

Engaging HBCU Students in Active Learning for Blockchain, FinTech, and Generative AI: A Human-Centered Pedagogical Framework

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Abstract

The convergence of blockchain, financial technology, digital assets, and generative artificial intelligence creates important opportunities and challenges for undergraduate education, especially at Historically Black Colleges and Universities. Students preparing for careers in business, computing, analytics, cybersecurity, and financial services need more than exposure to emerging technologies; they also need confidence, collaboration skills, ethical awareness, computational fluency, and experience applying tools to realistic problems. This paper proposes a human-centered pedagogical framework to engage HBCU students in active learning about blockchain, FinTech, and generative AI. The framework synthesizes classroom-tested strategies

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from computer information systems, business analytics, programming, mathematics, and interdisciplinary student research. It emphasizes structured collaboration, low-stakes practice, role rotation, peer evaluation, reflective learning, responsible use of generative AI, reproducible computational notebooks, and applied problem contexts such as credit risk, fraud detection, investment analysis, digital trust, and smart financial systems. The paper presents an evidence-informed model that instructors can adapt across introductory and advanced undergraduate courses. The framework suggests that active, collaborative, and AI-supported pedagogy can increase student participation, reduce anxiety around technical topics, support inclusive learning, and strengthen workforce readiness for emerging blockchain and FinTech ecosystems.

Keywords: HBCU education, active learning, generative AI, blockchain education, FinTech education, student engagement, collaborative learning, Google Colab, Python, workforce development

1. Introduction

Blockchain, financial technology (FinTech), digital assets, cybersecurity, artificial intelligence (AI), and generative AI are reshaping business, finance, government, and higher education. Financial institutions increasingly rely on intelligent systems for fraud detection, credit-risk modeling, customer analytics, compliance monitoring, and digital identity verification. Blockchain and distributed ledger technologies continue to influence secure records, smart contracts, tokenization, decentralized finance, and transparent transaction infrastructures (Narayanan et al., 2016; Yaga et al., 2018). Generative AI adds another layer of transformation by enabling natural-language interaction with data, code, models, explanations, and decision processes.

For undergraduate students, these developments create both opportunity and pressure. Emerging digital finance technologies open pathways to high-demand careers, but students may experience anxiety when confronted with unfamiliar technical vocabulary, programming environments, mathematical models, security concepts, and ethical concerns. This challenge is especially important for Historically Black Colleges and Universities (HBCUs), which play a critical role in broadening participation in STEM undergraduate education and research (National Science Foundation, 2023).

The central question addressed in this paper is: How can instructors engage HBCU students in active learning that prepares them to understand and apply blockchain, FinTech, and generative AI in responsible, human-centered, and career-relevant ways? This paper argues that effective instruction in these areas requires more than lectures about emerging technologies. It requires purposeful instructional design that connects technical content to active participation, peer collaboration, problem-based learning, ethical reflection, and applied research.

The proposed framework builds on classroom-tested work in active learning, collaborative learning, unplugged computing activities, AI-supported problem-solving, Python and Google Colab, business analytics, and student-centered pedagogy. Instead of treating blockchain, FinTech, and generative AI as isolated topics, the paper positions them as interconnected domains that can be taught through a coherent educational model. Students learn by working together, asking questions, testing ideas, using AI as a learning partner rather than a replacement for thinking, and applying computational tools to meaningful financial and social problems.

2. Literature Review

2.1 Active Learning and Student Engagement

Active learning refers to instructional practices that require students to participate meaningfully in the learning process rather than passively receive information. Bonwell and Eison (1991) described active learning as involving students in activities and reflection on those activities. Prince (2004) reviewed evidence supporting active learning in engineering education, and Freeman et al. (2014) demonstrated that active learning improves student performance in STEM courses.

In technical and quantitative courses, active learning is valuable because students often need repeated practice, dialogue, and feedback to develop conceptual understanding. A lecture can introduce an algorithm, blockchain concept, financial model, or AI workflow, but students usually understand these ideas more deeply when they manipulate data, write code, explain their reasoning, critique outputs, and compare solutions with peers. Prior work in computer science and computer information systems emphasizes collaborative learning, problem-based learning, integrated learning, oral assessment, unplugged activities, group assignments, and technology-supported practice as ways to increase participation (Gao et al., 2022).

