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Enhancing Curriculum and Student Experience through Project-Based Learning in an Undergraduate Information Systems Course

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Abstract

Declining enrolment and retention continue to challenge Information Systems (IS) and related computing disciplines, particularly as student populations become increasingly diverse. This study examines the effectiveness of project-based learning (PBL) as an instructional approach for enhancing student experience and learning outcomes in an undergraduate IS course. Using a longitudinal, quantitative research design, the study compares outcomes from PBL and non-PBL sections through pre- and post-test measures. Results indicate that students in PBL sections report higher levels of course satisfaction, perceived confidence, career goal clarity, test performance, and likelihood of recommending the course compared to students in non-PBL sections. Importantly, learning outcomes did not differ significantly across gender or first-generation status (i.e., the first in the family to attend college), suggesting that PBL may support inclusive learning experiences across diverse student pathways relevant to higher-education settings internationally. This study contributes to the scholarship on curriculum and assessment design by demonstrating how PBL can be structured around authentic, experiential assignments aligned with course learning objectives. The findings further position PBL as an inclusive pedagogical approach that enhances engagement and student satisfaction. This research offers practical insights for educators seeking to foster student engagement, belonging, and persistence in IS and other computing-related disciplines.

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Practitioner Notes

1. Embedding project-based learning (PBL) into IS courses increases student satisfaction and confidence in their skills.
2. PBL provides equitable learning experiences for women, underrepresented minorities, and first-generation students.
3. Faculty can use PBL to connect classroom tasks with real-world business problems and career preparation.
4. Structured milestones and feedback in PBL help students build confidence and sustain engagement across a semester.
5. Universities adopting PBL can improve retention and success rates in IS and other STEM disciplines.

Keywords

project-based learning, satisfaction, confidence, information systems, equity

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Introduction

Recent national reports indicate that student persistence and retention remain ongoing challenges in higher education. In the United States, only 77.6% of first-time students who began college in Fall 2023 were still enrolled one year later, and just 69.5% remained at their original institution, indicating substantial attrition beyond the first year of study (National Student Clearinghouse Research Center, 2025). In England, official continuation data show a decline in continuation rates for full-time first-degree students from 91.1% in 2022 to 89.5% in 2024, with particularly notable challenges in data, computing, and business-related subjects (Higher Education Statistics Agency, 2024). These national trends underscore the need to move beyond access-focused reforms and examine how instructional design and classroom experiences shape student persistence in skill-intensive fields.

Within this broader context, Information Systems (IS) and related computing programs face a distinct set of challenges. Despite the growing demand for IS graduates in the job market, IS and related computing fields have experienced long-standing enrolment challenges that have persisted into recent years, including slower growth and retention in the post–COVID-19 period (Tabatabaei & Tehrani, 2010; Tims et al., 2023; Wong, 2015; Zweben & Tucker, 2022). Prior studies indicate that a key factor contributing to student attrition is dissatisfaction with the learning experience, particularly when courses fail to engage students meaningfully (Cervantes et al., 2015; Joo et al., 2018). At the same time, the student population in higher education has become increasingly diverse, with growing participation by women and first-generation students. Despite these gains, such diverse student groups remain underrepresented in STEM fields and continue to experience disproportionately higher dropout rates and lower graduation rates (DeClou, 2016; Fry et al., 2021; Lawler et al., 2018).

These demographic shifts underscore the need for instructional structures and pedagogical approaches that better align with the learning needs of an increasingly heterogeneous student body (de Freitas et al., 2025; Eather et al., 2022; Pedler et al., 2022). Compounding the issues of dissatisfied and disengaged students in IS courses are the standard-driven reform efforts to standardise and control content and learning, which leave little room for innovative pedagogical practices (Børte et al., 2023; Elmore & City, 2011). Large class sizes and limited institutional resources result in a higher workload and grading pressures for the faculty. Thus, the courses are often designed to prioritise proficiency over engagement. Recognising the problems of curriculum standardisation and shifting student demographics, recent scholarship has begun to explore innovative redesign methodologies for courses to improve academic learning satisfaction and achievement among millennials and minorities by increasing student engagement and interest (de Freitas et al., 2025; Tight, 2020).

Recent research further highlights the importance of a sense of belonging as a crucial factor influencing persistence and retention among historically underrepresented and low-income students in STEM disciplines. Hansen et al. (2024) demonstrate that STEM domain-specific sense of belonging and academic hope are strong longitudinal predictors of persistence to degree completion for underrepresented students, emphasising that belonging is not an individual trait but an outcome shaped by curricular, instructional, and community-building structures within

academic programs. Complementing this evidence, qualitative studies of first-generation students in international contexts similarly highlight how instructional and institutional environments shape belonging and engagement, rather than student background alone (James & Taylor, 2022). These findings reinforce the need to examine pedagogical approaches that intentionally cultivate inclusive learning environments, particularly in computing- and analytics-oriented disciplines such as Information Systems (Sax et al., 2018). One such methodology to achieve higher engagement and enhanced learning among students is the project-based learning (PBL) approach, where students engage in investigating a real-world problem to create a meaningful and relevant use of their educational experiences (Cervantes et al., 2015; Rehman et al., 2024). PBL approaches have been employed in recent years to enhance educational outcomes and student satisfaction in courses such as engineering and technology (Martinez-Rodrigo et al., 2017). While PBL has been used and experimented with in a few academic programs, including Science, Technology, Engineering, and Mathematics (STEM), there has been limited empirical research on the impact of PBL in improving the interest, engagement, and learning of the students in the IS discipline (LaForce et al., 2017).

Given the issues of declining enrolments and higher dropouts among IS students (Wong, 2015), it is, therefore, prudent to understand the impact of PBL. The primary objective of this study is to empirically examine the impact of PBL pedagogy on learning satisfaction among diverse student groups in undergraduate information systems courses. These objectives are primarily addressed by comparing the differences in learning experiences and outcomes between students enrolled in PBL instructional sections and those enrolled in non-PBL sections, and, where appropriate, by examining whether the effects of the PBL approach are consistent across student subgroups. This longitudinal study examines the effectiveness of PBL in an IS course by enabling students to work on an extended group project that solves a real business problem by designing and developing an information system, thereby utilising the learning objectives of the course.

Prior studies suggest that students from historically underrepresented and first-generation backgrounds often experience unequal access to early exposure in computing, analytics, and applied problem-solving before entering university (Iorio, 2019; Zaragoza, 2018). These differences reflect structural variations in educational opportunity rather than individual ability. Brown (2018) reported that underrepresented students, including women, often report lower access to institutional support structures and professional socialisation opportunities that foster self-efficacy and networking. As a result, traditional lecture-based instructional designs may inadvertently privilege students with prior exposure, while students from instructional environments that did not explicitly incorporate inclusive pedagogical supports may inadvertently limit opportunities for belonging within the campus, community, and the classroom (Brown, 2018), which may lead to lower engagement, satisfaction, and positive reaction to classroom activities and further reduce student's academic satisfaction and success (Bryan & Simmons, 2009). Pedagogical approaches that emphasise scaffolded learning, authentic application, collaboration, and iterative feedback may therefore play a critical role in shaping engagement, confidence, and sense of belonging across diverse student populations (Sharma & Giannakos, 2025).

To address the research objectives, we propose several hypotheses drawing upon the PBL theory. These hypotheses are used as the underlying theoretical framework. We then describe

our research methodology, including the survey design, data collection strategy, and data analysis, followed by the findings, discussion of the implications of this study, and avenues for future research.

