrooms. While faculty wouldn't necessarily need to state their pedagogy explicitly, it is noteworthy that the majority of students have not been able to connect PBL to the facility and their learning experience, a likely indication that their course assignments are not project or problem-based, and at least do not prioritize collaborative and self-directed learning. Beyond the classrooms, the design of the many flexible and adaptable spaces, such as the huddle rooms, physically meets the goal of creating environments that support active collaboration and project-based learning. Although popular amongst students and faculty, the spaces are often used for private study rather than collaborative work. Collaborative elements such as wall monitors, writable surfaces, the makerspace (SPARK), and One Button Studio were rarely used.

Quantitative Analysis

Frisco F23 Census Enrollment Data Heat Map

The information shown in Figure 14 is an occupancy heat map of the kind that the UNT at Frisco scheduling and data provide regularly to administrators to plan for essential student support services. This one reflects the total number of students enrolled during the fall 2023 semester and when they are in the building for scheduled classes. It notes the number of occupants each day of the week and captures when the building was most in use. It indicates that the most populated days are Tuesdays from 2:00 pm to 8:30 pm, followed by Monday evenings from 6:30 pm to 9:00 pm.

FIGURE 14
TIME AND DAY OCCUPANCY HEAT MAP BASED ON ENROLLMENT

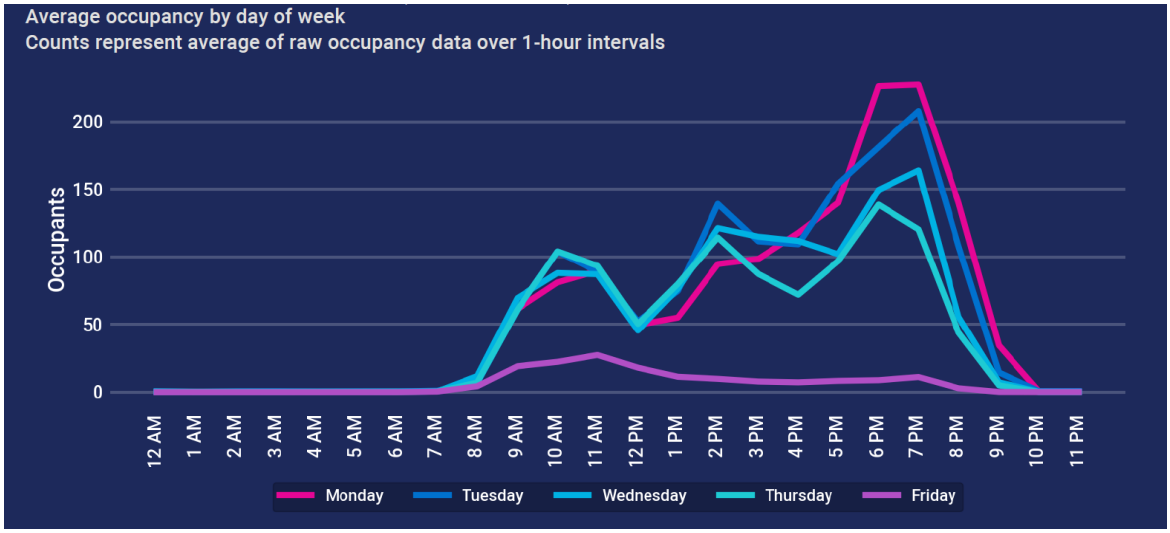
	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday**	Sunday**
7:30 AM	0	0	0	0	0	0	0
8:00 AM	0	0	0	0	0	0	10
8:30 AM	0	10	0	0	0	0	10
9:00 AM	83	120	86	110	7	69	10
9:30 AM	150	226	156	216	7	69	10
10:00 AM	143	237	188	216	0	69	10
10:30 AM	192	278	203	257	0	69	10
11:00 AM	165	250	249	217	0	69	10
11:30 AM	171	268	255	245	0	69	10
12:00 PM	46	163	130	57	0	0	10
12:30 PM	55	150	96	115	0	0	10
1:00 PM	172	260	180	179	0	49	10
1:30 PM	172	260	180	179	0	49	10
2:00 PM	194	444	120	241	21	49	10
2:30 PM	184	416	110	211	21	49	10
3:00 PM	184	414	134	255	21	49	10
3:30 PM	180	442	183	186	21	49	10
4:00 PM	137	465	181	154	21	0	10
4:30 PM	149	512	193	220	21	0	10
5:00 PM	115	309	149	260	0	0	0
5:30 PM	167	383	189	324	0	0	0
6:00 PM	264	435	346	346	0	0	0
6:30 PM	629	521	453	395	0	0	0
7:00 PM	670	505	453	377	0	0	0
7:30 PM	642	501	439	348	0	0	0
8:00 PM	583	461	384	325	0	0	0
8:30 PM	444	403	273	222	0	0	0
9:00 PM	314	228	146	106	0	0	0
9:30 PM	0	0	0	0	0	0	0

** Saturday and Sunday reflect the four weekends with courses offered

Wireless Access Devices

The data gathered in Figure 15 indicates the number of occupants in the building, captured through the institution's wireless access system installed throughout the facility and dependent upon the occupant logging into the institution's Wi-Fi. This data coincides with the enrollment heat map, with comparable results indicating that the greatest numbers of students are in the building for classes on Monday and Tuesday evenings.