2.2 Collaboration, Human-Centered Pedagogy, and Psychological Safety

Collaboration is an essential workforce competency in financial technology and digital systems. Real-world blockchain and FinTech projects require cooperation among software developers, data analysts, business strategists, cybersecurity specialists, compliance professionals, economists, managers, and policymakers. Consequently, higher education must replicate these collaborative dynamics to prepare career-ready graduates. Collaborative learning is grounded in sociocultural and social learning theories, which emphasize the role of interaction, modeling, and shared problem-solving in learning (Bandura, 1977; Vygotsky, 1978). Johnson and Johnson (2009) and Slavin (1995) emphasized positive interdependence, individual accountability, structured interaction, and group processing as central components of cooperative learning.

However, assigning group work does not automatically produce meaningful collaboration. Students may experience unequal participation, unclear expectations, interpersonal conflict, or anxiety. Oakley et al. (2004) argued that student teams need structure and guidance to function effectively. Recent instructional work supports this principle by showing that structured group assignments, role rotation, peer evaluation, communication guidance, and reflective practice can improve student engagement, accountability, and collaborative competence (Gao et al., 2026b).

Human-centered pedagogy emphasizes the learner as a whole person with experiences, motivations, anxieties, identities, strengths, and aspirations. Edmondson (1999) described psychological safety as a shared belief that a group environment supports interpersonal risk-taking. In classrooms, psychological safety allows students to ask questions, admit confusion, test ideas, and participate without fear of embarrassment. This is especially important when teaching fast-changing topics such as generative AI, blockchain, and FinTech, where even experienced professionals must continuously learn.

2.3 Generative AI, Blockchain, and FinTech Education

Generative AI can support student learning by helping students brainstorm, explain concepts, debug code, generate practice examples, compare alternative solutions, and reflect on reasoning. However, generative AI also introduces risks. Students may over-rely on AI-generated answers, reproduce inaccuracies, or fail to critically evaluate outputs. To mitigate these risks,

generative AI should be taught as a tool for guided inquiry, not as a substitute for human reasoning. Responsible use should align with risk-management principles such as validity, reliability, transparency, accountability, privacy, and fairness, consistent with the NIST AI Risk Management Framework (National Institute of Standards and Technology [NIST], 2023).

Prior work on Python, generative AI, and Google Colab demonstrates the value of integrating AI-supported computation with foundational skills, reproducible notebooks, and human-centered reasoning (Gao & Gao, 2026a; Gao et al., 2024; Gao et al., 2026c; Gao et al., 2026d). Google Colab provides a low-barrier environment for students to write, run, revise, and share Python notebooks without the need for complex local software installation. When combined with generative AI, Colab can support iterative learning: students formulate a problem, generate code or explanations, test outputs, debug errors, interpret results, and reflect on what the computation means.

Blockchain and FinTech education requires interdisciplinary curriculum design. Students need to understand distributed ledgers, cryptographic hashing, consensus, smart contracts, tokens, digital wallets, cybersecurity, and data integrity. Technical coverage should be grounded in established treatments of cryptocurrency technologies and distributed ledger concepts (Narayanan et al., 2016; Yaga et al., 2018). Students also need to understand financial concepts such as risk, credit, payments, markets, fraud, regulation, inclusion, and trust.

3. Methodology

This paper employs a conceptual, evidence-informed, design-based methodology. It does not report a new controlled experiment. Instead, it synthesizes prior classroom-tested practices, published pedagogical research, instructor experience, student-centered evidence, and interdisciplinary teaching examples to develop a practical framework for HBCU-centered blockchain, FinTech, and generative AI education.

