Testing the Synergistic Mechanism of Project-Based Learning and Credit Bank Systems:A SmartPLS-Based Empirical Study of Industry-Education Integration in Applied Animation and Game Programs

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Abstract:Project-based learning has become a common instructional arrangement in applied animation and game programs, yet its educational value often depends on whether project outputs can be translated into recognizable and transferable learning records. Using questionnaire data from 203 students, this study examines how project-based learning quality and credit bank integration are connected with industry-education integration outcomes through digital platform capability. The model is estimated with SmartPLS. The results show that stronger project design is associated with higher digital platform capability (β = 0.518, 95% CI [0.397, 0.645]), and the same pattern appears for credit bank integration (β = 0.411, 95% CI [0.270, 0.539]). Digital platform capability is, in turn, positively related to industry-education integration outcomes (β = 0.411, 95% CI [0.276, 0.545]). Both indirect effects are supported. The interaction between digital platform capability and industry participation is negative (β = −0.193, 95% CI [−0.317, −0.070]), suggesting that intensive enterprise involvement can absorb part of the coordinating function usually provided by the platform. The findings indicate that project pedagogy becomes more institutionally effective when learning evidence can be captured, endorsed, and converted across school-enterprise settings. The study contributes empirical evidence to current discussions on credit recognition, platform governance, and the organization of applied talent cultivation.

Keywords: Project-Based Learning; Credit Bank; Digital Platform Capability; Industry Participation; Industry-Education Integration; PLS-SEM

1. Introduction

In applied animation and game education, student competence is rarely formed through isolated classroom instruction alone. It is developed in extended production processes that involve concept design, digital asset creation, engine-based implementation, team coordination, iterative revision, and public presentation of outcomes. For that reason, project-based learning has become a central instructional arrangement in many applied programs. Its value lies not only in improving classroom engagement, but also in bringing students closer to the collaborative logic of professional production.

Even so, the practical effectiveness of project-based learning is not guaranteed by project activity itself. In many institutions, evidence of learning remains scattered across portfolios, internship tasks, competition works, course submissions, and team deliverables. Once these materials are fragmented, they are difficult to standardize, difficult to compare, and even harder to convert into stable credit recognition. A related problem appears in school-enterprise collaboration. Some partnerships rely heavily on a small number of teachers or enterprise contacts, which makes the mechanism difficult to sustain beyond specific projects or individuals. Under such conditions, credit bank arrangements and digital platforms become important because they can connect project evidence, recognition rules, and institutional transfer.

2. Theoretical Framework and Hypotheses

2.1 Quality of Project-Based Learning and Digital Platform Capability

High-quality PBL emphasizes authentic tasks, process feedback, teamwork, and iterative production. In industry-education integration settings, such design does not simply improve classroom engagement; it also generates traceable learning evidence. Once project activities are documented in a structured way, they become easier for a digital platform to capture, classify, circulate, and analyze. Better PBL design should therefore strengthen the institutional conditions under which platform capability develops. Accordingly, H1 is proposed.

H1. Project-based learning quality (PBLQ) positively affects digital platform capability (DPC).

2.2 Credit Bank Integration and Digital Platform Capability

Credit bank integration concerns the standardization, recognition, and conversion of learning outcomes. These arrangements require technical support for evidence collection, identity and permission management, evaluation procedures, multi-party endorsement, and data interoperability. As a result, the deeper the integration of credit bank rules into teaching and assessment, the stronger the demand for a capable digital platform. The institutionalization of credit transfer is therefore expected to reinforce DPC.

H2. Credit bank integration (CBI) positively affects digital platform capability (DPC).

2.3 Digital Platform Capability and Industry-Education Integration Outcomes

Digital platform capability can improve cross-actor coordination, reduce the transaction costs of evidence governance, and increase the consistency and traceability of evaluation. In applied programs, those functions are closely related to educational outcomes such as competence development, project performance, and readiness for employment. A platform that effectively connects teachers, students, and enterprise partners should therefore contribute to better industry-education integration outcomes.

H3. Digital platform capability (DPC) positively affects industry-education integration outcomes (IEIO).

2.4 Mediation and Boundary Conditions

From a mechanism perspective, the effects of PBLQ and CBI are unlikely to be converted into learning outcomes automatically. Their influence is more plausibly realized through an operational translation layer in which evidence is captured, recognized, and circulated. DPC represents that layer. If so, DPC should mediate the relationship between PBLQ and IEIO, as well as the relationship between CBI and IEIO.

