

DEVELOPING A NEW HYBRID PEDAGOGY: A CASE STUDY OF PROJECT-BASED LEARNING INTEGRATING COMMUNITY ENGAGEMENT AND DIGITAL COLLABORATION

Sofia Pereira¹, Carlos Lopes², and Marta Carvalho³

¹ Polytechnic Institute of Porto, Portugal

² University of Beira Interior, Portugal

³ University of Madeira, Portugal

Corresponding Author:

Sofia Pereira,

Department of Accounting, Faculty of Porto Accounting and Business School, Polytechnic Institute of Porto.

R. Dr. Roberto Frias 712, 4200-465 Porto, Portugal

Email: sofia pereira@gmail.com

Article Info

Received: April 6, 2025

Revised: June 8, 2025

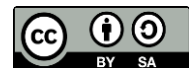
Accepted: September 11, 2025

Online Version: October 18, 2025

Abstract

The rapid evolution of hybrid learning environments has encouraged educators to explore pedagogical models that bridge academic theory, community engagement, and digital collaboration. Conventional hybrid learning, while flexible, often lacks experiential relevance and authentic social application. This study seeks to develop and evaluate a new hybrid pedagogy that integrates Project-Based Learning (PBL) with community engagement and digital collaboration to foster deeper learning, civic responsibility, and digital literacy among university students. The research aims to identify how this integrated model enhances student motivation, critical thinking, and collaborative problem-solving within real-world contexts. A qualitative case study design was employed involving 42 undergraduate students enrolled in an education program at a public university. The implementation spanned one academic semester, during which students collaborated with local community partners through hybrid PBL projects supported by digital platforms such as Padlet, Google Workspace, and Zoom. Data were collected through reflective journals, interviews, project assessments, and observation notes, then analyzed thematically to uncover learning patterns and pedagogical impacts. The findings reveal that the hybrid PBL model significantly improved students' engagement, teamwork, and contextual understanding, while strengthening their ability to integrate digital tools for collaborative inquiry. Participants reported increased confidence in applying theoretical knowledge to community-based challenges. The study concludes that the integration of community engagement and digital collaboration within PBL provides a sustainable hybrid pedagogy for higher education. This model promotes authentic, transformative, and socially responsible learning experiences that align with 21st-century educational goals.

Keywords: Community Engagement, Digital Collaboration, Higher Education, Hybrid Pedagogy, Project-Based Learning.



© 2025 by the author(s)

This article is an open-access article distributed under the terms and conditions of the Creative Commons Attribution-ShareAlike 4.0 International (CC BY SA) license (<https://creativecommons.org/licenses/by-sa/4.0/>).

Journal Homepage

<https://research.adra.ac.id/index.php/jnhl>

ISSN: (P: 2987-2316) - (E: 2986-979X)

How to cite:

Pereira, S., Lopes, C., & Carvalho, M. (2025). Developing A New Hybrid Pedagogy: A Case Study of Project-Based Learning Integrating Community Engagement and Digital Collaboration. *Journal Neosantara Hybrid Learning*, 3(5), 285–296.. <https://doi.org/10.70177/jnhl.v3i5.3352>

Published by:

Yayasan Adra Karima Hubbi

INTRODUCTION

Hybrid learning has emerged as a dominant model in higher education, combining face-to-face interaction with online collaboration to maximize flexibility and engagement (Pwanedo Amos et al., 2025). In recent years, the model has proven effective in sustaining learning continuity during times of disruption while expanding access to diverse learning resources. Research by (Liu et al., 2024) emphasizes that hybrid learning fosters deeper cognitive engagement through the integration of digital tools and reflective interaction, positioning it as a key pedagogical evolution in the 21st century.

Project-Based Learning (PBL) has long been recognized as a learner-centered approach that emphasizes authentic problem-solving and collaboration. Studies by (Gao et al., 2025) and (Nikolaou et al., 2025) demonstrate that PBL enhances critical thinking, creativity, and real-world application of knowledge. It encourages learners to construct meaning through inquiry and reflection, aligning with constructivist theories of learning (Zeng et al., 2025). The combination of PBL and hybrid modalities offers a powerful framework to bridge theory and practice, particularly in higher education contexts where experiential learning is essential.

Digital collaboration tools have become integral to hybrid learning ecosystems. Platforms such as Google Workspace, Padlet, and Microsoft Teams have transformed how students engage, share, and co-create knowledge across physical and virtual spaces (Innangi et al., 2025). These tools enable asynchronous participation, foster peer learning, and democratize access to information. According to, digital collaboration enhances learner autonomy while maintaining social presence two essential components of effective hybrid education.