The evidence base includes active-learning experiences in computer science and computer information systems courses (Gao et al., 2022), unplugged parallel and distributed computing activities that made complex computing concepts more accessible in early undergraduate courses (Srivastava et al., 2019), longitudinal collaboration research involving structured group assignments and peer evaluation (Gao et al., 2026b), and recent work on

blockchain, AI, generative AI, Python, Google Colab, investment decision-making, and computational problem-solving (Gao, 2025; Gao & Gao, 2026a; W. Gao et al., 2026).

The synthesis emphasized publications and classroom practices that met three criteria: relevance to active learning, applicability to computing or business education, and transferability to blockchain, FinTech, or generative AI instruction. The sources and practices were reviewed for recurring instructional design patterns, including collaborative structures, low-stakes practice, guided use of technology, student reflection, responsible use of AI, and applied problem contexts. These recurring patterns were then organized into the five-component framework presented in Section 4.

The framework was developed through four steps. First, common challenges in emerging technology instruction were identified, including student anxiety, uneven preparation, passive learning, unclear expectations for AI use, limited confidence in coding, and difficulty connecting technical topics to financial systems. Second, prior classroom-tested strategies were mapped to these challenges. Third, the strategies were reorganized around blockchain, FinTech, and generative AI learning outcomes. Fourth, the resulting model was refined into instructional components, course modules, assessment strategies, and implementation recommendations.

4. A Human-Centered Active-Learning Framework

The proposed framework includes five mutually reinforcing components: psychological safety and learning norms, structured collaboration, applied FinTech problem contexts, responsible use of generative AI, and reflective assessment. As shown in Table 1, each component is paired with specific instructional practices and measurable learning outcomes.

Table 1*Framework Components and Instructional Practices*

Component	Instructional practices	Learning outcome
Psychological safety and norms	Strengths-based introductions, early surveys, AI-use policy, collaboration norms	Confidence, belonging, and willingness to participate
Structured collaboration	Role rotation, team contracts, peer evaluation, communication checkpoints	Accountability, teamwork, and professional communication
Applied FinTech contexts	Fraud detection, credit risk, digital identity, smart contracts, investment analysis	Connection between concepts and real-world financial systems
Responsible generative AI use	Prompting, verification, code debugging, output critique, AI-use statements	AI literacy, critical thinking, and ethical awareness
Reflective assessment	Learning journals, project reflections, peer feedback, oral explanation	Metacognition, self-regulation, and transferable skills

The first component establishes a classroom culture in which students feel safe asking questions, making mistakes, and learning unfamiliar technologies. Instructors can begin with strengths-based introductions, early surveys, collaborative norm-setting, and explicit discussion of responsible technology use. Students should be told that confusion is expected when learning emerging technologies and that the course is designed to help them develop confidence through practice.

The second component is structured collaboration. Students work in teams, but the teamwork is intentionally designed. Each team may include rotating roles such as facilitator, coder, data analyst, financial interpreter, ethics reviewer, presenter, and documentation lead. For example, in a credit-risk modeling activity, the coder may prepare the Python notebook, the data analyst may interpret the variables, the financial interpreter may explain the business implications, the ethics reviewer may identify fairness concerns, and the presenter may summarize the findings. In the next activity, students rotate roles.

The third component is the use of realistic problem contexts. Students should not learn blockchain, FinTech, and AI only as abstract concepts. They should apply them to problems such as fraud detection, loan approval, risk scoring, digital identity, payment systems, tokenization,

smart contracts, market simulation, financial inclusion, and cybersecurity. Applied contexts increase motivation because students can see why technology matters.

The fourth component centers on responsible generative AI use. In this framework, generative AI is treated as a learning partner that supports inquiry, coding, explanation, and reflection. Students may use AI to generate Python code, explain blockchain concepts, compare financial models, debug errors, draft project plans, or create plain-language summaries. However, students must verify outputs, cite sources when appropriate, explain their reasoning, and identify limitations. A recommended classroom rule is: AI may assist the process, but students remain responsible for understanding, verifying, and explaining the final work.

