

Bridging Learning and Impact: OpenImpactLab for Developing AI Readiness, Literacy and Cognitive Skills

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Abstract

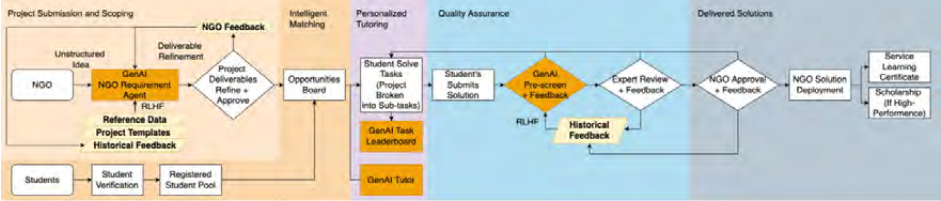
As Generative AI (GenAI) reshapes higher education, there is a pressing need for pedagogies that move beyond tool usage to foster AI literacy and cognitive development. This paper introduces *OpenImpactLab*, an AI-powered platform that connects students with NGOs to co-create social impact projects. We present a specialised GenAI curriculum embedded in the platform, “From Code to Cognition.” The course follows a three-phase structure: (1) building AI readiness through Python foundations; (2) enhancing AI literacy via agent construction; and (3) fostering cognitive development through a capstone “AI Data Scientist” project. We report baseline data from 40 upper-secondary students (Pre-test) and outline the mixed-methods research design. Baseline results reveal a gap between high affective motivation and moderate technical readiness. We discuss expected outcomes and show how this ecosystem transforms learning from theoretical instruction to applied, experiential problem-solving.

Keywords: AI Literacy, AI Readiness, OpenImpactLab, Project-Based Learning, Cognitive Development

1. Introduction

The future of higher education demands a shift from theoretical instruction to applied, experiential problem-solving. In response, the *OpenImpactLab* project proposes an AI-powered platform aligned with Industry 4.0 readiness that connects students, educators, and Non-Governmental Organisations (NGOs) to co-create real-world social impact projects. Using Generative AI, the platform transforms complex NGO challenges into structured project missions and supports guidance, collaboration, and assessment throughout the learning process. Figure 1 illustrates this ecosystem.

Figure 1. *OpenImpactLab Platform Design: Key Components Highlighting the Cyclical Feedback Loop Between Students, NGOs, and AI Tutors*



However, successful participation in such projects requires specific competencies. AI literacy is increasingly defined as a set of competencies enabling effective and critical interaction with AI (Long & Magerko, 2020; Ng, Su, Leung, & Chu, 2024). In parallel, “AI readiness” refers to the prerequisite knowledge and dispositions for AI-rich work, including technical skills and psychological preparedness (Dai et al., 2020; Karaca, Çalışkan, & Demir, 2021). Project-Based Learning (PBL) has been identified as an effective approach for developing these competencies in AI education (Chiu et al., 2022). This paper describes the preparatory curriculum, “From Code to Cognition,” embedded in *OpenImpactLab*, and reports the initial phase of an embedded mixed-methods study evaluating its impact on student development.

2. Methodology

This study utilises an Embedded Mixed-Methods Design to evaluate the educational intervention. The methodology comprises the pedagogical design of the curriculum and the research framework used to assess it.

2.1 Pedagogical Intervention: “From Code to Cognition” Curriculum Design

The course is structured into three phases, each mapping to a specific developmental goal (Table 1).

Table 1. *Phases of the Curriculum and Construct Alignment*

Phase	Project Form	Example Tasks	Main Construct Focus	Future OpenImpactLab Project Type
1	Structured micro-projects	Playlist analyser; Spam message classifier	AI Readiness (Python, data wrangling, basic ML)	Data cleaning; descriptive analytics
2	Medium-scale AI agent tasks	CSV QA agent; API-based data helper	AI Literacy (ABCE; critical GenAI use)	FAQ bots; internal data assistants
3	Capstone “AI Data Scientist”	End-to-end agent for a data problem	Cognitive Development (Decomposition, systems thinking)	NGO dashboards; decision-support agents

- **Phase 1: The Foundation (Building AI Readiness)**

Rationale: This phase builds AI readiness through targeted, auto-gradable tasks. By mastering core code and data operations, students establish the technical floor for later complexity.