This study addresses the need for curriculum reform in the IS discipline by examining how project-based learning can be utilised to redesign coursework, thereby better aligning it with contemporary student needs and expectations. It also examines how PBL pedagogy enhances students' academic experiences by increasing relevance, motivation, and ownership of the learning process. From a curriculum design perspective, this research demonstrates how PBL can be structured around real-world business problems to scaffold learning objectives across a semester. The PBL approach not only guides students through progressive assessment checkpoints but also provides flexible pathways for learners to construct and demonstrate knowledge collaboratively. The study further evaluates how this approach can be especially impactful for improving the student experience by offering meaningful engagement and reducing barriers to participation for historically underserved groups.

Background

Literature Review

Dewey (1900) suggested that educational experiences should be integrated with life experiences. It is essential to provide personalised learning experiences that enable students to connect their learning with authentic, real-world problems. The use of PBL is especially important when the students are racially, ethnically, and economically diverse. Research suggests that project-based learning can support meaningful engagement and skill development for students from diverse educational backgrounds, particularly when instructional designs emphasise scaffolding and authentic assessment (Holmes & Hwang, 2016). A longitudinal study spanning three years of high school students taught using PBL revealed that STEM PBL instruction had a positive influence on student achievement in mathematics, regardless of students' diverse demographic backgrounds and performance levels, with low-performing students showing statistically significantly higher growth rates in mathematics scores than high- and middle-performing students over the three years (Han et al., 2015).

PBL evolved from its roots in the project method developed by educational theorists, such as Kilpatrick (1918) and Dewey (1900). The PBL approach to learning is considered to lead to a deeper understanding of a topic and increased motivation to learn. It is a key pedagogical strategy for encouraging students to be independent thinkers and learners (Bell, 2010). The PBL methodology has been effective due to its emphasis on being a student-centred, teacher-facilitated approach to learning, utilising formative assessment and community-based learning environments (Bell, 2010; Han et al., 2015). PBL is grounded in the theory of constructivism by providing opportunities for students to engage in activities requiring critical thinking, creativity, problem-solving, interdisciplinary knowledge, unstructured and ill-defined inquiry with a view to achieving a well-defined artfact or outcome, hands-on work, and interactive group activities (Capraro & Slough, 2008; Clark & Ernst, 2007; Dolmans et al., 2005; Han et al., 2015). Baran and Maskan (2010) studied the effect of PBL on university students. They found that the PBL approach resulted in significantly higher comprehension scores and engagement. Kaldi et al. (2011) showed

that the main reason for positive effects in content knowledge and attitude toward learning among students was due to hands-on activities and field-based contexts used in PBL methodology. This pedagogical shift supports contemporary efforts in higher education to integrate assessment design with instructional delivery, ensuring that formative and summative assessments reflect real-world performance tasks.

Educational institutions have been under financial, technological, political, pedagogical, and consumer pressure. As the introduction of Massive Open Online Courses (MOOCs) grows, it will challenge the traditional revenue models and institutional strategies (Hanover Research, 2025). These courses challenge traditional universities to differentiate their value from accessible, market-responsive digital offerings that influence student satisfaction and confidence in institutional credentials (Huang & Qi, 2025; Sarnou & Schug, 2025). Student-focused pedagogies have been considered as a solution to engage, satisfy, and be more effective in impacting learning outcomes. The administrators, instructors, and practitioners believe the PBL pedagogical approach is superior to other teacher-focused pedagogies (Garnjost & Lawter, 2019) as PBL focuses on students' overall satisfaction and engagement. Student satisfaction is generally defined as the short-term attitude students develop toward the university, college, department, or course based on students' educational experience when the actual learning and performance meet or exceed the expected learning and performance (Elliott & Healy, 2001). In the competitive higher education marketplace, particularly in science and technology disciplines, student satisfaction plays a critical role in attracting and retaining students (Kenney & O'Halloran, 2024; Levitz, 2025). A highly satisfied student usually has good word-of-mouth about the course or the university, which is highly important for a demanding discipline related to science, technology, and mathematics.

PBL, Belonging, and Inclusive Curriculum Design in Contemporary Higher Education

Recent higher education scholarship on equity in STEM and computing-related disciplines highlights equity, sense of belonging, and inclusive instructional and curriculum design as a central mechanism that influences student persistence (Hansen et al., 2024; Jaiswal et al., 2022). These studies highlight that sense of belonging is not an individual characteristic but an outcome shaped by instructional design, assessment practices, and learning environments. For example, Hansen et al. (2024) demonstrate that STEM-specific sense of belonging and academic hope are strong predictors of persistence for underrepresented and low-income students, reinforcing the role of curricular and community structures in shaping equitable outcomes. Similarly, PBL literature has expanded to consider authentic assessment and engagement in hybrid and digitally mediated learning environments, particularly in the context of post-COVID instructional shifts. Recent work suggests that pedagogies emphasising real-world application, collaborative learning, and iterative feedback can support student engagement and confidence across diverse learning pathways, even as students navigate increased variability in prior preparation and learning contexts (Almulla, 2020; Hansen et al., 2024; Jaiswal et al., 2022; Tierney et al., 2022). Within this contemporary discourse, PBL is increasingly framed not as a remedial strategy but as an inclusive curriculum design that supports transition, belonging, and engagement in complex learning environments.

Recent international higher-education policy frameworks similarly emphasise equity, belonging, and student experience as core indicators of institutional quality and success. In Australia, Robinson et al. (2025) introduce the Student Equity in Higher Education Evaluation Framework, which positions student engagement, belonging, and participation across the student lifecycle as key dimensions for evaluating equity initiatives within universities. Likewise, in the United Kingdom, the Office for Students requires institutions to articulate and evaluate Access and Participation Plans that address risks to equality of opportunity in access, continuation, attainment, and graduate outcomes, with a growing emphasis on student experience and belonging as mechanisms of success (Bolton & Lewis, 2025). Together, these frameworks highlight a shared international shift toward evaluating equity not only through access metrics but through inclusive curricular and pedagogical practices that support engagement, persistence, and positive student experiences.

PBL Implementation in an Information Systems Course

The PBL course design reflects a structured curriculum model that embeds assessment within each stage of the project timeline, offering students iterative opportunities to demonstrate mastery through applied, authentic application. The PBL approach was applied in a required undergraduate IS course, which is typically delivered over a semester (16 weeks) in face-to-face or hybrid modality. We followed Krajcik et al. (1994) and Thomas's (2000) model of the PBL approach to shape the project for our IS course:

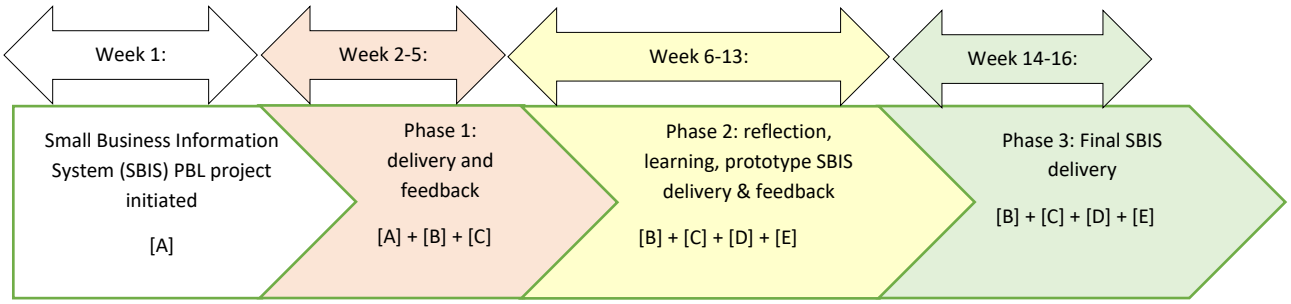
- [A] an authentic and engaging driving question,
- [B] student-generated artefacts,
- [C] student collaborated research,
- [D] an audience of the community,
- and [E] the use of technology-based cognitive and communication tools.