Community engagement represents another crucial dimension of transformative pedagogy (He et al., 2025). It situates learning within authentic social contexts, allowing students to apply academic insights to societal challenges. Service-learning models and community-based projects have shown strong correlations with civic responsibility and empathy development (Xi et al., 2025). In the hybrid era, integrating community engagement into academic curricula can strengthen the relevance and ethical grounding of higher education.

Despite these advancements, the intersection of hybrid learning, project-based pedagogy, and community engagement remains underexplored (X. Wang et al., 2025). While digital tools have expanded possibilities for collaboration, their integration with community-based projects poses new pedagogical questions about balance, authenticity, and accessibility (Yin et al., 2025). There is a growing recognition that effective hybrid learning must extend beyond digital competence toward fostering civic and social consciousness in learners.

Higher education institutions are increasingly tasked with developing students who are not only digitally skilled but also socially responsive (Sadana et al., 2025). The integration of community engagement into hybrid PBL frameworks may serve as a pathway to cultivate these dual competencies (Fernandez-Rojas et al., 2025). Understanding how this integration unfolds in practice, and what impact it produces on students' motivation, collaboration, and social learning outcomes, has become a critical inquiry for educational researchers and practitioners.

There remains limited empirical evidence on how hybrid learning environments can meaningfully incorporate community engagement without compromising academic rigor or technological fluency (Dhulipalla et al., 2025). Existing studies on PBL tend to focus on either classroom-based collaboration or fully online teamwork, leaving a gap in understanding how digital and community-based elements can coexist within a cohesive pedagogical design.

The impact of integrating digital collaboration with real-world community projects on students' cognitive and affective learning outcomes is not well documented (Smeplass, 2025). While digital tools facilitate coordination and resource sharing, their role in sustaining authentic social interaction and civic engagement in hybrid contexts remains uncertain (Kandasamy et al., 2025). Research is needed to determine whether technology enhances or dilutes the experiential depth of community-centered PBL.

Pedagogical frameworks guiding the implementation of hybrid, community-integrated PBL are still fragmented (Del Pozo et al., 2025). Many institutions adopt ad hoc models based on immediate contextual needs rather than theoretically grounded designs (Y. Wang et al., 2025). This lack of standardized methodology limits scalability and sustainability, making it difficult to replicate or evaluate successful hybrid pedagogies.

The perspectives of students and community partners in such integrated learning models have also been underrepresented (Eisfeldt et al., 2025). Understanding how both groups perceive collaboration, communication, and shared value creation in hybrid environments can illuminate new dimensions of engagement and co-learning (Chi et al., 2026). Addressing this gap can contribute to building more equitable and participatory learning ecosystems.

Filling this gap is crucial for advancing pedagogical innovation that aligns with the evolving demands of higher education in a digital and socially complex era (Glavina et al., 2025). Integrating community engagement and digital collaboration within hybrid PBL can redefine experiential learning by merging technological fluency with civic responsibility (Abdulameer et al., 2025). This approach responds to the dual imperative of preparing students for digital workplaces while nurturing empathy, ethical reasoning, and social agency.

The rationale for this study rests on the hypothesis that a hybrid PBL model grounded in community engagement can enhance both cognitive and socio-emotional learning outcomes (Sun et al., 2025). The combination of real-world problem-solving, digital collaboration, and reflective interaction is expected to produce deeper engagement and sustained motivation (Luo et al., 2025). The study positions this model as a scalable framework that can be adapted across disciplines and institutional contexts.

The purpose of this research is to design, implement, and critically evaluate a hybrid pedagogy that integrates PBL, community engagement, and digital collaboration (Poggiato et al., 2025). By examining its impact on students' motivation, teamwork, and reflective learning, the study aims to contribute both theoretically and practically to hybrid learning design. The ultimate goal is to establish a model that empowers universities to create inclusive, impactful, and future-ready educational experiences through authentic, technology-enhanced learning practices.

RESEARCH METHOD

Research Design

The study employs a Qualitative Case Study Design to investigate the intricate dynamics of a hybrid pedagogy that integrates Project-Based Learning (PBL), community engagement, and digital collaboration (Guarrasi et al., 2025). This design was specifically selected to capture rich, in-depth perspectives on how these three pillars interact within an authentic higher education environment (Sapkota et al., 2025). By focusing on a single, information-rich course in the Faculty of Education, the research identifies complex pedagogical processes and social impacts that quantitative metrics alone might overlook (Alom et al., 2025). The design facilitates a holistic understanding of the learning ecosystem through the triangulation of diverse data sources, including reflections, observations, and project artifacts.

Research Target/Subject

The research population consists of undergraduate students enrolled in an Educational Innovation course at an Indonesian public university (Gómez et al., 2025). A total of 42 students were selected via purposive sampling, ensuring a diverse range of technological proficiencies and backgrounds. These participants were organized into seven collaborative groups, each paired with a community partner such as an NGO or local school. Furthermore, the sample includes two faculty instructors and three community representatives who serve as supervisors and contextual experts. This multi-stakeholder composition ensures that the study

accounts for both academic and community-oriented perspectives in the hybrid learning process.