The fifth component is reflective assessment. Students should be assessed not only on final answers but also on process, reasoning, collaboration, ethical awareness, and communication. Reflection prompts may ask students to explain how they used generative AI, what they verified, what errors they found, how their team divided responsibilities, and what they learned about financial technology.

5. Findings and Synthesized Evidence

Because this paper is a conceptual synthesis based on prior classroom-tested work, the findings are presented as evidence-informed themes rather than new experimental results. First, structured active learning increases participation. Students participate more when instructors provide course materials early, clarify expectations, use first-day surveys, encourage study partnerships, and assign collaborative tasks. In blockchain, FinTech, and AI courses, similar structures can help students overcome hesitation through pre-class vocabulary guides, short videos, example notebooks, and guiding questions (Freeman et al., 2014; Gao et al., 2022).

Second, collaboration becomes more effective when it is designed. Students benefit from clear roles, timelines, deliverables, peer evaluation, and reflection. Without structure, group work may lead to unequal participation or frustration. With structure in place, students are more likely to contribute, communicate, and support one another. In blockchain and FinTech education, designed collaboration is useful because the work is interdisciplinary. A student strong in business may interpret financial implications, while a student strong in coding may implement the model, and a student interested in ethics may raise questions about fairness, privacy, or community impact (Gao et al., 2026b; Oakley et al., 2004).

Third, low-stakes practice reduces technical anxiety. Emerging technology topics can be intimidating, and students may worry that they are not technical enough to understand blockchain, programming, data analytics, or AI. Short in-class activities, simple notebooks, group concept maps, unplugged simulations, and guided AI prompts allow students to build confidence before high-stakes projects. Prior work on unplugged parallel and distributed computing activities shows how active, low-barrier exercises can make complex computing topics more accessible to early undergraduate students (Srivastava et al., 2019).

Fourth, generative AI supports access but requires critical oversight. Students can ask AI to explain code, define blockchain terms, summarize articles, generate practice problems, or help debug errors. However, AI outputs may be incomplete, biased, outdated, or incorrect. Therefore, students should document how they used AI and what they verified. A short AI Use and Verification Statement can explain the prompts used, the modifications made, the errors corrected, and the sources checked. This practice aligns with the NIST AI Risk Management Framework emphasis on trustworthy, accountable, and reliable AI systems (NIST, 2023).

Fifth, applied projects strengthen workforce readiness. In a FinTech course, students might build a credit-risk dashboard, analyze fraud patterns, simulate investment decisions, compare digital payment systems, design a conceptual smart contract, or evaluate cybersecurity risks in a blockchain application. These projects develop technical, analytical, communication, and ethical skills while supporting students' participation in research and professional identity. Prior work on blockchain and generative AI in HBCU programming education, AI-integrated business education, and investment decision-making in the AI era provides a useful foundation for such applied learning experiences (Gao, 2025; Gao & Gao, 2026a; W. Gao et al., 2026).

6. Course Implementation and Assessment

The framework can be implemented in a full course, a course module, a workshop, or a research mentoring program. The following model illustrates a six-module structure suitable for undergraduate courses in business analytics, computer information systems, computer science, or interdisciplinary FinTech.

Table 2*Sample Course Implementation Model*

Module	Topic	Active-learning activity	Generative AI integration	Assessment
1	FinTech, blockchain, and AI	Team concept mapping and vocabulary challenge	AI-assisted concept explanation with verification	Reflection memo
2	Digital trust and blockchain fundamentals	Unplugged distributed ledger simulation	Compare centralized and decentralized systems	Group explanation
3	Python and Google Colab for financial data	Guided notebook lab	AI-assisted code debugging	Notebook submission
4	Credit risk and fraud detection	Team classification activity and simple model	Model explanation critique	Model report
5	Smart contracts, governance, and ethics	Case discussion and role-play	Policy summary with fact-checking	Ethics analysis
6	Capstone project	Team project on applied FinTech problem	AI-supported research, coding, and presentation preparation	Presentation, notebook, peer evaluation, and AI verification statement.