We combined these five steps into three major sections suitable for our IS course (see Figure 1). For example, in week 1, students initiate the course project to design an information system for a small business (SBIS) using Excel to meet step [A] of the PBL model by identifying an authentic and engaging driving question.

The course intentionally used Excel, macros, and VBA due to their low barrier to entry, widespread availability, and strong relevance to business contexts. These tools provide an accessible platform for students with varied levels of prior technical exposure, including first-generation learners. This accessibility is particularly important in the current AI environment, where Large Language Models (LLMs) can readily generate isolated code snippets, formulas, or VBA routines without requiring deep conceptual understanding from students. While such tools can support surface-level task completion, they do not inherently foster systems-level thinking. In contrast, the PBL approach emphasised the design, integration, and iterative refinement of a complex, context-specific information system. Students were required to engage with interconnected components such as system design logic, data structures, data flow, automation sequences, dependencies, and error handling, processes that cannot be meaningfully completed through piecemeal, AI-generated solutions alone.

Figure 1

PBL Phases and Timeline across a Semester



Phase 1 focuses on [A], [B], and [C]. Phase 1 of the course project includes identifying the Problem Statement of a real-world local small retail business that is of interest to the student group. Groups are formed typically in week two of the semester. Students communicate with the local business company several times to understand and identify the business processes, data sources, and the data problem related to the company. Each group presents their Phase 1 proposal with details to the faculty and their peers. The faculty provides feedback as required.

Phase 2 focuses on [B], [C], [D], and [E]. In Phase 2, students develop and present the working prototype in week thirteen of the semester. The course is structured so that each class session after Phase 1 is designed to enable students to acquire the knowledge and skills necessary for project completion, thereby utilising the PBL approach. The faculty meets with each group periodically to monitor and guide the progress of their working prototype and provide feedback on the presentation of the prototype.

Phase 3 of the project reiterates the PBL model with the expectation that the students will significantly expand on their Phase 2 artefact based on the extensive feedback received. Phase 3 of the course project is typically due in the final week (week 16) of the course. It entails delivery of the final, complete Excel-based Small Business Information System (SBIS) for a real business utilising advanced Excel functions, macros, and VBA. Whenever possible, a representative from the company (for which the SBIS is developed) is invited for the final presentations, and a memo on the functionalities of the software is discussed. Each group receives the final feedback from the faculty, peers, and the company representative.

Figure 2 summarises the different activities that happen within each phase of PBL in a weekly timeline.

Figure 2

PBL Project Phases for the Small Business Information System

PBL Project Phases for the Small Business Information System (SBIS)			PBL Learning Activities
Phase 1 of PBL, 4 weeks	Week 1	Project Guidelines, Expectations & Requirement Discussed	In Class
		Sample Projects Demonstrated	
	Week 2	Student Groups Formed	In & Out of Class
	Week 3	Phase 1 Delivered (Finding a Company and its details)	Out of Class
	Week 4	Phase 1 **Feedback** by Peers and Faculty	In Class
Phase 2 of PBL, 9 weeks	Week 5-8	Students Reflect on Feedback & Update the Project	Out of Class
	Week 9	2nd **Feedback** by Faculty	In Class
		Students Reflect on Feedback	
		Set Goals for Developing Prototype for the SBIS	In & Out of Class
	Week 10-12	Students Work in Groups the SBIS Prototype	
	Week 13	Phase 2 Delivered (Prototype SBIS Presented)	In Class
		Phase 2 **Feedback** by Peers	
		Phase 2 **Feedback** by Faculty	
Phase 3 of PBL, 3 weeks	Week 14-15	Phase 3: Student Reflect on Phase 2 Feedback & Develop Final SBIS	In & Out of Class
	Week 16	Phase 3 Delivered (SBIS Presented)	In Class
		Phase 3 **Feedback** by Faculty, Peers, and Company Representative	In Class

Research Hypotheses

Drawing on prior research on project-based learning (PBL), inclusive pedagogy, and student experience in Information Systems and related STEM disciplines, this study advances a set of hypotheses examining the impact of PBL on student learning outcomes and experiences. Specifically, the hypotheses test whether students enrolled in PBL instructional sections report higher levels of:

H1. Perceived confidence toward learning

H2. course satisfaction (H2),

H3: career goal development,

H4: job-search preparation),

H5: analytical knowledge competency,

H6: classroom involvement,

H7: course recommendation

H8a: whether the impact of the PBL approach is consistent across gender and

H8b: whether the impact of the PBL approach is consistent across first-generation college status.

H9: whether students in PBL sections demonstrate greater learning gains over time, as measured by pretest–post-test performance, compared to students in non-PBL sections.

These hypotheses are tested using quantitative analyses and are reported in the subsequent Results section. Each hypothesis is explicitly aligned with a corresponding measured construct (e.g., perceived confidence, satisfaction, career goals), with a consolidated mapping of hypotheses to constructs provided in Appendix 2.

Method

Research Design, Data Collection, and Sample Characteristics

This study uses a survey design research methodology for data collection in a public university in the United States. This study employed a quantitative, quasi-experimental research design involving an experimental group and a control group drawn from undergraduate Information Systems (IS) courses offered over a 16-week semester. This study uses a survey design research methodology for data collection in a public university in the United States from January 2018 to December 2019 over three semesters. Students were enrolled in course sections that implemented either a project-based learning (PBL) instructional approach (experimental group) or a non-PBL instructional approach (control group). The experimental group experienced a semester-long PBL curriculum, while the control group followed a traditional instructional format without a project-based component.

The survey was administered via Qualtrics and distributed to students through email and the institution's learning management system (LMS). All participants were at least 18 years of age. Students in both instructional conditions completed a pretest at the beginning of the semester and a post-test at the end of the semester to assess changes in course-related quantitative knowledge over time. These pretest and post-test measures were separate from the primary survey instrument and were used exclusively to examine learning gains across the semester. The pretest and post-test consisted of instructor-developed quantitative assessment items aligned with the core learning objectives of the course, focusing on applied Information Systems concepts, data analysis, and problem-solving skills addressed across the semester. In addition, all students completed an end-of-semester survey during Week 16. Participation in the research was voluntary and anonymous, and informed consent was obtained from all participants prior to data collection. Students who chose to participate received a small amount of extra credit. The study was conducted in accordance with institutional guidelines for research involving human participants.

A total of 492 undergraduate students initially completed the survey. Responses that were incomplete, completed in under three minutes, or failed embedded attention-check questions were excluded during data screening. The final analytic sample, therefore, consisted of 468 undergraduate students, with 234 students in the PBL group and 234 students in the non-PBL group. This sample size reflects complete end-of-semester survey responses that met all data quality criteria, with group sizes determined by course enrolment across instructional sections.

As summarised in Appendix 1, the sample was demographically diverse. Gender and first-generation college status were examined as distinct demographic dimensions. Across instructional conditions, the average age of participants was approximately 23–24 years, with a relatively balanced gender distribution. More than half of the sample identified as first-generation college students, and a substantial proportion of students identified as Hispanic, reflecting the racial, ethnic, and educational diversity of the institution and the IS program. Please refer to Appendix 1 for additional information on sample characteristics.