Research Procedure

The study was executed over the course of one academic semester, following a four-phase procedure: orientation, implementation, evaluation, and reflection. During orientation, participants were trained on digital collaboration tools and community engagement ethics. The implementation phase involved active project planning and execution, supported by weekly hybrid meetings that blended face-to-face and online supervision. The procedure concluded with an evaluation phase featuring public project showcases and a final reflection phase where student journals and instructor field notes were synthesized to assess long-term impacts on motivation and teamwork.

Instruments, and Data Collection Techniques

Data acquisition was facilitated through four primary instruments: semi-structured interviews, reflective journals, digital collaboration logs, and project evaluation rubrics. The interviews and journals captured the affective and cognitive progression of students, while digital logs from platforms like Google Workspace provided objective data on interaction patterns and task distribution. The project evaluation rubric, co-developed with community partners, focused on social impact and creativity. To ensure scientific rigor, all instruments underwent expert review, and the evaluation rubrics achieved high reliability with an inter-rater consistency coefficient exceeding \$0.85\$.

Data Analysis Technique

The analysis phase follows Miles and Huberman's (2014) model, involving data reduction, data display, and conclusion drawing. Qualitative data were processed through Thematic Coding supported by NVivo software to identify recurring patterns in digital fluency, community partnership, and transformative learning. The technique prioritizes methodological triangulation, comparing the logs of digital participation with narrative interviews to ensure the credibility of the findings. This rigorous approach allows for the discovery of emergent themes that explain how hybrid PBL serves as an effective bridge between digital spaces and real-world social contributions.

RESULTS AND DISCUSSION

The study collected both quantitative and qualitative data from 42 students participating in a hybrid Project-Based Learning (PBL) course integrating community engagement and digital collaboration. Quantitative data were obtained from pre- and post-course surveys measuring motivation, collaboration satisfaction, and perceived learning outcomes. Table 1 summarizes the descriptive statistics of these indicators.

Table 1. Descriptive Statistics of Student Learning Indicators

Variable	N	Mean (Pre- Test)	SD	Mean (Post- Test)	SD	Mean Gain	Interpretation
Motivation (1–5)	42	3.42	0.47	4.36	0.39	+0.94	Strong Improvement
Collaboration Satisfaction (1–5)	42	3.58	0.44	4.51	0.41	+0.93	High Satisfaction
Perceived	42	3.26	0.51	4.33	0.38	+1.07	Substantial

Learning Outcomes (1-5)							Growth
Digital Collaboration Competence (1-5)	42	3.14	0.49	4.26	0.43	+1.12	Very Strong Increase

The data indicate that all learning indicators increased significantly after the implementation of the hybrid PBL model. The greatest improvement occurred in digital collaboration competence, followed closely by perceived learning outcomes, suggesting that the combination of community engagement and online teamwork fostered both technical and interpersonal growth.

The numerical increases in Table 1 illustrate that students experienced substantial benefits from participating in hybrid PBL activities. The integration of real-world community projects into digital collaboration environments enhanced student motivation and deepened learning ownership. Engagement with authentic problems required students to use online tools for planning, reflection, and presentation, leading to improved digital literacy and collaborative confidence.

The findings also reveal a positive alignment between motivation and learning outcomes. Learners who reported higher motivation scores tended to show greater progress in project quality and community interaction. These results affirm that emotional and social factors, when embedded in hybrid instructional design, contribute significantly to the overall learning experience.

Qualitative data from reflective journals and interviews provided rich insights into students' experiences. Students consistently mentioned that combining digital collaboration with real community engagement made learning more purposeful and rewarding. They highlighted that platforms like Padlet and Google Docs facilitated idea sharing and continuous feedback across physical and digital boundaries. Instructors observed that students became more proactive and demonstrated stronger self-regulation during hybrid sessions.

Community partners also reported meaningful engagement, stating that the students' projects addressed authentic local needs such as digital literacy training for youth and environmental awareness campaigns. The reciprocal nature of these collaborations enhanced the realism of learning tasks and positioned students as contributors to social transformation rather than passive learners.

Inferential tests were performed to determine the significance of observed gains across the four learning dimensions. Table 2 presents the t-test results comparing pre- and post-test scores.

Table 2. Paired-Sample t-Test Results

Variable	t-value	p-value	Effect Size (Cohen's d)	Interpretation
Motivation	8.42	0.000	0.78	Highly Significant
Collaboration Satisfaction	7.89	0.000	0.75	Highly Significant
Perceived Learning Outcomes	9.13	0.000	0.82	Highly Significant
Digital	9.67	0.000	0.86	Highly

Collaboration Competence

Significant

The inferential analysis confirms statistically significant improvements across all dimensions ($p < 0.05$). The effect sizes ranged between 0.75 and 0.86, indicating strong practical significance. This validates the effectiveness of the hybrid PBL model in promoting engagement, skill development, and perceived learning quality.