The role of industry participation is more complex. A common assumption is that stronger enterprise involvement complements platform resources. Under conditions of intense industry participation, however, enterprise mentors and direct project governance may perform some of the coordinating work that a platform would otherwise provide. This raises the possibility of a substitution effect rather than a purely complementary one.

H4. DPC mediates the relationship between PBLQ and IEIO.

H5. DPC mediates the relationship between CBI and IEIO.

H6. Industry participation (IP) moderates the effect of DPC on IEIO through the interaction term DPC × IP.

3. Research Design

3.1 Sample and Data Source

The data were collected through a questionnaire survey administered to students in applied animation and game programs. After screening, 203 valid responses were retained. The questionnaire included an attention-check item, and all retained cases passed that test. Table 1 reports the sample profile.

Table 1. Sample Profile (N = 203)

Variable	Category	n	%
Year of study	Year 1	25	12.32
Year of study	Year 2	45	22.17
Year of study	Year 3	23	11.33
Year of study	Year 4	91	44.83
Year of study	Graduate	19	9.36
Gender	Male	105	51.72
Gender	Female	98	48.28
Internship frequency	0	94	46.31
Internship frequency	1	33	16.26
Internship frequency	2+	76	37.44
Weekly study hours	0-5	25	12.32
Weekly study hours	6-10	34	16.75
Weekly study hours	11-15	83	40.89
Weekly study hours	16-20	34	16.75
Weekly study hours	20+	27	13.30

3.2 Measures

All constructs were measured with five-point Likert scales ranging from 1 (strongly disagree) to 5 (strongly agree). PBLQ was measured with six items, CBI with five items, DPC with five items, IP with four items, and IEIO with five items.

3.3 Analytical Strategy

The empirical analysis follows the logic of PLS-SEM [3]. The measurement model was evaluated through indicator loadings, Cronbach's alpha, composite reliability (CR), and average variance extracted (AVE). Discriminant validity was examined using the square roots of AVE in line with established practice [4]. The structural model was then estimated with bootstrapped confidence intervals, explained variance (R^2), predictive relevance (Q^2), and effect sizes (f^2).

4. Results

4.1 Descriptive Statistics, Correlations, and Measurement Quality

Table 2 presents the correlation matrix, the square roots of AVE on the diagonal, and the means and standard deviations of the main constructs. Table 3 reports the reliability and convergent validity of the measurement model. All constructs satisfy the commonly used thresholds for internal consistency and convergent validity.

Table 2. Correlations, Square Roots of AVE, and Descriptive Statistics

	PBLQ	CBI	DPC	IP	IEIO	Mean	SD
PBLQ	0.80					3.25	1.10
CBI	0.89	0.81				3.31	1.11
DPC	0.88	0.87	0.80			3.26	1.11
IP	0.86	0.84	0.87	0.85		3.25	1.16
IEIO	0.88	0.86	0.89	0.86	0.80	3.27	1.07

Note: Lower-triangular cells report Pearson correlations; diagonal cells report the square root of AVE.

Table 3. Reliability and Convergent Validity

Construct	Items	Loading range	Cronbach's α	CR	AVE	Mean ± SD
PBLQ	6	0.775-0.826	0.891	0.917	0.647	3.25 ± 1.10
CBI	5	0.787-0.858	0.872	0.907	0.662	3.31 ± 1.11
DPC	5	0.762-0.823	0.857	0.898	0.637	3.26 ± 1.11
IP	4	0.823-0.871	0.870	0.911	0.720	3.25 ± 1.16
IEIO	5	0.728-0.850	0.860	0.900	0.642	3.27 ± 1.07

4.2 Structural Model and Hypothesis Testing

The structural model shows substantial explanatory power for both DPC and IEIO ($R^2\_DPC = 0.815$, $R^2\_IEIO = 0.837$), together with strong predictive relevance ($Q^2\_DPC \approx 0.808$, $Q^2\_IEIO \approx 0.832$). Table 4 reports the main path coefficients, bootstrapped confidence intervals, and effect sizes. All three direct hypotheses are supported.

Table 4. Structural Paths and Hypothesis Testing

Hypothesis	Path	β	95% CI	f²	Conclusion
H1	PBLQ → DPC	0.518	[0.397, 0.645]	1.605	Supported
H2	CBI → DPC	0.411	[0.270, 0.539]	1.009	Supported
H3	DPC → IEIO	0.411	[0.276, 0.545]	0.704	Supported

4.3 Mediation, moderation, and robustness

The mediation analysis indicates that DPC partially transmits the effects of both PBLQ and CBI to IEIO. The moderation analysis further shows that the interaction term DPC × IP is significantly negative ($\beta = -0.193$, 95% CI [-0.317, -0.070]), which points to a substitution boundary condition rather than a purely complementary relationship. To examine robustness, a second-order synergy model was also estimated by aggregating PBLQ, CBI, DPC, and IP into an IEI synergy construct. The second-order model strongly predicts IEIO ($R^2 = 0.845$, $Q^2 \approx 0.843$), which supports the stability of the findings.

Table 5. Indirect Effects

Hypothesis	Indirect path	Indirect effect(β estimate)	Conclusion
H4	PBLQ → DPC → IEIO	0.213	Supported (partial mediation)
H5	CBI → DPC → IEIO	0.169	Supported (partial mediation)

5. Conclusion and Discussion

The results suggest that the contribution of project-based learning to industry-education integration should not be understood as a direct or automatic effect. Project arrangements create opportunities for authentic learning, yet their institutional value depends on whether project traces can be recorded, interpreted, and circulated in a form that different actors are able to recognize. In the present study, digital platform capability occupies this translational position. It connects project activity with credit recognition and turns dispersed learning evidence into a more stable governance resource. This point also helps explain why credit bank integration matters. Credit rules are not effective simply because they exist at the policy level. Their practical force emerges when standards of evidence, review procedures, endorsement mechanisms, and transfer pathways are embedded in an operational system. The negative interaction between digital platform capability and industry participation adds another layer to this interpretation. Stronger enterprise involvement does not always amplify the effect of the platform. In some cases, direct supervision from enterprise mentors can take over part of the coordination work that would otherwise be handled by the platform. What emerges, therefore, is not a single optimal path, but a set of institutional combinations through which applied programs may reach similar integration outcomes.

The negative moderation effect also deserves attention. A high level of industry participation does not simply reinforce the value of platform capability. In settings where enterprise mentors are deeply involved, some coordinating functions can be performed directly through project supervision and workplace governance. The marginal contribution of the platform is therefore reduced. This does not diminish the importance of enterprise engagement; rather, it clarifies that universities may reach effective collaboration through different institutional combinations. In some contexts, platform infrastructure compensates for weak external participation. In others, strong industry involvement can offset part of the coordination burden that would otherwise fall on the platform.

Several practical implications follow. Universities need common standards for project evidence so that portfolios, internship outputs, competition achievements, and course products can be interpreted within a shared recognition framework. Credit bank reform should be linked to clear review procedures and conversion rules rather than handled as a separate administrative device. Platform investment should focus on evidence capture, evaluation circulation, multi-party endorsement, and data interoperability, because those functions help school-enterprise cooperation move from one-off project collaboration to more durable mechanism-based collaboration.

6. Limitations and Future Research

The study relies on cross-sectional self-reported data, so causal inference remains limited and common method concerns cannot be fully ruled out [5], [6]. Future research may combine longitudinal designs, multi-source evaluation, and more objective indicators, such as portfolio ratings, internship offers, or credit transfer records. Further refinement of the measurement model would also help strengthen discriminant validity and extend the analysis to other applied disciplines.

References

[1]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.

[2]Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. American Psychologist, 55(1), 68-78.

[3]Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2017). A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM) (2nd ed.). Thousand Oaks, CA: Sage.

[4]Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. Journal of the Academy of Marketing Science, 43(1), 115-135.

[5]Podsakoff, P. M., MacKenzie, S. B., Lee, J.-Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. Journal of Applied Psychology, 88(5), 879-903.

[6]Kock, N. (2015). Common method bias in PLS-SEM: A full collinearity assessment approach. International Journal of e-Collaboration, 11(4), 1-10.

[7]The General Office of the State Council of the People's Republic of China. (2017, December 19). Several opinions on deepening industry-education integration.

[8]The General Office of the State Council of the People's Republic of China. (2021, October 12). Opinions on promoting the high-quality development of modern vocational education.

[9]Ministry of Education of the People's Republic of China. (2023, September 14). Notice on key tasks for building a learning society.

[10]National Development and Reform Commission et al. (2023, June 13). Implementation plan for empowering and upgrading industry-education integration in vocational education (2023-2025).