All statistical analyses were conducted using SPSS (Version 19) for descriptive statistics, independent-sample and paired-sample t-tests, ANCOVA, and regression analyses. SmartPLS was used for supplementary modelling and robustness checks where appropriate.

Instrument Design

A Qualtrics-based online survey with seven variables, each with its own items, was constructed. The survey items were adapted from previous literature that had validated the items in a context similar to our research. The survey instrument was pilot tested by 26 undergraduate students who were representative of the target population. These participants evaluated the flow of the survey, language, choice of words, and the meaning of items to ensure that the items accurately represented the construct's definition. The survey instrument was refined based on their feedback (see the list of adapted items and their respective sources in Appendix 3).

Results

We performed a t-test to evaluate whether sections of the courses with PBL have a higher impact on students compared to non-PBL sections. Table 1 presents the independent-samples t-test results comparing students in PBL and non-PBL instructional sections, based on 234 students in each condition (N = 468). The results indicate that, for all measured variables, the mean values were higher for sections that implemented the PBL approach than for sections that did not. However, not all observed differences reached statistical significance. Specifically, the independent t-tests show statistically significant differences between the two instructional approaches in terms of perceived confidence in learning (H1), satisfaction with the course (H2), and recommendation of the course (H7), providing support for three hypotheses. In contrast, no statistically significant differences were observed between PBL and non-PBL courses for job-search preparation (H4), knowledge of analysis (H5), and involvement in class (H6), and therefore, these hypotheses were not supported. A summary of the hypothesis testing outcomes corresponding to these analyses, along with the output from Table 1, is provided in Appendix 2.

Unlike the analyses reported in Table 1, which compared outcomes between PBL and non-PBL sections, we next examined whether the impact of the PBL approach differed across student subgroups within the PBL instructional condition only (n = 234). Specifically, we performed independent-samples t-tests to explore whether the effects of the PBL approach varied by gender, in order to test Hypothesis 8a. Table 2 presents an independent-samples t-test comparing male (n = 124) and female (n = 110) students within the PBL group. The results indicate that none of the observed differences between male and female students were statistically significant, suggesting that the impact of the PBL approach did not differ by gender. Accordingly, Hypothesis

8a was supported. A consolidated summary of hypothesis testing outcomes is provided in Appendix 2.

Table 1

Independent Sample t-test (PBL vs. non-PBL)

Constructs	Approach	Mean	SD	S.E. Mean	F	T	Sig.
Perceived Confidence	Non-PBL	3.828	0.860	0.056	11.084	-2.953	0.003
	PBL	4.041	0.688	0.045			
Career Goals	Non-PBL	3.957	0.945	0.062	4.677	-2.573	0.010
	PBL	4.162	0.771	0.050			
Job-search Preparation	Non-PBL	3.981	0.769	0.050	0.660	-0.760	0.447
	PBL	4.038	0.850	0.056			
Knowledge Analysis	Non-PBL	3.978	0.765	0.050	2.100	-1.081	0.280
	PBL	4.050	0.668	0.044			
Involvement in Class	Non-PBL	4.030	1.072	0.070	0.096	-1.317	0.189
	PBL	4.160	0.961	0.063			
Satisfaction with Course	Non-PBL	3.792	0.934	0.061	1.361	-2.105	0.036
	PBL	3.967	0.866	0.057			
Recommendation of course	Non-PBL	3.872	0.949	0.062	6.215	-4.414	0.000
	PBL	4.232	0.810	0.053			

Table 2

Independent Sample t-test by Gender within the PBL Group

Constructs	Gender	Mean	Std Dev	Std Err	t-value	p-value
Perceived Confidence	Male	4.0685	0.6621	0.0595	0.66	0.5125
	Female	4.0091	0.7175	0.0684		
Career Goals	Male	4.1694	0.721	0.0647	0.15	0.8846
	Female	4.1545	0.826	0.0788		
Job-search Preparation	Male	4.0968	0.7995	0.0718	1.11	0.2698
	Female	3.9727	0.9032	0.0861		
Knowledge Analysis	Male	4.0387	0.6535	0.0587	-0.26	0.793
	Female	4.0618	0.6874	0.0655		
Involvement in Class	Male	4.0806	0.9508	0.0854	-1.31	0.1915

	Female	4.2455	0.9691	0.0924		
Satisfaction with Course	Male	3.9738	0.7768	0.0698	0.13	0.8984
	Female	3.9591	0.9593	0.0915		
Recommendation of the course	Male	4.2601	0.7438	0.0668	0.56	0.5762
	Female	4.2	0.881	0.084		

Table 3 below shows the outcome of an independent-samples t-test examining whether the impact of the PBL approach differed across first-generation and non-first-generation students within the PBL instructional condition (n = 234). Proving Hypothesis 8b, the independent-samples t-test shows no statistically significant differences between the two groups across these outcomes. A consolidated summary of hypothesis testing outcomes is provided in Appendix 2.

As shown in Table 4, we performed paired-samples t-tests to compare pretest and posttest performance for students; performance of both groups significantly improved (H9).

Table 3

Independent Sample t-test for First Generation within the PBL Group

Constructs	First Gen?	N	Mean	Std Dev	Std Err	t-value	p-value
Perceived Confidence	Yes	120	4.0333	0.6966	0.0636	-0.17	0.8687
	No	114	4.0482	0.6815	0.0638		
Career Goals	Yes	120	4.1875	0.7914	0.0722	0.51	0.6096
	No	114	4.136	0.7505	0.0703		
Job-search Preparation	Yes	120	4.0694	0.8423	0.0769	0.57	0.5687
	No	114	4.0058	0.861	0.0806		
Knowledge Analysis	Yes	120	4.0683	0.6724	0.0614	0.44	0.6604
	No	114	4.0298	0.6664	0.0624		
Involvement in Class	Yes	120	4.2417	0.9074	0.0828	1.36	0.1741
	No	114	4.0702	1.0107	0.0947		
Satisfaction with Course	Yes	120	4.0229	0.8212	0.075	1.01	0.3119
	No	114	3.9079	0.9098	0.0852		
Recommendation of the course	Yes	120	4.2458	0.8141	0.0743	0.27	0.7869
	No	114	4.2171	0.8089	0.0758		

Table 4

Paired Sample t-test for pre- and post-test performance within the PBL and non-PBL Groups

Group		N	Mean	Std. Dev.	Mean Changes	t Value	Pr > |t|
PBL Group	Pretest	206	10.22	4.30	4.38	15.19	<0.0001
	Post-test	206	14.60	3.66			
Non-PBL Group (Control Group)	Pretest	194	7.31	3.52	2.73	6.06	<0.0001
	Post-test	194	10.04	5.78			

Using the same matched pretest–post-test samples as in Table 4, we conducted an independent-samples t-test comparing change scores (post-test minus pretest) for the two groups (Table 5).

The results indicate a statistically significant difference in performance gains between the two instructional approaches, with students in PBL courses demonstrating larger improvements than students in non-PBL courses (Table 5). This finding provides evidence that the PBL approach was associated with greater learning gains over the semester, contributing to the evaluation of Hypothesis 9. A summary of hypothesis testing outcomes related to this analysis is provided in Appendix 2.