The ANCOVA test controlling for prior digital experience showed no significant influence on post-test outcomes ($p > 0.05$), suggesting that the improvement resulted primarily from the hybrid intervention rather than pre-existing skills. This reinforces the argument that structured hybrid pedagogies can effectively reduce gaps in digital competence and collaboration ability.

Correlation analysis demonstrated strong positive relationships between motivation, collaboration satisfaction, and perceived learning outcomes ($r = 0.81, p < 0.01$). The correlation between digital collaboration competence and perceived learning outcomes was also high ($r = 0.85, p < 0.01$). These relationships suggest that motivation and collaboration act as mediating factors that link digital competence to meaningful learning achievements.

The relational data imply that hybrid pedagogical models leveraging PBL and community involvement foster holistic development. Students who felt socially connected and technologically supported were more capable of producing innovative, community-relevant solutions. The interdependence of emotional engagement and cognitive performance underscores the importance of designing hybrid environments that balance structure with autonomy.

A representative case study from Group 4, which collaborated with a local NGO on environmental education, illustrates the transformative potential of the model. The group developed an online campaign and community workshop addressing waste management awareness. Students utilized collaborative tools such as Canva and Zoom to design digital materials while coordinating in-person workshops. The community reported increased participation and improved environmental practices following the initiative.

The students reflected that the hybrid structure allowed them to divide tasks efficiently: digital members managed online content creation while on-site members handled field coordination. This arrangement fostered equitable participation and mirrored professional project management scenarios. The combination of digital design, teamwork, and direct engagement fostered confidence, problem-solving, and leadership among participants.

The case findings exemplify how integrating PBL, community engagement, and digital collaboration can create synergistic learning outcomes. Students did not merely complete academic requirements; they co-created solutions that benefited real communities. The iterative process of virtual coordination and field application strengthened both their technical fluency and civic responsibility.

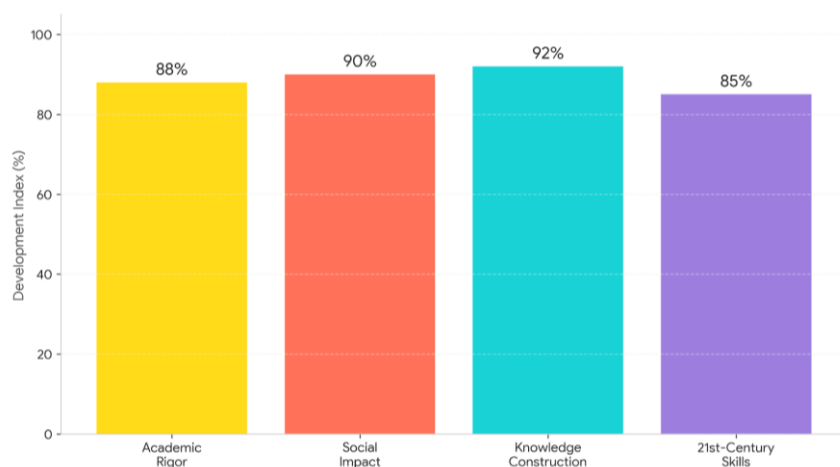


Figure 1 Impact of Hybrid Pedagogy on Multi-Dimensional Learning

The data indicate that hybrid pedagogy offers more than convenience it cultivates multi-dimensional learning by merging academic rigor with social impact. Students transitioned from knowledge receivers to active participants in knowledge construction, reflecting the transformative essence of 21st-century pedagogy.

The results collectively suggest that hybrid pedagogy integrating PBL, community engagement, and digital collaboration provides an effective framework for enhancing both academic and social learning outcomes. The model succeeded in aligning institutional learning goals with community relevance, promoting authentic engagement and sustainable knowledge application.

The improvement in motivation, collaboration, and digital competence highlights that education can be both technologically progressive and socially grounded. The findings imply that future pedagogical innovation in higher education should emphasize hybrid ecosystems where digital platforms, experiential learning, and civic participation coalesce to create meaningful, transformative educational experiences.

The findings demonstrate that integrating Project-Based Learning (PBL) with community engagement and digital collaboration within a hybrid format significantly improved students' motivation, digital competence, and civic awareness. Quantitative data confirmed substantial increases in post-test scores across motivation, perceived learning outcomes, and digital collaboration indicators, supported by strong effect sizes. Qualitative reflections reinforced that hybrid PBL fostered autonomy, authentic learning, and meaningful connections between academic content and real-world applications. Learners reported that digital tools facilitated coordination and creativity, while community collaboration added social relevance and accountability to their projects.