- **Phase 2: The AI Agent Lab (Enhancing AI Literacy)**

Rationale: Through open-ended exploration and component-based construction, students deepen AI literacy by moving beyond treating AI as a “magic box” to understanding inputs, context windows, and tool calls.

- **Phase 3: The AI Data Scientist (Fostering Cognitive Development)**

Key milestones include model retrieval, code generation, and refinement/debugging. This capstone promotes cognitive development by requiring problem decomposition and systems thinking as students integrate LLMs with Python runtimes.

2.2 Research Design

Research Questions:

- **RQ1 (AI Readiness):** How does the course affect students’ technical skills and AI readiness?
- **RQ2 (AI Literacy):** How does the curriculum influence students’ affective, behavioural, cognitive, and ethical AI literacy?
- **RQ3 (Cognitive Development):** What evidence of problem decomposition, systems thinking, and metacognition emerges from the capstone projects?

Participants: The study involves 40 upper-secondary students ($M_{age} = 15.78$), serving as a pilot cohort for university-level implementation.

2.3 Operationalisation and Assessment Framework

To ensure the rigour and replicability of the study, the core components of the pedagogical intervention are operationalised as follows:

- **Capstone Performance Assessment:** The Phase 3 “AI Data Scientist” project is evaluated using a multi-dimensional rubric. This assesses: (1) Technical Execution (code accuracy and API integration); (2) Systems Thinking (the integration of LLMs with Python runtimes); and (3) Requirement Alignment (the efficacy of the solution in addressing the specific social impact needs of the partner NGO).
- **Process Data Analysis:** We analyse student development through Git metadata. Specifically, we track Commit Granularity to evaluate problem-solving decomposition skills and Debugging Loops (the temporal interval between system errors and corrective commits) to assess meta-cognitive persistence and self-correction strategies.

2.4 Data Collection

Data is collected across a timeline:

- **Pre-Course:** Demographic survey, AI Readiness Test (10 items), and the AI Literacy Questionnaire (AILQ, 31 items) adapted from Ng, Wu, Leung, Chiu, and Chu (2024).
- **In-Course:** Project process data (Git commits), code documentation, and reflective journals.
- **Post-Course:** Post-test (Readiness), Post-survey (AILQ), semi-structured interviews, and focus groups.

2.5 Data Analysis

- **Quantitative:** Paired sample t-tests will compare pre- and post-test scores.
- **Qualitative:** Thematic analysis will be applied to interview transcripts and project artefacts.
- **Triangulation:** Quantitative scores will be cross-referenced with qualitative evidence to validate whether self-reported literacy increases match demonstrated cognitive depth.

Quantitative data are analysed using descriptive statistics and paired-sample t-tests to measure growth. For qualitative data, a thematic analysis is conducted on reflective papers. The study employs a data transformation strategy for mixed-methods integration: qualitative themes regarding coding behaviours are cross-tabulated with quantitative literacy scores. This triangulation validates whether self-reported literacy gains align with the technical and cognitive depth demonstrated in the students' final artefacts.

3. Results and Discussion

3.1 Baseline Findings (Pre-Test Data)

Currently, baseline data has been collected for 40 students. Table 2 summarises the descriptive statistics.

Table 2. *Baseline AI Readiness and AI Literacy Scores (N = 39–40)*

Measure	N	Mean (M)	SD	Range
AI Readiness (0–10)	40	6.50	2.29	1–10
AI Literacy (1–5)				
Affective	39	4.03	0.58	2.00–5.00
Behavioural	39	4.03	0.60	2.12–5.00
Cognitive	39	3.92	0.61	2.17–5.00
Ethical	39	4.69	0.39	3.75–5.00

- **AI Readiness:** The mean score was 6.50/10. Students showed competence in basic logic but struggled with API concepts and data structuring—skills critical for the *OpenImpactLab* context.
- **AI Literacy (ABCE):** Students reported high Ethical awareness ($M = 4.69$) and Affective motivation ($M = 4.03$). However, correlation analysis revealed a weak relationship between Readiness and Literacy (r ranges from .13 to .29), indicating an “illusion of competence” where motivation exceeds technical ability. This necessitates the structured approach found in our curriculum to bridge the gap.

3.2 Expected Outcomes and Discussion

Based on the research design and pilot observations, we anticipate the following outcomes upon study completion:

- **Addressing RQ1 (Readiness):** We expect quantitative post-test data to show significant improvements in technical scores, validating Phase 1’s efficacy in establishing the necessary technical “floor.”
- **Addressing RQ2 (Literacy):** While self-reported scores are expected to rise, the qualitative data (interviews/demos) will likely reveal a qualitative shift in how students understand AI—moving from a vague, abstract perception to a concrete, structured mental model.
- **Addressing RQ3 (Cognitive Development):** We anticipate that the qualitative analysis of the “AI Data Scientist” capstone will yield rich evidence of cognitive growth. Specifically, we expect to see students actively applying systems thinking (integrating components), problem decomposition (following milestones), and metacognition (iterative debugging loops).

These expected findings will demonstrate that the *OpenImpactLab* model successfully bridges the gap between novice enthusiasm and the rigorous demands of real-world social impact projects.

3.3 Limitations and Future Work

Whilst this study provides essential baseline insights, it is currently more programmatic than empirical. As a “Work in Progress” submission, the conclusions regarding student development and the effectiveness of the “From Code to Cognition” curriculum remain preliminary. To validate the proposed impacts, the next phase of research will include:

- **Post-Course Comparative Analysis:** Utilising paired-sample t-tests to quantify growth from baseline AI readiness and literacy scores to final outcomes.

- **Empirical Artefact Analysis:** Applying thematic coding to Git metadata and capstone project artefacts to provide objective evidence of cognitive growth and systems thinking.

4. Implications

The integration of the “From Code to Cognition” curriculum with the *OpenImpactLab* platform offers significant implications for higher education institutions. Firstly, it validates the strategic focus on applied learning found in many modern educational initiatives. By using GenAI to break down complex NGO challenges into manageable missions, the platform provides the necessary scaffolding for students to contribute meaningfully to society.

Secondly, the study highlights the importance of diagnostic assessment. The baseline data revealed a gap between student interest and readiness. Higher education institutions must not assume “digital natives” are automatically “AI ready” (Dai et al., 2020). Curricula must explicitly design for the “Foundation” phase before expecting students to orchestrate complex AI agents.

Finally, this project demonstrates a scalable pathway. The curriculum acts as a gateway, equipping students with the specific literacies and cognitive skills needed to utilise the *OpenImpactLab*’s AI Tutor and Collaborative Dashboard effectively. This ensures that when students eventually engage with NGOs, they do so not just as learners, but as capable co-creators of social value.

Beyond the local pilot, these findings address critical international challenges in AI education. The identified “readiness-literacy gap” suggests that global institutions must move beyond treating AI as a standalone digital tool, instead adopting structured pedagogical models that bridge novice enthusiasm with rigorous computational foundations. The *OpenImpactLab* ecosystem serves as a scalable blueprint for the “AI for Social Good” (AI4SG) agenda, demonstrating how universities worldwide can foster civic engagement whilst developing Industry 4.0 competencies. By aligning structured scaffolding with real-world NGO needs, this model provides a pathway for global higher education to standardise AI literacy frameworks and democratise AI creation in diverse geographical contexts.

Ethical Declaration Statement

The ethics approval process for this project is currently in progress.

Generative AI Policy: Declaration of Use of AI in the Writing Process

Statement: The author(s) used ChatGPT/Gemini during the preparation of this work to assist in structuring the argument and refining the language. After utilising the tool, the author(s) thoroughly reviewed and edited the content as necessary and assumed full responsibility for the publication's content.

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