Table 5

Independent Sample t-test for Test Performance for PBL and non-PBL Groups

Approach	N	Mean	Std Dev	Std Error	T-test	P-value
Non-PBL	194	2.7286	6.2745	0.4505	-3.08	0.0022
PBL	206	4.3767	4.1364	0.2882		

To further examine between-group differences in post-test performance while accounting for baseline differences, a one-way analysis of covariance (ANCOVA) was conducted to compare the post-test performance of the two instructional groups, using the pretest score as a covariate. This analysis was conducted using the same matched pretest–post-test sample as in Tables 4 and 5. Instructional approach (PBL vs. non-PBL) was specified as the independent variable. After confirming the assumption of homogeneity of regression slopes ($F = 1.676$, $p = .196 > .05$), the ANCOVA was performed (Table 6).

The results indicate a statistically significant difference between the two instructional approaches, with students in PBL courses demonstrating significantly higher post-test scores than students in non-PBL courses after controlling for pretest performance. This analysis provides additional evidence that the PBL approach was associated with stronger learning outcomes, complementing the pre–post and gain-score analyses reported in Tables 4 and 5 and contributing to the evaluation of Hypothesis 9. A consolidated summary of hypothesis testing outcomes is provided in Appendix 2.

Table 6

ANCOVA Result of the Post-test Score (PBL vs. non-PBL)

Approach	F	Sig.	Partial Eta Squared
PBL vs. Non-PBL	79.760	0.000	0.167

To further understand why students enrolled in PBL instructional sections were more likely to recommend the course, we conducted a series of linear regression analyses examining which aspects of the student learning experience were associated with students' likelihood of recommending the course. These analyses were conducted using end-of-semester survey responses from students in the PBL instructional sections only (n = 234). Using the recommendation of the course as the dependent variable, we examined the relationships between perceived confidence in learning, career goals, job-search preparation, knowledge of analysis, involvement in class, and satisfaction with the course among students who experienced the PBL approach.

We estimated seven regression models, as reported in Table 7. Models 1 through 6 examine the bivariate relationships between each learning-related construct and course recommendation. When considered separately, each of these constructs shows a positive and statistically significant relationship with students' likelihood of recommending the course. Model 7 presents an integrated regression model that includes all learning-related predictors simultaneously, along with age, gender, prior experience, and first-generation status as control variables. In this full model, satisfaction with the course remains a strong and statistically significant predictor of course recommendation. In contrast, perceived confidence in learning does not retain a statistically significant relationship with recommendation, and career goals, while positively related, are also not statistically significant when controlling for other factors. These results suggest that while multiple aspects of the learning experience are individually associated with course recommendation, satisfaction with the course emerges as the most robust predictor when overlapping influences are considered.

Appendix 2 shows a summary of our hypothesis testing based on the data analysis presented above (in Tables 1 to 6).

Table 7

Linear Regression of Recommendation of the PBL Course

	Model 1			Model 2			Model 3		
Constructs	**B**	**S.E**	**t-value**	**B**	**S.E**	**t-value**	**B**	**S.E**	**t-value**
Career Goals	0.66	0.05	12.26						
Job-search Preparation				0.56	0.05	11.17			
Knowledge Analysis							0.81	0.06	13.59

	Model 4			Model 5			Model 6		
Constructs	**B**	**S.E**	**t-value**	**B**	**S.E**	**t-value**	**B**	**S.E**	**t-value**
Involvement in Class	0.49	0.05	10.88						
Perceived Confidence				0.65	0.06	10.19			
Satisfaction with Course							0.75	0.04	20.17

Model 7

Constructs	**B**	**Std. Error**	**t-value**	**Sig.**
(Constant)	0.471	0.273	1.725	0.086
Satisfaction with Course	0.506	0.048	10.432	0.000
Perceived Confidence	-0.065	0.066	-0.986	0.325
Career Goals	0.095	0.063	1.511	0.132
Job-search Preparation	0.155	0.051	3.045	0.003
Knowledge Analysis	0.184	0.076	2.426	0.016
Involvement in Class	0.084	0.041	2.079	0.039
Age	-0.004	0.006	-0.645	0.520
Gender	-0.043	0.060	-0.718	0.474
Experience	-0.006	0.006	-1.014	0.312
First Generation	0.067	0.059	1.120	0.264

Discussion

By anchoring project work within real-world contexts, this study offers a practical blueprint for curriculum and assessment design that prioritises student-centred learning. It also advances our understanding of how inclusive teaching strategies, such as PBL, can directly enhance the student experience by promoting a sense of belonging, confidence, and academic persistence among diverse student populations.

The study found that test performance was better for students who took PBL courses than for students who took non-PBL control courses. This finding aligns with those from previous research (Rehman et al., 2024) and warrants particular emphasis. The findings related to test performance are based on objective pretest–post-test assessments and are supported by three complementary analytic approaches: paired-sample comparisons, gain-score analysis, and ANCOVA controlling for baseline performance. Across all methods, students in PBL sections demonstrated significantly larger learning gains than students in non-PBL sections. Importantly, the ANCOVA results indicate a large effect size, suggesting that the instructional approach accounts for a meaningful proportion of variance in post-test performance beyond initial differences in prior knowledge.

This strengthens the argument that PBL is not only associated with enhanced satisfaction and confidence but also with measurable improvements in applied IS learning. This also highlights the importance of incorporating project-based structures to promote more substantial learning gains in the IS education context, where students must integrate technical, organisational, and analytical reasoning.

In contemporary learning environments being shaped by generative AI tools, which can readily produce isolated code fragments or formulaic solutions, instructional designs that require students to repeatedly design, refine, and integrate a complete information system artefact, such as the SBIS project implemented across three structured phases in this study, may be especially important.

Also, the findings suggest that perceived confidence in learning is higher among students who experience the PBL approach compared to those who experience a non-PBL approach. A PBL approach uses projects that imitate real-world projects, which may enhance the perceived confidence of the students in their ability to perform tasks in their prospective job, similar to previous studies (Garnjost & Lawter, 2019; Shin, 2018; Zhang & Ma, 2023). This study also found that satisfaction with the course is higher among students who experience the PBL approach compared to those who experience a non-PBL approach. Students consider the PBL project to be a visible manifestation of their achievement and are, therefore, satisfied with the final course project deliverables in the IS courses (Mutanga, 2024; Sánchez-García & Reyes-de-Cózar, 2025; Shin, 2018). Interpreted within contemporary higher-education scholarship on inclusive curriculum design, these findings suggest that PBL may function as a stabilising instructional structure that supports class involvement and confidence across diverse students.

The PBL approach was found to have no significant impact on class involvement compared to non-PBL courses, which is contrary to the findings from previous research (Guo et al., 2020; Zhang & Ma, 2023). Similarly, in contrast to findings from previous studies (Beckett, 2005; Sánchez-García & Reyes-de-Cózar, 2025), the PBL approach did not have a significant impact on knowledge of analysis compared to non-PBL courses. It is worth noting that the mean value for PBL approach courses was higher for all three constructs compared to non-PBL courses. While this finding contradicts our assumptions, upon further analysis, we found that our findings are not that uncommon. A recent study has reported similar findings, showing that while PBL is often associated with improvements in overall achievement, its effects on specific analytical or application-based knowledge outcomes are mixed and context dependent (Zhang & Ma, 2023). Some reviews further suggest that learners accustomed to traditional instructional approaches may initially perceive PBL as more demanding due to its cognitive load, ambiguity, and requirement for sustained self-directed effort, which can delay observable gains in analytical understanding (Balleisen et al., 2024; Guo et al., 2020; Sánchez-García & Reyes-de-Cózar, 2025). As such, students may not always see the immediate benefit of the project they are completing. Although there are no specific reasons to attribute the non-significant outcome of these hypotheses, it may be important for future researchers to review these constructs in more detail.