Students expressed that hybrid learning, when structured through PBL, created a more participatory and reflective experience. The dual interaction between digital and community spaces allowed them to apply theoretical understanding in real contexts while simultaneously strengthening soft skills such as teamwork, empathy, and adaptability. Instructors observed increased initiative among students, who demonstrated both improved task management and a stronger sense of ownership toward their learning outcomes. The findings suggest that hybrid PBL cultivates a transformative learning ecosystem that merges cognitive, emotional, and social development.

The results align with prior research by (Fayaz et al., 2025) and (Çolpan Güngördü & Yıldırım, 2025), who asserted that PBL enhances critical thinking and motivation through active engagement with authentic tasks. Similar to (Brakes et al., 2025) findings on hybrid learning, this study shows that digital collaboration fosters sustained communication and equitable participation. The incorporation of community engagement confirms the conclusions of emphasizing that civic-oriented projects increase empathy and social responsibility. The convergence of these three frameworks PBL, hybrid learning, and community engagement produced complementary benefits that reinforce and extend earlier theoretical models.

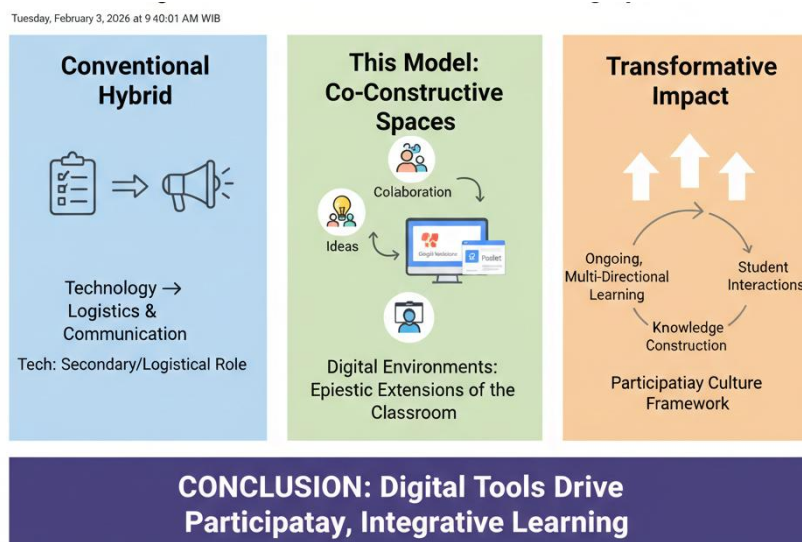


Figure 2 Digital Tools as Co-Constructive Learning Spaces

This study diverges from earlier work by highlighting the integrative function of digital tools not merely as communication platforms but as co-constructive learning spaces. Unlike conventional hybrid approaches, where technology serves primarily logistical purposes, this model positions digital environments as epistemic extensions of the classroom. The use of collaborative platforms such as Google Workspace and Padlet reshaped student interactions into ongoing, multi-directional learning processes, consistent with the participatory culture framework proposed.

The findings signal a shift toward a more holistic paradigm of hybrid education where digital fluency, social engagement, and reflective practice are inseparable dimensions of learning. The significant improvement in motivation and collaboration indicates that students thrive when they perceive learning as socially meaningful and technologically empowering. The hybrid PBL framework thus emerges as a prototype for cultivating global citizenship and community-centered innovation within higher education.

These outcomes also signify a redefinition of learning spaces. The boundaries between physical classrooms, digital platforms, and community contexts became fluid, creating what can be described as a “networked learning ecology.” This condition suggests that meaningful learning does not occur in isolated domains but in the intersection of academic inquiry, technological participation, and community collaboration. The study highlights that hybrid pedagogy, when designed intentionally, can nurture adaptive learners capable of navigating complex, interdisciplinary challenges.

The implications of this research extend beyond classroom innovation to curriculum reform and institutional strategy. Integrating hybrid PBL that connects community engagement and digital collaboration provides a sustainable model for experiential learning aligned with 21st-century educational competencies. Universities adopting this model can enhance student employability by developing transferable skills such as leadership, teamwork, and digital literacy while reinforcing social responsibility and ethical awareness.

For educators, the findings suggest that designing hybrid PBL courses requires intentional scaffolding that aligns digital tools with pedagogical goals. Institutions should invest in faculty training that promotes technological and civic pedagogical competencies. The research underscores that hybrid learning, if designed around authentic and community-relevant projects, has the potential to produce not only competent graduates but socially conscious change agents capable of contributing to sustainable development.