FIGURE 15
TIME AND DAY OCCUPANCY BASED ON WIRELESS ACCESS DATA



The quantitative data collected helped to understand when the facility was most in use. It illustrates the gaps in overall utilization that are primarily the result of the building plan's infancy and its demographic majority of a commuter population of graduate students and upper-division undergraduate students, both of whom prefer evening class options. Fall 2023 is only the second semester of operation in this facility, and future growth and scheduling will expand occupancy into earlier morning hours and Fridays.

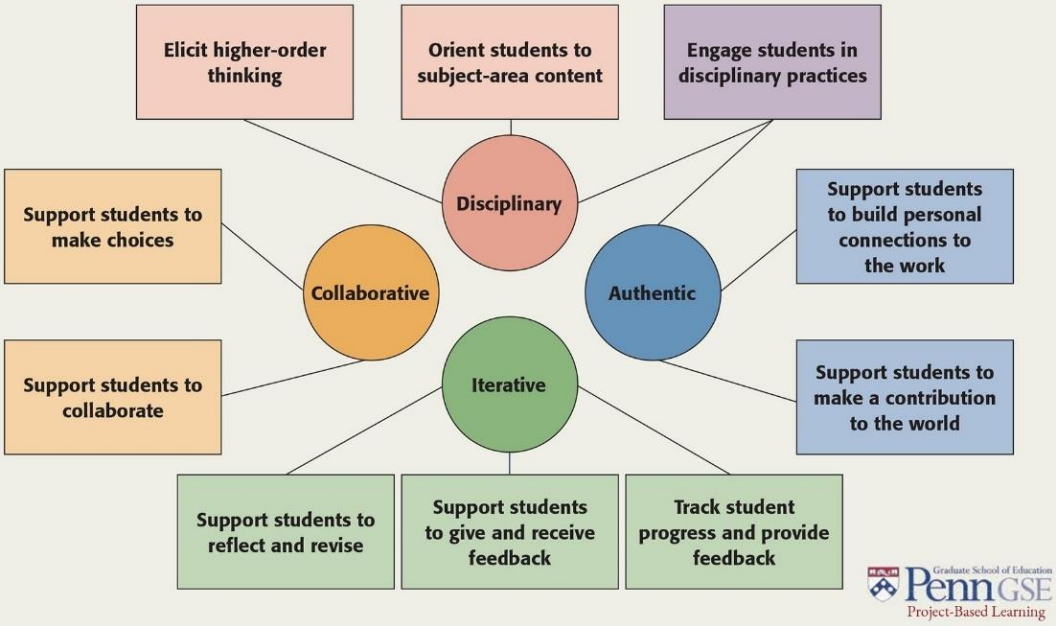
DISCUSSION

In-person PBL directed by faculty who engage with industry partners and community creates relevant, authentic educational experiences that allow students to form meaningful connections that contribute to their educational growth, understand and retain knowledge more meaningfully, and gain professional, real-world experience that benefits both students and employers. This approach to education benefits the students, the university, and the professional community. The case study results suggest a need for more education to (1) align faculty practices with the initial program goals and maximize the potential of the innovative learning environment and (2) engage students directly with the educational technologies available to them in the various designed learning spaces, within and beyond the classroom. An outcome of our investigation suggests that one likely reason for the success of a few faculty members is significantly more training with respect to both PBL and the innovative technologies available in the building. The building design positively nudges all instructors to teach differently. Still, our literature review and conversations with end users indicate that more time and faculty training are critically needed to create cultural change around PBL and engaged instruction for the facility to meet the full potential of its intended design.

Recommendations to the University

In response to the case study results, a recommendation was made to university leadership to implement a learning and development plan that includes engagement activities, project-based learning techniques based on the core practices suggested by Grossman, et.al. (2019) in Figure 16, educational and pedagogical development, and technology training as the next step to optimize facility utilization, enhance the learning outcomes for students, and accomplish the goals for the original building design.

FIGURE 16
THE CORE PRACTICES OF PROJECT-BASED LEARNING



The three options are summarized below with further details included in the Appendix.

- 5-Year Plan: Make a significant investment in implementing a robust plan to develop a Project-Based Learning Institute or Center. Hire a curriculum director (a PBL specialist) and an instructional technologist to educate faculty on designing and helping facilitate PBL implementation into the curriculum. Train staff to effectively use facility features to enhance the PBL experience.
- 2-Year Plan: Make a reasonable investment in implementing a limited plan to educate and train the faculty. Hire graduate students who will report to existing academic affairs leadership at the new campus to support PBL curriculum design and technology integration.
- 1-Year Plan: Make a small investment in implementing a minimal plan to offer some training to faculty. An existing technology support group will make online training videos about PBL, suggest ways to incorporate them into the curriculum, provide instructions on using the spaces and equipment, and offer some on-demand support and techniques to integrate PBL practices into their pedagogy.

LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

During the fall 2023 study, the study had low survey participation (14% of faculty and 2% of students) compared to the number of students and faculty in the facility. It must also be noted that more students at the campus are part-time, and the engagement of part-time students is often more challenging than full-time students. For future surveys, it would be beneficial to find ways to encourage more students and faculty to

complete the survey and to conduct individual interviews and focus groups. Furthermore, the observations were conducted primarily during the day and not during the peak evening hours discovered from the occupancy tracking data. Extending the observations until 9:00 pm may capture a new set of data.

Future research will involve following up on the case study after the university has completed implementing a learning and development plan. This follow-up aims to understand whether the training leads to greater integration of problem-based learning (PBL) in pedagogy and whether there is a ripple effect in utilizing the physical elements of the building in relation to PBL, ultimately resulting in improved student learning outcomes. Plus, what benefits would designers gain from understanding how a classroom's spatial layout relates to the dynamics of the activities conducted in that space?

CONCLUSION

Per the university campus master plan, UNT at Frisco is on target with enrollment expectations for a new facility to inspire innovation, connections, and achievement among its students and faculty. The present study explored how students and faculty use the project-based learning environmental features designed to meet the goals established at the beginning of the design to build upon UNT's role as a leader in innovative education.

Still, the results fall short of the established goals due to the faculty's lack of knowledge and willingness to use PBL practices to engage the students and fully utilize the building features specifically designed to enhance high-impact learning experiences. Although 95% of faculty are aware of PBL practices, only 50% incorporate it into their pedagogy. Fewer than 20% are aware of some specifically 21st-century features, so despite the university's best intentions and on-target enrollment, the vision is not yet manifest.

The results match the literature review's finding that faculty need training in the facility's intended use and the incorporation of PBL practices. Also needed is buy-in from faculty that, together, these components strengthen the learning outcomes for students as they enter an evolving workplace. Further gaps include the discrepancies between designer-intended space uses in a setting and user-intended uses of such spaces for optimal utilization.

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APPENDIX

Options	Impact	Artifacts & Mode of Delivery	Human Resources	Curriculum	Incentives
Option 1 **5-year plan to build a** Project-based Learning Institute or Resource Center that will advertise UNT's commitment to leadership in innovative and career-ready/applied education.	Regional, eventually national. UNT will set the bar for 21st-century education.	A repository of curricular ideas that incorporate the latest technologies PBL learning techniques and model industry partner engagement. Summer institutes, workshops, conferences, and ongoing faculty trainings for UNT faculty that encourage PBL and other high-impact practices	Leadership for curriculum development and delivery: Curriculum director, PBL specialist Instructional technologist	Training program for faculty on high-impact teaching practices; focus on rigor and relevance in active classrooms, for which building features, including technology are aids.	Certificates Professional development stipends Connection with a cohort of other faculty invested in pedagogy, relevance, and high-impact practices.
Option 2 2-year plan to educate and train faculty and staff on PBL practices, the building design features and how to integrate the two to close the gap between the building's intended use to enhance PBL.	Campus-wide with some institutional impact. Learn to use UNTF classroom & building features through a pedagogical lens of PBL.	Primarily online training for faculty with an option for individual help upon request Resources website Training sessions that connect discipline-specific curriculum with technology. Run videos clips, using facility monitors, to educate students, faculty and staff on PBL benefits and opportunities on how to integrate its' practices in the learning environment.	- Housed under existing UNTF Academic Affairs campus leadership - Graduate students develop and refine PBL-specific and site-specific content to close last-mile gaps - Graduate students on the UNTF tech team	Training materials and sessions specific to building features and PBL, including relevant literature, benefits of industry engagement, incorporating contemporary technology to better prepare 21st century graduates	Certificate Small professional development stipend.

Option 3 **1-year plan** to make faculty and staff aware of the technology and learning spaces in the building to alleviate frustration by sharing AV documentation, ~~and~~ on-demand support and techniques to integrate PBL practices into their pedagogy.	Interested faculty who self-select; some campus impact. Learn to use the UNTF building PBL design elements, with emphasis on technology.	QR codes/quick reference cards by AV equipment to link to related training videos for: ◦ AV monitor ◦ Classroom lighting and sunshade options ◦ Sound options (e.g., playing music) ◦ Video conferencing options - Links to existing online literature supporting high impact teaching practices - Maker Space and 1 Button Studio: Training by request on how to use the space by class or program with students and faculty - Host Demonstration Days to engage faculty and students - Add hold-opens to makerspace, 1-Button Studio doors to create a more welcoming and engaging environment; generate curiosity - Online and physical graphics of how the classroom furniture can be set up	IT and PBL personnel to create instructional videos	Instructions on flexible spaces and technologies available.	For integrating projects created in SPARK into the curriculum: Faculty: $500 professional development Program: access to resources from SPARK budget to purchase tools & equipment.

Note: With respect to artifacts, each level includes all artifacts in the levels below it on the table. For example, artifacts for Option 1, the highest level of commitment, would also include the artifacts from Option 2 and Option 3.