The PBL project also helped students develop career goals. The hands-on nature of the PBL project enables students to understand and practise the skills, knowledge, and abilities required in the job market (Meyer, 2015; Subhamol & Shobhana, 2025). Our study also found that the PBL approach did not have a significant impact on job-search preparation, knowledge of analysis, and class involvement as compared to non-PBL courses. Thus, our Hypotheses 4, 5, and 6 were not supported. One of the reasons the PBL approach was not significant to job-search preparation is likely because many students work on their resumes in their final semester before graduation. The PBL approach was used in an IS course that is at least one semester before graduation. Additionally, students have been taught in prior writing courses to use a shorter one-page resume format, which does not provide sufficient room for including course projects completed and skills learned during their coursework. Thus, students may not have included PBL project skills in their job search cover letter and resume. In addition, many students in the sample, including a substantial proportion of first-generation students, encountered the PBL experience at different points in their academic trajectories, which may shape when and how learning gains become visible. The PBL activity emphasised applied system development using Excel, macros, and VBA, which may require additional scaffolding or cumulative exposure across courses before measurable improvements in analytical reasoning and classroom involvement are observed.

Also, this study found that students using the PBL approach are more likely to recommend it to other students than those using a non-PBL approach. Students are challenged by projects that enable them to create artefacts that simulate real-life information systems software implementations, which in turn leads to an increase in engagement and positive reactions among students (Balleisen et al., 2024).

Prior research indicates that women and first-generation students are more likely to encounter educational contexts in which access to resources, opportunities, and experiences that foster a sense of belonging is unevenly distributed (Stebleton et al., 2014). Our study found no significant difference in learning levels between different genders and first-generation students. It is important to note that these findings should not be interpreted as reflecting deficits in ability, motivation, or preparedness among women or first-generation students. Rather, the findings suggest that when pedagogical structures are intentionally designed to emphasise authentic application, collaboration, and scaffolded learning, differences in outcomes associated with unequal prior exposure may be reduced. In this sense, PBL functions as an inclusive curriculum design rather than a remedial intervention. This supports our Hypotheses 8a and 8b, as recent longitudinal research emphasises the role of a sense of belonging in supporting persistence among diverse STEM students (Hansen et al., 2024). Viewed through this lens, the absence of statistically significant differences across gender and first-generation status in this study does not indicate equivalence or deficit; instead, it suggests that the project-based learning design may provide conditions that support inclusive engagement and confidence-building across diverse learning pathways.

This research has several practical and theoretical implications. This research would help IS departments, colleges, and faculty members to understand the benefits and impact of incorporating the PBL approach in their courses. This is especially important as the enrolment of students in the IS field has been declining. This study could help educators design IS course

assignments using a PBL approach to increase student engagement and thus, retention in IS programs. Additionally, this study may be useful to other STEM fields where students need to acquire quantitative skills. Several universities that serve diverse student groups in their programs may also use this study to understand if and how PBL could impact the learning and success of their students. This study may help universities design courses that incorporate the PBL approach to enhance student satisfaction, engagement, and retention, especially for gender and first-generation students. Although this study focuses on students at a public university in the United States, the findings resonate with international higher-education contexts in which student engagement, sense of belonging, and persistence are recognised as key equity outcomes. In this regard, project-based learning represents an instructional approach with relevance beyond a single national context.

From a theoretical perspective, this study expands the existing research of the PBL approach to the IS academic field. This is especially important, given the limited research on the IS classroom environment and pedagogical approaches.

Although data were collected just prior to the COVID-19 pandemic, the pedagogical mechanisms examined in this study, authentic assessment, collaborative problem-solving, and scaffolded learning, remain central to contemporary hybrid and digitally mediated higher-education contexts. For future research, we suggest collecting data from a larger sample size and employing a mixed-methods research approach, incorporating qualitative data collection. As part of future research, researchers could investigate other variables and constructs that were not covered in this study, which may be important for student satisfaction and retention in the IS major. Future research should expand this work by examining whether learning gains associated with PBL differ across different demographic groups, such as gender and first-generation status.

Conclusion

This study provides empirical evidence that a structured project-based learning (PBL) design can enhance measurable learning outcomes in undergraduate Information Systems education. Students in PBL sections demonstrated significantly greater performance gains than students in non-PBL sections, even after controlling for baseline differences. These objective improvements, alongside higher levels of satisfaction and confidence, indicate that PBL strengthens both the cognitive and experiential dimensions of IS learning. Importantly, the absence of significant differences across gender and first-generation status suggests that the PBL structure functioned as an inclusive curriculum design, supporting learning growth across diverse student pathways. In an educational environment increasingly shaped by generative AI tools, instructional approaches that require integrative system development and applied reasoning may be especially important for developing durable competence in IS programs.

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References

Almulla, M. A. (2020). The effectiveness of the project-based learning (PBL) approach as a way to engage students in learning. *Sage Open*, *10*(3), 2158244020938702. https://doi.org/10.1177/215824402093

Balleisen, E. J., Howes, L., & Wibbels, E. (2024). The impact of applied project-based learning on undergraduate student development. *Higher Education, 87*(4), 1141–1156. https://doi.org/10.1007/s10734-023-01057-1

Baran, M., & Maskan, A. (2010). The effect of project-based learning on pre-service physics teachers' electrostatic achievements. *Cypriot Journal of Educational Sciences, 5*(4), 243–257.

Beckett, G. H. (2005). Academic language and literacy socialization through project-based instruction: ESL student perspectives and issues. *Journal of Asian Pacific Communication, 15*(1), 191–206. https://doi.org/10.1075/japc.15.1.12bec

Bell, S. (2010). Project-based learning for the 21st century: Skills for the future. *The Clearing House, 83*(2), 39–43. https://doi.org/10.1080/00098650903505415

Bolton, P., & Lewis, J. (2025). *Equality of access and outcomes in higher education in England* (Commons Library Research Briefing No. 9195). House of Commons Library. https://commonslibrary.parliament.uk/research-briefings/cbp-9195/

Børte, K., Nesje, K., & Lillejord, S. (2023). Barriers to student active learning in higher education. *Teaching in Higher Education*, *28*(3), 597-615. https://doi.org/10.1080/13562517.2020.1839746

Brown, C. M. (2018). *The underprepared and underrepresented: Perceptions and experiences of self-efficacy on college persistence among low-income African American first-generation college students* [Doctoral dissertation, Governors State University]. OPUS Open Portal to University Scholarship. https://opus.govst.edu/capstones/359/

Bryan, E., & Simmons, L. A. (2009). Family involvement: Impacts on post-secondary educational success for first-generation Appalachian college students. *Journal of College Student Development, 50*(4), 391–406. https://doi.org/10.1353/csd.0.0081

Capraro, R. M., & Slough, S. W. (2008). Why PBL? Why STEM? Why now? In R. M. Capraro & S. W. Slough (Eds.), *Project-based learning: An integrated science, technology, engineering, and mathematics (STEM) approach* (pp. 1–6). Sense Publishers. https://doi.org/10.1007/978-94-6209-143-6_1

Cervantes, B., Hemmer, L., & Kouzekanani, K. (2015). The impact of project-based learning on minority student achievement: Implications for school redesign. *Education Leadership Review of Doctoral Research, 2*(2), 50–66.

Clark, A. C., & Ernst, J. V. (2007). A model for the integration of science, technology, engineering and mathematics. *The Technology Teacher, 66*(4), 24–26.

de Freitas, S., Curtis, G. J., & Ritchie, S. M. (2025). A multi-layered evaluation of university-wide education interventions to improve student engagement and retention. *Journal of Further and Higher Education*, *49*(10), 1348-1362. https://doi.org/10.1080/0309877X.2025.2560999

DeClou, L. (2016). Who stays and for how long: Examining attrition in Canadian graduate programs. *Canadian Journal of Higher Education, 46*(4), 174–198. https://doi.org/10.47678/cjhe.v46i4.185181

Dewey, J. (1900). *The School and Society*. University of Chicago Press.

Dolmans, D. H. J. M., De Grave, W., Wolfhagen, I. H. A. P., & van der Vleuten, C. P. M. (2005). Problem-based learning: Future challenges for educational practice and research. *Medical Education, 39*(7), 732–741. https://doi.org/10.1111/j.1365-2929.2005.02205.x

Eather, N., Mavilidi, M. F., Sharp, H., & Parkes, R. (2022). Programmes targeting student retention/success and satisfaction/experience in higher education: A systematic review. *Journal of Higher Education Policy and Management, 44*(3), 223–239. https://doi.org/10.1080/1360080X.2021.2021600

Elliott, K. M., & Healy, M. A. (2001). Key factors influencing student satisfaction related to recruitment and retention. *Journal of Marketing for Higher Education, 10*(4), 1–11. https://doi.org/10.1300/J050v10n04_01

Elmore, R., & City, E. (2011). Using technology to move beyond schools. *Education Week, 30*(31), 24–26.

Fry, R., Kennedy, B., & Funk, C. (2021, April 1). *STEM jobs see uneven progress in increasing gender, racial and ethnic diversity*. Pew Research Center. https://www.pewresearch.org/social-trends/2021/04/01/stem-jobs-see-uneven-progress-in-increasing-gender-racial-and-ethnic-diversity/

Garnjost, P., & Lawter, L. (2019). Undergraduates' satisfaction and perceptions of learning outcomes across teacher- and learner-focused pedagogies. *The International Journal of Management Education, 17*(2), 267–275. https://doi.org/10.1016/j.ijme.2019.03.004

Guo, P., Saab, N., Post, L. S., & Admiraal, W. (2020). A review of project-based learning in higher education: Student outcomes and measures. *International Journal of Educational Research, 102*, 101586. https://doi.org/10.1016/j.ijer.2020.101586

Han, S., Capraro, R., & Capraro, M. M. (2015). How STEM project-based learning affects high, middle, and low achievers differently. *International Journal of Science and Mathematics Education, 13*(5), 1089–1113. https://doi.org/10.1007/s10763-014-9526-0

Hansen, M. J., Palakal, M. J., & White, L. (2024). The importance of STEM sense of belonging and academic hope in enhancing persistence for low-income, underrepresented STEM students. *Journal for STEM Education Research, 7*, 155–180. https://doi.org/10.1007/s41979-023-00096-8

Hanover Research. (2025). *2025 trends in higher education*. https://www.hanoverresearch.com/reports-and-briefs/higher-education/2025-trends-in-higher-education/

Higher Education Statistics Agency. (2024). *Higher education student statistics: UK, 2022/23*. https://www.hesa.ac.uk/data-and-analysis/students

Holmes, V. L., & Hwang, Y. (2016). Exploring the effects of project-based learning in secondary mathematics education. *The Journal of Educational Research, 109*(5), 449–463. https://doi.org/10.1080/00220671.2014.979911

Huang, H., & Qi, D. (2025). Is MOOC really effective? Exploring the outcomes of MOOC adoption in higher education. *PLOS ONE, 20*(2), e0317701. https://doi.org/10.1371/journal.pone.0317701

Iorio, M. F. (2019). *Perceived gains in cognitive skills among first-generation college students: Differences by race* (Doctoral dissertation, Azusa Pacific University).

Jaiswal, A., Magana, A. J., & Ward, M. D. (2022). Characterizing identity formation and sense of belonging in a data science learning community. *Education Sciences, 12*(10), 731. https://doi.org/10.3390/educsci12100731

James, C. E., & Taylor, L. E. (2022). *First-generation student experiences in higher education: Counterstories*. Routledge. https://doi.org/10.4324/9781003090281

Jones, B. D., Tendhar, C., & Paretti, M. C. (2016). The effects of students' course perceptions on domain identification and motivational beliefs. *Journal of Career Development, 43*(5), 383–397. https://doi.org/10.1177/0894845315603821

Joo, Y. J., So, H. J., & Kim, N. H. (2018). Examination of relationships among students' self-determination, technology acceptance, and satisfaction. *Computers & Education, 122*, 260–272. https://doi.org/10.1016/j.compedu.2018.01.003

Kaldi, S., Filippatou, D., & Govaris, C. (2011). Project-based learning in primary schools. *Education 3–13, 39*(1), 35–47. https://doi.org/10.1080/03004270903179538

Kenney, T., & O'Halloran, K. C. (2024). The impact of student satisfaction and sense of belonging on academic success. *Journal of Interdisciplinary Studies in Education, 14*(2), 90–114. https://doi.org/10.32674/v7gyzx59

Kilpatrick, W. H. (1918). The project method. *Teachers College Record, 19*, 319–335.

Krajcik, J. S., Blumenfeld, P. C., Marx, R. W., & Soloway, E. (1994). A collaborative model for helping middle-grade science teachers learn project-based instruction. *The Elementary School Journal, 94*(5), 483–497. https://doi.org/10.1086/461779

LaForce, M., Noble, E., & Blackwell, C. (2017). Problem-based learning and student interest in STEM careers. *Education Sciences, 7*(4), 92. https://doi.org/10.3390/educsci7040092

Lawler, J., Joseph, A., & Greene, M. (2018). Diversity in information systems: Increasing Opportunities in STEM for Capable Students with Developmental and Intellectual Disabilities *Information Systems Education Journal, 16*(4), 13-26.

Levitz, R. N. (2025). *2025 national college student satisfaction and priorities report*. https://www.ruffalonl.com/papers-research-higher-education-fundraising/national-student-satisfaction-and-priorities-report/

Martinez-Rodrigo, F., Herrero-De Lucas, L. C., De Pablo, S., & Rey-Boue, A. B. (2017). Using PBL to improve educational outcomes. *IEEE Transactions on Education, 60*(3), 229–237. https://doi.org/10.1109/TE.2016.2633959

Meyer, K. A. (2015). *Students' perceptions of life skill development in project-based learning schools* (Publication No. 3745394) [Doctoral dissertation, Minnesota State University, Mankato]. ProQuest Dissertations & Theses Global.

Mutanga, B. M. (2024). Students' perspectives and experiences in project-based learning. *Trends in Higher Education, 3*(4), 903–911. https://doi.org/10.3390/higheredu3040052

National Student Clearinghouse Research Center. (2025, June 26). *Persistence and retention report: Fall 2023 beginning postsecondary student cohort*. https://nscresearchcenter.org/persistence-retention/

Pedler, M. L., Willis, R., & Nieuwoudt, J. E. (2022). A sense of belonging at university. *Journal of Further and Higher Education, 46*(3), 397–408. https://doi.org/10.1080/0309877X.2021.1955844

Rehman, N., Huang, X., Batool, S., Andleeb, I., & Mahmood, A. (2024). Assessing the effectiveness of project-based learning. *ASR: Chiang Mai University Journal of Social Sciences and Humanities, 11*(2), e2024015. https://doi.org/10.12982/CMUJASR.2024.015

Rinaldo, S. B., Laverie, D. A., Tapp, S., & Humphrey, W. F., Jr. (2013). The benefits of social media in marketing education. *Journal for Advancement of Marketing Education, 21*(1), 16–26.