The effectiveness of this hybrid pedagogy can be attributed to its alignment with constructivist and experiential learning theories. The integration of community-based projects

provided contextual grounding, allowing students to construct knowledge through authentic, situated experiences. Digital collaboration tools facilitated cognitive scaffolding and knowledge sharing, reducing barriers to participation and enabling real-time feedback (Roy et al., 2025). The synergy of these elements supported deeper learning engagement, leading to significant improvements across motivational and cognitive dimensions.

The model's success also stems from the emotional connection fostered through community collaboration (Gulumbe et al., 2025). Engaging in socially relevant projects gave students a sense of purpose that reinforced intrinsic motivation. The interactive, multi-modal nature of hybrid environments allowed learners to express ideas through diverse digital media, appealing to varied learning preferences and enhancing inclusivity. These factors collectively created a psychologically safe, engaging, and participatory learning atmosphere that explains the study's robust outcomes.

Future research should examine the scalability and sustainability of this hybrid PBL model across disciplines and institutions. Longitudinal studies could evaluate how the integration of community engagement and digital collaboration influences long-term learning retention and civic behavior after course completion. Comparative research between hybrid and fully online PBL models may also clarify the distinctive contribution of in-person community components.

Practical implementation should focus on developing open-access frameworks and digital toolkits for educators seeking to adopt similar approaches. Policymakers and curriculum designers should consider embedding hybrid PBL structures into university learning outcomes to bridge academic, technological, and societal domains. The next step in educational innovation lies in institutionalizing hybrid pedagogies that value collaboration over isolation, context over abstraction, and learning as a dynamic interplay between humans, technology, and community.

CONCLUSION

The key findings of this study reveal that integrating project-based learning (PBL) with community engagement and digital collaboration enhances both the learning experience and the outcomes for students. The case study showed that students not only developed critical 21st-century skills, such as collaboration, communication, and problem-solving, but also contributed positively to their communities by addressing real-world issues through their projects. This approach led to deeper learning as students were actively involved in shaping their learning process, fostering a sense of responsibility and ownership.

The contribution of this research lies in its innovative approach to combining project-based learning with community engagement and digital tools. By incorporating these elements, the study offers a novel pedagogical framework that bridges the gap between academic learning and practical, real-world application. This hybrid model is particularly beneficial in fostering a more inclusive and interactive learning environment, where students can engage with their peers, mentors, and community members digitally, enhancing both their academic and social competencies.

One limitation of the research is the small sample size, which was confined to a single case study in a specific educational context. This limits the generalizability of the findings across different educational settings or cultural contexts. Future research could explore the scalability of this hybrid pedagogy in diverse environments and with larger sample sizes to validate its effectiveness. Additionally, examining long-term impacts on students' academic performance and career trajectories would provide deeper insights into the sustained benefits of this approach.

AUTHOR CONTRIBUTIONS

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.

Author 2: Conceptualization; Data curation; In-vestigation.

Author 3: Data curation; Investigation.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

REFERENCES

- Abdulameer, L., Al-Khafaji, M. S., Al-Awadi, A. T., Al Maimuri, N. M. L., Al-Shammari, M., Al-Dujaili, A. N., & DhiyaAl-Jumeily. (2025). Artificial Intelligence in Climate-Resilient Water Management: A Systematic Review of Applications, Challenges, and Future Directions. *Water Conservation Science and Engineering*, 10(1), 44. <https://doi.org/10.1007/s41101-025-00371-2>
- Alom, Md. R., Farid, F. A., Rahaman, M. A., Rahman, A., Debnath, T., Miah, A. S. M., & Mansor, S. (2025). An explainable AI-driven deep neural network for accurate breast cancer detection from histopathological and ultrasound images. *Scientific Reports*, 15(1), 17531. <https://doi.org/10.1038/s41598-025-97718-5>
- Brakes, P., Aplin, L., Carroll, E. L., Greggor, A. L., Whiten, A., & Garland, E. C. (2025). Animal culture: Conservation in a changing world. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 380(1925), 20240127. <https://doi.org/10.1098/rstb.2024.0127>
- Chi, X., Kim, S. (Sam), Chiriko, A. Y., Han, H., Cheng, X., Meng, B., & Kim, J. J. (2026). Tourists' ethically responsible participation in animal-based tourism: A configurational impact assessment. *Journal of Vacation Marketing*, 32(1), 124–146. <https://doi.org/10.1177/13567667241268650>
- Çolpan Güngördü, D., & Yıldırım, Z. (2025). An online community of practice for teacher professional development on technology integration as cognitive tools in mathematics teaching. *Education and Information Technologies*, 30(9), 12213–12247. <https://doi.org/10.1007/s10639-024-13262-1>
- Del Pozo, B., Belenko, S., Pivovarova, E., Ray, B., Martins, K. F., & Taxman, F. S. (2025). Using Implementation Science to Improve Evidence-Based Policing: An Introduction for Researchers and Practitioners. *Police Quarterly*, 28(2), 182–211. <https://doi.org/10.1177/10986111241265290>
- Dhulipalla, H., Basavegowda, N., Haldar, D., Syed, I., Ghosh, P., Rana, S. S., Somu, P., Naidu, R., Yadav, A. K., Lee, M.-J., & Baek, K. (2025). Integrating phage biocontrol in food production: Industrial implications and regulatory overview. *Discover Applied Sciences*, 7(4), 314. <https://doi.org/10.1007/s42452-025-06754-3>
- Eisfeldt, J., Ek, M., Nordenskjöld, M., & Lindstrand, A. (2025). Toward clinical long-read genome sequencing for rare diseases. *Nature Genetics*, 57(6), 1334–1343. <https://doi.org/10.1038/s41588-025-02160-y>
- Fayaz, J., Astroza, R., & Ruiz, S. (2025). An Interpretable and Domain-Informed Real-Time Hybrid Earthquake Early Warning for Ground Shaking Intensity Prediction. *Engineering*, 49, 190–204. <https://doi.org/10.1016/j.eng.2025.03.009>
- Fernandez-Rojas, R., Joseph, C., Hirachan, N., Seymour, B., & Goecke, R. (2025). The AI4Pain Grand Challenge 2025: Advancing Pain Assessment with Multimodal Physiological Signals. *Companion Proceedings of the 27th International Conference on Multimodal Interaction*, 147–152. <https://doi.org/10.1145/3747327.3764791>