Module 1 establishes a shared foundation by asking students to define key terms and identify everyday examples of digital finance. Module 2 introduces blockchain concepts through a distributed ledger simulation in which teams record transactions, verify changes, and discuss what happens if one record is altered. Module 3 introduces Python and Google Colab, enabling students to load a dataset, inspect variables, calculate descriptive statistics, create visualizations, and interpret results. Module 4 applies machine learning to financial problems such as credit risk classification and fraud detection, with an emphasis on workflow, interpretation, false positives and false negatives, and fairness concerns. Module 5 introduces smart contracts conceptually by asking students to write pseudocode for a simple financial agreement and then discuss risks, accountability, and governance. Module 6 asks teams to complete an applied capstone project on topics such as fraud detection, digital identity, credit-risk fairness, investment analysis, decentralized finance risk, or financial inclusion.

Assessment should align with the framework's human-centered goals. Students should demonstrate technical understanding through quizzes, notebook exercises, short explanations, and project reports. They should demonstrate collaboration through role fulfillment, peer evaluation, respectful communication, and contribution to group deliverables. They should demonstrate responsible AI use through AI-use statements that describe the purpose of AI assistance, categories of prompts, verification methods, errors corrected, and lessons learned. They should demonstrate ethical reasoning by discussing who might benefit from technology, who might be harmed or excluded, what privacy concerns are present, and how the team verified AI-generated outputs.

7. Discussion

The proposed framework aligns with the needs of the blockchain, FinTech, and AI landscape by connecting technical learning to trust, accountability, reliability, and workforce preparation. Students entering financial technology fields will need to work with intelligent systems, distributed infrastructures, data-driven models, and human stakeholders. They will also need to communicate across disciplines and evaluate ethical risks.

For HBCUs, the framework supports inclusive innovation. It gives students access to emerging technology skills while honoring the importance of community, collaboration, confidence, and social responsibility. It also supports faculty who may wish to integrate blockchain, FinTech, and generative AI into existing courses without completely redesigning the curriculum. Many activities can be implemented gradually, such as adding a single AI-use statement, introducing one Colab notebook, using role rotation in a group project, or adding a FinTech case discussion to a business analytics course.

The framework also addresses a common problem in AI education: the tension between access and rigor. Generative AI can make technical work more accessible, but access without accountability can produce shallow learning. The proposed model responds to this tension by requiring verification, explanation, reflection, and human judgment. Students are encouraged to use AI, but they remain responsible for their reasoning.

8. Limitations and Future Research

This paper proposed a conceptual and evidence-informed framework rather than a new experimental study. Its conclusions are based on a synthesis of prior teaching experience, classroom-tested strategies, and published pedagogical work. Future research should empirically test the framework in blockchain, FinTech, and generative AI courses at HBCUs and other institutions.

Several research directions are recommended. Future studies can compare student learning outcomes before and after implementation of the framework, examine whether structured generative AI use improves confidence and coding persistence, analyze how students from different majors experience interdisciplinary FinTech learning, investigate whether AI-use statements improve academic integrity and metacognitive awareness, and examine the long-term impact of applied FinTech projects on internships, graduate study, and career pathways.

9. Conclusion

Blockchain, FinTech, and generative AI are transforming how business is and will be conducted in virtually every industry and sector. These emerging technologies are making routine and even more complex tasks and processes readily available at dramatically reduced time and cost. These realities are creating new demands and opportunities for how undergraduate education is delivered. HBCU students should be active participants in this transformation, not merely observers of technological change. To support their success, instructors need pedagogical approaches that combine technical learning with collaboration, confidence, ethical reasoning, and workforce relevance.

This paper proposes a human-centered active-learning framework for engaging HBCU students in blockchain, FinTech, and generative AI education. The framework emphasizes psychological safety, structured collaboration, the application of financial technology, responsible use of generative AI, and reflective assessment. It draws on prior classroom-tested practices in active learning, computer information systems, business analytics, Python, Google Colab, student research, and collaborative pedagogy. By adopting this approach, instructors can help prepare HBCU students for careers and leadership in blockchain, FinTech, AI, cybersecurity, analytics, and responsible digital innovation.

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