Robinson, M., Tomaszewski, W., Johnstone, M., Clague, D., Zając, T., Povey, J., & Salom, C. (2025). The Student Equity in Higher Education Evaluation Framework. *Journal of Higher Education Policy and Management, 47*(3), 416–425. https://doi.org/10.1080/1360080X.2025.2461802

Sánchez-García, R., & Reyes-de-Cózar, S. (2025). Enhancing project-based learning. *Sustainability, 17*(11), 4978. https://doi.org/10.3390/su17114978

Sarnou, H., & Schug, D. (2025). Exploring the challenges and benefits of MOOCs as an innovative pedagogical model in higher education. *SAR Journal, 8*(2), 115–123. https://doi.org/10.18421/SAR82-01

Sax, L. J., Blaney, J. M., Lehman, K. J., Rodriguez, S. L., George, K. L., & Zavala, C. (2018). Sense of belonging in computing. *Social Sciences, 7*(8), 122. https://doi.org/10.3390/socsci7080122

Sharma, K., & Giannakos, M. (2025). Carry-forward effect. *Behaviour & Information Technology, 44*(11), 2760–2799. https://doi.org/10.1080/0144929X.2024.2411592

Shin, M. H. (2018). Effects of project-based learning on motivation and self-efficacy. *English Teaching, 73*(1), 95–114. https://doi.org/10.15858/engtea.73.1.201803.95

Stebleton, M. J., Soria, K. M., & Huesman, R. L., Jr. (2014). First-generation students' sense of belonging. *Journal of College Counseling, 17*(1), 6–20. https://doi.org/10.1002/j.2161-1882.2014.00044.x

Subhamol, V. R., & Shobhana, S. (2025). Long-term outcomes of project-based learning. *International Journal of Education and Pedagogy, 1*(2). https://eduresearchjournal.com/index.php/ijep/article/view/137

Tabatabaei, M., & Tehrani, M. (2010). Factors impacting enrollment in information systems programs. *Issues in Information Systems, 11*(1), 319–321. http://www.iacis.org/iis/iis_articles.php?volume=11&issue=1

Thomas, J. W. (2000). *A review of research on project-based learning* (pp. 1–48). https://tecfa.unige.ch/proj/eteach-net/Thomas_researchreview_PBL.pdf

Tierney, G., Urban, R., Olabuenaga, G., & Paulger, C. (2022). Designing Project-Based Learning Curricula: Leveraging Curriculum Development for Deeper and More Equitable Learning. Rigorous Project-Based Learning: An Inquiry-Based Educational Approach. Lucas Education Research, George Lucas Educational Foundation. Available at https://eric.ed.gov/?id=ED658325

Tight, M. (2020). Student retention and engagement in higher education. *Journal of Further and Higher Education, 44*(5), 689–704. https://doi.org/10.1080/0309877X.2019.1576860

Tims, J. L., Tucker, C., Weiss, M. A., & Zweben, S. (2023). Computing enrollment and retention. *ACM Inroads, 14*(4), 24–43. https://doi.org/10.1145/3629980

Wong, Z. (2015). Student attitudes toward information systems management. *International Journal of Information and Education Technology, 5*(6), 409–413. https://doi.org/10.7763/IJIET.2015.V5.540

Zaragoza, D. (2018). *First-generation students' satisfaction with the CSUMB academic advising program* [Master's thesis, California State University, Monterey Bay]. CSUMB Digital Commons. https://digitalcommons.csumb.edu/caps_thes_all/424/

Zhang, L., & Ma, Y. (2023). A study of the impact of project-based learning. *Frontiers in Psychology, 14*, 1202728. https://doi.org/10.3389/fpsyg.2023.1202728

Zweben, S., & Tucker, C. (2022). How well did we keep students in computing programs. *ACM Inroads, 13*(4), 32–52. https://doi.org/10.1145/3571094

Appendices

Appendix 1. Demographic Variables

Categories	Control Group	Experimental Group
Age	24.17 years	24.02 years
Gender:		
Female	115	110
Male	119	124
First Generation	51.14%	52.99%
Race/Ethnicity		
Hispanic	28.20%	44.44%
Caucasian (white non-Hispanic)	30.76%	26.92%
Asian/Pacific Islander	22.22%	12.39%

Appendix 2. Summary of hypothesis testing results

Hypotheses	t-Score	Significance	Supported?
H1: PC: PBL vs. No PBL (+)	-2.953	0.003	Supported
H2: SAT: PBL vs. No PBL (+)	-2.105	0.036	Supported
H3: CG: PBL vs. No PBL (+)	-2.573	0.010	Supported
H4: JSP: PBL vs. No PBL (+)	-0.760	0.447	Not Supported
H5: KA: PBL vs. No PBL (+)	-1.081	0.280	Not Supported
H6: INV: PBL vs. No PBL (+)	-1.317	0.189	Not Supported
H7: REC: PBL vs. No PBL (+)	-4.414	0.000	Supported
H8a: PBL: Male vs. Female (+ -)	See Table 2	See Table 2	Supported
H8b: PBL: First Generation vs. Others (+ -)	See Table 3	See Table 3	Supported
H9: Posttest scores: PBL vs. No PBL (+)	-3.08	0.0022	Supported

Note: Perceived Confidence (PC); Career goals (CG); Job-search preparation (JSP); Knowledge competency (KA); Involvement (INV); Satisfaction (SAT); Students Recommendation (REC)

Appendix 3: Research Constructs and Sources

Constructs	Adapted Items	Source
Perceived Confidence (PC)	Completing the project has made me confident about analysing the information needs of small businesses. Completing the project, I am capable of designing an information system for small businesses. After the project, I feel I am able to analyse the data needs of small business organizations. I feel I can meet the challenges to analyse the information systems needs of small business organisations.	Rinaldo et al., (2013)
Career goals (CG)	Overall, the project has helped me develop my career skills. The project serves as a good surrogate for real-world experience.	Rinaldo et al., (2013); Jones et al., (2016)
Job-search preparation (JSP)	I plan to include the skills and knowledge gained from the class project on my resume I plan to discuss the skills and knowledge gained from the class project during job interviews I think knowledge about designing an information system would help me in my job search. I think knowing how to analyse data and create information systems will be something I will need to know when I have a job. I think the project has prepared me well for my job. I think the project will help me get a job.	Rinaldo et al., (2013); Jones et al., (2016)
Knowledge Analysis	The knowledge I gained from completing the project helps me understand Technology, People, and Organizational perspectives of Information Systems. The knowledge I gained from completing the project helps me assess ethical aspects of data and technology. The knowledge I gained from completing the project helps me analyse a business issue using the information systems approach. The knowledge I gained from completing the project does not help me design an information system for small businesses. The knowledge I gained from completing the project allows me to use advanced Excel functions such as Macros, VBA, database, and IF functions to solve business problems. The knowledge I gained from completing the project increased my ability to think critically.	Jones et al., (2016)
Involvement (INV)	Completing the project increased my involvement with the course. I am more involved with the course because of this SBIS project.	Jones et al., (2016)
Satisfaction (SA)	Completing the project contributed to my overall satisfaction with the course. Because of the project, I am satisfied with my experience with the class	Rinaldo et al., (2013); Jones et al., (2016)

	Because of the project, I am very pleased with the class Because of the project, I am very content with the class.	
Students recommendation (REC)	I think the integration of the project into the course material made this class valuable. I would recommend the instructor use similar project again in the course next semester. I believe the use of the project enhanced understanding of the course I would rate the use of the project highly. I am able to understand the material better because of the project.	Rinaldo et al., (2013); Jones et al., (2016)