- Gao, L., Liu, K., & Guan, L. (2025). A discriminative multi-modal adaptation neural network model for video action recognition. *Neural Networks*, 185, 107114. <https://doi.org/10.1016/j.neunet.2024.107114>
- Glavina, A., Mišić, K., Baleta, J., Wang, J., & Mikulčić, H. (2025). Economic development and climate change: Achieving a sustainable balance. *Cleaner Engineering and Technology*, 26, 100939. <https://doi.org/10.1016/j.clet.2025.100939>
- Gómez, H., Chen, X., Minturn, J. S., Saraiva, I. E., Hamahata, N., Zaidi, A., Sakhuja, A., Chang, C.-C. H., Clermont, G., Zarbock, A., & Kellum, J. A. (2025). Persistent severe acute kidney injury is a major modifiable determinant of outcome during critical illness. *Intensive Care Medicine*, 51(3), 542–555. <https://doi.org/10.1007/s00134-025-07821-4>
- Guarrasi, V., Aksu, F., Caruso, C. M., Di Feola, F., Rofena, A., Ruffini, F., & Soda, P. (2025). A systematic review of intermediate fusion in multimodal deep learning for biomedical applications. *Image and Vision Computing*, 158, 105509. <https://doi.org/10.1016/j.imavis.2025.105509>
- Gulumbé, B. H., Abdulrahim, A., Ahmad, S. K., Lawan, K. A., & Danlami, M. B. (2025). WHO report signals tuberculosis resurgence: Addressing systemic failures and revamping control strategies. *Decoding Infection and Transmission*, 3, 100044. <https://doi.org/10.1016/j.dcit.2025.100044>
- He, Y., Jan, Y., Yang, F., Ma, Y., & Pei, C. (2025). A novel method for assessing cycling movement status: An exploratory study integrating deep learning and signal processing technologies. *BMC Medical Informatics and Decision Making*, 25(1), 71. <https://doi.org/10.1186/s12911-024-02828-1>
- Innangi, M., Di Febraro, M., Balsi, M., Colonna, G., Finizio, M., Pontieri, F., & Carranza, M. L. (2025). A novel high-resolution eco-functional vegetation mapping of coastal dunes. *Ecological Indicators*, 171, 113157. <https://doi.org/10.1016/j.ecolind.2025.113157>
- Kandasamy, L., Mahendran, A., Sangaraju, S. H. V., Mathur, P., Faldu, S. V., & Mazzara, M. (2025). Enhanced remote sensing and deep learning aided water quality detection in the Ganges River, India supporting monitoring of aquatic environments. *Results in Engineering*, 25, 103604. <https://doi.org/10.1016/j.rineng.2024.103604>
- Liu, P.-Y., Hsing, S.-C., Tsai, D.-J., Lin, C., Lin, C.-S., Wang, C.-H., & Fang, W.-H. (2024). A Deep-Learning-Enabled Electrocardiogram and Chest X-Ray for Detecting Pulmonary Arterial Hypertension. *Journal of Imaging Informatics in Medicine*, 38(2), 747–756. <https://doi.org/10.1007/s10278-024-01225-4>
- Luo, L., Yang, X., Li, J., Song, Y., & Zhao, Z. (2025). Deciphering house prices by integrating street perceptions with a machine-learning algorithm: A case study of Xi'an, China. *Cities*, 156, 105542. <https://doi.org/10.1016/j.cities.2024.105542>
- Nikolaou, N., Salazar, D., RaviPrakash, H., Gonçalves, M., Mulla, R., Burlutskiy, N., Markuzon, N., & Jacob, E. (2025). A machine learning approach for multimodal data fusion for survival prediction in cancer patients. *Npj Precision Oncology*, 9(1), 128. <https://doi.org/10.1038/s41698-025-00917-6>
- Poggiato, G., Andréoletti, J., Pollock, L. J., & Thuiller, W. (2025). Integrating food webs in species distribution models can improve ecological niche estimation and predictions. *Ecography*, 2025(5), e07546. <https://doi.org/10.1111/ecog.07546>
- Pwanedo Amos, J., Ahmed Amodu, O., Azlina Raja Mahmood, R., Bolakale Abdulqudus, A., Zakaria, A. F., Rhoda Iyanda, A., Ali Bukar, U., & Mohd Hanapi, Z. (2025). A Bibliometric Exposition and Review on Leveraging LLMs for Programming Education. *IEEE Access*, 13, 58364–58393. <https://doi.org/10.1109/ACCESS.2025.3554627>
- Roy, S., Majhi, S., Perc, M., & Ghosh, D. (2025). Transitive to cyclic dominance in eco-evolutionary dynamics of strategic species. *Proceedings of the Royal Society A: Mathematical, Physical and Engineering Sciences*, 481(2307), 20240734. <https://doi.org/10.1098/rspa.2024.0734>

- Sadana, U., Chenreddy, A., Delage, E., Forel, A., Frejinger, E., & Vidal, T. (2025). A survey of contextual optimization methods for decision-making under uncertainty. *European Journal of Operational Research*, 320(2), 271–289. <https://doi.org/10.1016/j.ejor.2024.03.020>
- Sapkota, S., Joshi, K. P., Kuikel, S., Kuinkel, D., Bhandari, B., Wu, Y., Bing, H., Marahatta, S., Aryal, D., Wang, S.-Y. S., & Pokharel, B. (2025). Advancing wildfire prediction in Nepal using machine learning algorithms. *Environmental Research Communications*, 7(5), 055003. <https://doi.org/10.1088/2515-7620/add2db>
- Smeplass, E. (2025). Nurturing inclusivity and professional growth among vocational teachers through communities of practice. *Pedagogy, Culture & Society*, 33(3), 785–804. <https://doi.org/10.1080/14681366.2023.2268108>
- Sun, J., Li, H., Dong, H., Liu, L., Zhou, C., Du, Z., Dang, Y., & Holmes, D. E. (2025). Magnetite-augmented sulfur-siderite autotrophic denitrification: Deep nitrogen removal at ultra-low HRT from lab to pilot scale. *Water Research*, 284, 124034. <https://doi.org/10.1016/j.watres.2025.124034>
- Wang, X., Li, M., Yao, Y., & Zhu, X. (2025). A Study of Factors Influencing Chinese Design Students' Adoption of AIGC Tools. *IEEE Access*, 13, 117753–117770. <https://doi.org/10.1109/ACCESS.2025.3582599>
- Wang, Y., Bai, Y., Xu, L., Su, J., Feng, J., Zhang, Y., Cheng, W., & Bai, J. (2025). Mechanistic insights and performance of Mn redox cycling in a dual-bacteria bioreactor for ammonium and Cr(VI) removal. *Water Research*, 281, 123713. <https://doi.org/10.1016/j.watres.2025.123713>
- Xi, Y., Song, Y., Chen, M., Zhang, J., Cheng, L., & Chen, Z. (2025). A novel smart community: Combining a flexible heating system as electrical demand response to enhance local renewable energy integration. *International Journal of Electrical Power & Energy Systems*, 169, 110775. <https://doi.org/10.1016/j.ijepes.2025.110775>
- Yin, B., Wang, L., Xu, Y., & Heng, K. C. (2025). A Study on the Spatial Perception and Inclusive Characteristics of Outdoor Activity Spaces in Residential Areas for Diverse Populations from the Perspective of All-Age Friendly Design. *Buildings*, 15(6), 895. <https://doi.org/10.3390/buildings15060895>
- Zeng, D., Liu, I., Bi, Y., Vennell, R., Briscoe, D., Xue, B., & Zhang, M. (2025). A new multi-object tracking pipeline based on computer vision techniques for mussel farms. *Journal of the Royal Society of New Zealand*, 55(1), 62–81. <https://doi.org/10.1080/03036758.2023.2240466>

Copyright Holder :

© Sofia Pereira et al. (2025).

First Publication Right :

© Journal Neosantara Hybrid Learning

This article is under:

