Designing an AI4ALL Course for Establishing AI Literacy as a Baseline Skill for All University Graduates

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Abstract

Artificial Intelligence (AI) is rapidly transforming nearly every sector of society, from healthcare and education to business and the arts. Recent advances in generative AI have further accelerated this shift, enabling students from all disciplines to interact directly with powerful AI tools. As a result, graduates are increasingly expected not only to use AI, but to exercise sound judgment about its capabilities, limitations, and implications. However, most universities lack accessible, credit-bearing AI education for non-Computer Science (non-CS) students, and existing efforts often emphasize tool use or conceptual exposure without explicitly supporting students' ability to reason critically, act responsibly, and maintain agency when working with AI.

To address this challenge, we present AI4ALL (AI for All), a course designed to establish AI literacy as a foundational competency for all undergraduate students, with particular emphasis on cultivating an AI mindset—the capacity to make informed, reflective, and ethical decisions when engaging with AI systems. The course adopts a project-based learning approach to situate AI use within open-ended, discipline-relevant problem contexts, where students must actively evaluate, justify, and take ownership of AI-informed decisions. The course design is informed by a systematic requirement analysis that integrates two complementary sources of evidence: (1) a review of existing AI literacy resources and educational research, and (2) a multi-stakeholder survey encompassing students, faculty, community members, and industry professionals.

The outcome of this study is a set of design requirements and a prototype project-based course structure that foregrounds conceptual understanding, reflective judgment, and responsible AI use over narrow technical proficiency. We argue that explicitly centering AI mindset within project-based introductory AI education is essential for preparing students to engage thoughtfully with AI in academic, professional, and civic contexts, and we offer AI4ALL as a transferable model for institutions seeking to integrate AI literacy into the undergraduate curriculum.

1 Introduction

Artificial Intelligence (AI) has rapidly become a general-purpose technology that affects nearly every discipline and profession[1,2]. Recent advances in generative AI and emerging agentic systems have further accelerated this shift, enabling non-experts to directly interact with powerful AI tools for writing, design, analysis, decision support, and creative work[3,4]. As a result, AI is no longer confined to technical roles or computing-intensive fields; instead, it increasingly shapes everyday professional practice in business, healthcare, education, public policy, and the arts[5,6,3]. Employers now expect college graduates, regardless of major, to demonstrate foundational AI literacy, including an understanding of what AI systems can do, how they are used responsibly, and how they influence human behavior and society[7,8].

Despite this growing demand, AI education at the undergraduate level remains largely concentrated within Computer Science (CS) and closely related disciplines[2]. Non-CS students are often exposed to AI only indirectly, through tools they use rather than concepts they understand, leaving them ill-equipped to grasp the underlying mechanisms or limitations of the technology[9,4]. This disconnect risks producing graduates who are frequent users of AI systems but lack the critical judgment, conceptual grounding, and ethical awareness necessary to engage with AI thoughtfully and responsibly[10,9]. Establishing AI literacy as a baseline competency for all students has therefore become both a timely and necessary educational priority[11,1].

While interest in AI literacy is increasing, universities face several structural and pedagogical gaps when attempting to serve non-CS learners[1,12]. First, most existing AI courses assume prior programming experience or mathematical background, creating high barriers to entry for students from other disciplines[13,14]. Second, introductory offerings often emphasize technical mechanisms over interpretive understanding, leaving students ill-prepared to reason about AI's limitations, biases, and societal implications[1,3]. Third, many AI learning opportunities for non-CS students take the form of workshops, one-off modules, or external online courses, rather than coherent, credit-bearing courses integrated into the undergraduate curriculum[15,16]. At a curricular level, there is also limited guidance on what non-CS students should know about AI and how that knowledge should be taught[5,4]. Questions such as which concepts are essential, how hands-on interaction should be structured without coding, and how ethical and societal considerations should be embedded remain underexplored[1,17]. As a result, institutions lack a clear framework for designing scalable, interdisciplinary AI courses that are accessible, rigorous, and pedagogically grounded[13,14].

To address these gaps, this paper presents AI4ALL, a course designed to establish AI literacy as a foundational skill for all undergraduate students, independent of technical background. Rather than proposing a purely conceptual or purely tool-focused course, AI4ALL is grounded in a systematic requirement analysis that integrates multiple perspectives on AI literacy needs.

This paper makes two primary contributions. First, it develops an empirically grounded understanding of AI literacy requirements for non-CS students by synthesizing evidence from a multi-stakeholder survey involving students, faculty, community members, and industry professionals, together with a review of existing AI literacy literature. This analysis clarifies shared expectations, concerns, and gaps in current introductory AI education.

Second, it presents a mindset-centered, project-based AI4ALL course design that operationalizes these requirements in a credit-bearing, interdisciplinary setting. The course explicitly integrates critical judgment, student agency, and responsible AI use as core learning objectives, illustrating how AI literacy for non-CS learners can be structured beyond tool proficiency or isolated conceptual exposure.

Together, these contributions position AI4ALL as a practical and transferable model for universities seeking to institutionalize AI literacy as a baseline undergraduate competency. The

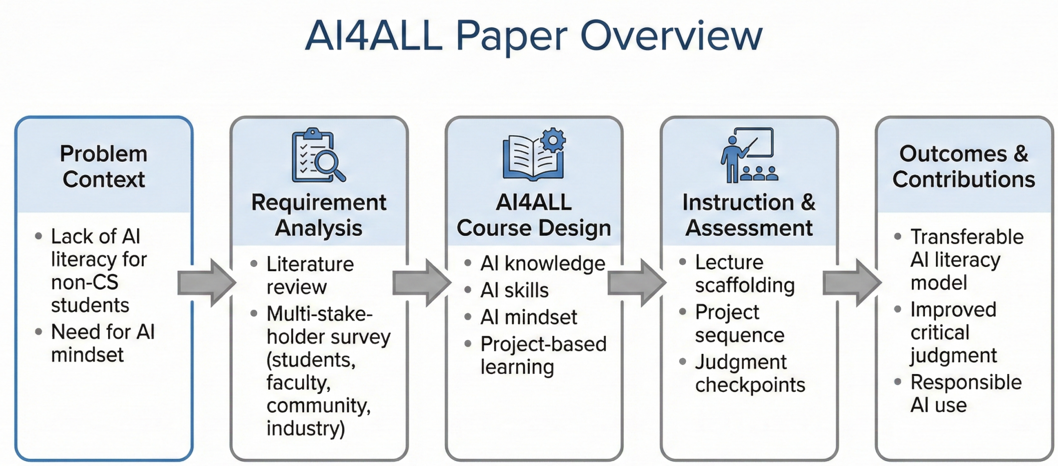

Figure 1: Overview of the AI4ALL methodology.

course design emphasizes conceptual understanding, critical reflection, and responsible engagement with AI, preparing students to interact with AI technologies not only as users, but as informed participants in an increasingly AI-shaped society.

The rest of this paper is organized as follows: Section 2 reviews related work on AI literacy and project-based learning. Section 3 presents findings from the pilot workshop and multi-stakeholder survey that inform the AI4ALL design requirements. Section 4 describes the AI4ALL course structure and instructional approach. Finally, Section 5 discusses limitations and future directions, and concludes this paper.

2 Literature Review and Reflection

This section reviews prior work relevant to the design of introductory AI education for students of all majors. Rather than providing an exhaustive survey, we synthesize the literature through a design-oriented lens, with the goal of identifying requirements and constraints relevant to a first-year, interdisciplinary AI literacy course. We focus on three themes: (1) existing online and modular AI learning resources for broad audiences, (2) educational research on AI and computing education that informs the design of interdisciplinary courses, and (3) reflective insights derived from the literature that shape the instructional choices of the AI4ALL course.

2.1 Online and Modular AI Learning Resources for All Learners

A number of initiatives have emerged in recent years to introduce AI concepts to learners without technical or coding backgrounds. These efforts collectively demonstrate strong interest in AI literacy and highlight diverse approaches to making AI accessible to non-CS audiences.

One prominent example is AI4ALL Open Learning, which provides modular curricula and open-access teaching materials originally designed for high school and early college learners[18]. These materials emphasize conceptual understanding, real-world applications, and social implications of AI, often through project-based exploration. Their modular structure and minimal technical prerequisites make them adaptable to interdisciplinary university settings.

Similarly, Day of AI, developed by MIT RAISE, offers short, scaffolded lesson plans that introduce AI concepts through interactive activities[19]. The focus on engagement, accessibility, and reflection allows non-CS students to encounter AI ideas without the barrier of programming, making these modules suitable for introductory exposure.

Other initiatives explicitly foreground ethical, societal, and human-centered dimensions of AI. The AI4K12 Guidelines identify the "Five Big Ideas in AI" as a conceptual foundation for curriculum design, emphasizing perception, learning, reasoning, interaction, and societal impact[20]. Although originally developed for K–12 education, this framework has influenced broader discussions of AI literacy by highlighting conceptual ideas that transcend technical implementation. Complementary resources from the International Society for Technology in Education further emphasize critical reflection on bias, fairness, and human–AI interaction[21].

In addition to curricular initiatives, several non-technical MOOCs and open-access courses target general audiences. AI for Everyone introduces AI capabilities, limitations, and use cases without requiring programming experience[22], while courses such as AI Tools for Everyone emphasize hands-on interaction with generative AI tools for everyday tasks[23]. Interactive platforms such as Teachable Machine further demonstrate how no-code tools can make abstract AI concepts tangible for learners with little technical background[24].

Collectively, these resources suggest emerging best practices for introductory AI education: prioritizing conceptual understanding over coding, leveraging accessible tools for experiential learning, and embedding ethical and societal considerations throughout. At the same time, most of these efforts exist as standalone modules or external learning opportunities rather than integrated, credit-bearing university courses, highlighting a gap between exposure-oriented resources and sustained curricular experiences.

2.2 Educational Research Informing AI4ALL Course Design

AI Literacy as a Universal First-Year Competency: As AI becomes a general-purpose technology reshaping nearly every discipline, educational research increasingly argues that AI instruction must move beyond siloed technical training toward an interdisciplinary "AI for All" model[2,1]. For first-year students, the goal is not to prepare AI developers, but to cultivate AI competency, the confidence and ability to apply AI effectively, ethically, and productively within one's field of study[25,26]. Recent frameworks emphasize that AI literacy must be sociotechnical in nature, integrating foundational technical understanding with critical evaluation of social, ethical, and civic implications[2,27]. This foundational literacy is increasingly viewed as essential for workforce readiness and informed citizenship[28,29].

Four Pillars of AI4ALL Literacy: Building on this perspective, prior work proposes structured curriculum frameworks that balance accessibility with conceptual depth for non-CS learners. A commonly referenced "Four Pillar" approach organizes AI literacy around technical scope, interaction skills, ethical reasoning, and societal impact[2]. Together, these pillars suggest that effective AI literacy education must integrate not only knowledge and skills, but also an AI mindset that supports critical judgment, ethical reasoning, and reflective engagement with AI systems[27,10].

Project-Based Learning for AI4ALL: Educational research consistently identifies project-based learning (PBL) as a particularly effective pedagogy for AI4ALL courses, as it enables students from diverse majors to connect abstract AI concepts with authentic, discipline-relevant applications[30,31]. Effective AI4ALL projects are typically open-ended and situated in interdisciplinary contexts, allowing students to draw on their own interests and backgrounds[32]. Prior studies emphasize the importance of scaffolding, reflection, and iterative design cycles to support exploratory learning and student agency without requiring advanced technical expertise[33,34].

Generative AI in Project-Based Learning Contexts: Within AI4ALL courses, generative AI often appears both as a subject of study and as a tool that can support ideation, iteration, and feedback. Research suggests that when used intentionally, generative AI can help students explore alternatives, test assumptions, and refine project ideas[35,36]. At the same time, effective course designs emphasize human–AI collaboration rather than automation, requiring students to critically evaluate, modify, or reject AI-generated outputs[37,38]. These findings reinforce the importance of preserving human agency and judgment, positioning generative AI as a catalyst for learning rather than a substitute for thinking.

Assessment Aligned with AI4ALL Learning Goals: Assessment research further reinforces the need for AI4ALL courses to move beyond outcome-oriented evaluation toward process-focused assessment. Rather than grading only final artifacts, effective approaches emphasize documenting the process of AI interaction, including iteration, reflection, and decision-making[39,40]. Reflective portfolios and design rationales are commonly recommended mechanisms for capturing students' evolving understanding of AI concepts, ethical reasoning, and limitations[38,41]. These assessment strategies support the transfer of AI literacy to real-world contexts[13,32].

Key Literature-Informed Takeaways for AI4ALL Design

Takeaway 1: AI literacy for non-CS students must extend beyond tool use to include judgment and responsibility. Across prior work, there is broad agreement that introductory AI education should emphasize not only what AI systems can do, but also how and when they should be used. This highlights the need to cultivate an AI mindset centered on critical judgment, ethical reasoning, and reflective awareness.

Takeaway 2: Project-based learning is well suited for interdisciplinary AI literacy when carefully scaffolded. The literature consistently identifies PBL as an effective pedagogy for engaging students from diverse majors with AI concepts through authentic problems, provided that scaffolding, reflection, and accessible tools are intentionally incorporated.

Takeaway 3: Integrated, credit-bearing courses are necessary for sustained AI learning. While workshops and modular resources provide valuable exposure, the literature reveals a gap in curriculum-integrated approaches that allow AI knowledge, skills, and mindset to develop progressively over time.

2.3 Reflections on AI4ALL Course Design

Reflecting on the literature reviewed above, several observations emerge that shaped the design of the AI4ALL course. Rather than identifying shortcomings in prior work, these reflections highlight tensions that arise when translating AI literacy research into a first-year, credit-bearing course for non-CS students.

First, many AI learning opportunities are episodic, delivered through workshops or short modules that limit opportunities for developmental learning. Designing AI4ALL as a semester-long course allows learning objectives, activities, and assessments to be aligned and revisited over time.

Second, ethical and societal considerations are often treated as separate discussions rather than embedded within hands-on AI use. The literature suggests that ethical reasoning is more likely to be internalized when integrated directly into authentic tasks. In AI4ALL, ethical reflection is therefore treated as a core component of AI mindset and embedded throughout project activities.

Third, there remains limited consensus on which AI concepts are essential for non-CS students. To address this uncertainty, the AI4ALL design is informed by requirement analysis that synthesizes input from students, educators across disciplines, and professionals who increasingly encounter AI in their work.

Finally, while AI technologies evolve rapidly, the ability to exercise critical judgment and reflective awareness remains a durable learning outcome. This observation reinforces the importance of prioritizing AI mindset alongside knowledge and skills, enabling students to adapt to future AI systems beyond those encountered in the course.

Together, these reflections motivate the AI4ALL course design, which integrates AI knowledge, AI skills, and AI mindset as complementary learning dimensions to support accessible, responsible, and transferable AI literacy.

3 Stakeholder Survey and AI Literacy Requirements

To inform the design of a credit-bearing AI4ALL course, we conducted a stakeholder-informed requirement analysis centered on surveys of students, faculty, community members, and industry professionals. An earlier AI4ALL workshop series served as a formative outreach effort to raise awareness of AI across disciplines, attract students from diverse academic backgrounds, and provide a shared baseline introduction to AI concepts. Insights from these workshops also informed the refinement of the subsequent survey instrument[42].

3.1 Survey Design and Stakeholder Groups

The survey was designed to support course design rather than statistical generalization. Questions focused on participants' perceptions of AI relevance, learning priorities, concerns about AI use, and views on pedagogical approaches such as project-based learning (PBL). A mix of Likert-scale and open-ended questions was used to balance interpretability with qualitative insight. Separate but aligned versions of the survey were administered to four stakeholder groups (i.e., students, faculty, community members, and industry professionals) to capture complementary perspectives on AI literacy needs.

Survey Design and Core Dimensions. The survey instrument was designed to elicit stakeholder perspectives on what constitutes meaningful and durable AI literacy for non-CS learners, rather than to assume a predefined hierarchy among technical knowledge, practical skills, and reflective competencies. In particular, the survey explicitly probes whether stakeholders view the development of an *AI mindset*, including critical judgment, ethical reasoning, awareness of limitations, and reflective decision-making, as important, and how they prioritize it relative to AI knowledge and tool proficiency. This design allows the study to empirically examine whether an emphasis on AI mindset is broadly supported, contested, or context-dependent across stakeholder groups.

To support comparison while remaining actionable for curriculum design, survey questions across all stakeholder groups were organized around four shared dimensions:

- **Perceived relevance of AI:** Questions assess whether respondents view AI as relevant to academic, professional, or civic contexts, and how strongly they believe AI will impact future work and society.
- **AI mindset and judgment:** Items probe stakeholder views on the importance of critical evaluation of AI outputs, ethical reasoning, awareness of AI limitations, and reflective decision-making when interacting with AI systems.
- **Knowledge versus skills:** Respondents are asked to compare the relative importance of conceptual understanding of AI, practical tool use, and judgment-oriented competencies.
- **Pedagogical preferences:** Questions explore preferred learning formats, with particular attention to project-based learning, real-world case studies, and experiential approaches.

These shared dimensions provide a consistent analytical framework across stakeholder groups while allowing question wording and emphasis to be adapted to each group's role and context. Importantly, each dimension maps directly to a course design decision, enabling the survey results to inform both instructional emphasis and pedagogical strategy in the AI4ALL course.

Stakeholder-Specific Adaptation. While the overall structure of the survey remained consistent across stakeholder groups, question wording and emphasis were adapted to reflect each group's role, context, and relationship to AI. Separate survey instruments were therefore designed for students, faculty, community members, and industry professionals.

For *students*, questions emphasize learning preferences, perceived career relevance of AI, concerns about overreliance and impacts on critical thinking, and expectations for an AI4ALL course.[1] For *faculty*, questions focus on pedagogical appropriateness, transfer of AI literacy into subsequent coursework, and perspectives on the relative importance of AI mindset versus tool proficiency in supporting disciplinary learning.[2] For *community members*, questions foreground access, trust, equity, and responsible participation in an AI-mediated society, reflecting civic and societal concerns beyond formal coursework.[3] For *industry professionals*, questions probe the durability of AI-related competencies, gaps observed in recent graduates, and the perceived value of project-based learning for workforce readiness in evolving professional contexts.[4]

By intentionally designing the survey around shared dimensions while adapting question phrasing to stakeholder context, the instrument supports a triangulated requirement analysis that informs both *what* AI4ALL should teach and *how* it should be taught.

3.2 Student Perspectives on Learning AI

Table 1: AI perceptions by major group (student respondents).

Major Group	**n**	**Career Relevance**	**Mindset Importance**	**PBL Support**
Computer & Data Sciences	10	4.70	4.50	80%
Business & Economics	4	4.25	4.50	100%
Social Sciences	4	3.00	5.00	50%
Humanities & Arts	5	2.25	4.20	80%
Engineering	2	4.00	4.50	100%

Note: Small subgroup sizes limit statistical interpretation; results are used to surface design-relevant patterns.

We surveyed 27 undergraduate and graduate students across a range of academic disciplines. Students largely viewed AI as a permanent and influential technology, rating its relevance to future careers at a mean of 4.00/5. Importantly, students expressed strong interest in developing an AI mindset, defined as critical evaluation, ethical awareness, and reflective use, rating its importance at a mean of 4.48/5.

[1] Student Survey: `https://forms.gle/Cf6aqmPTC7qnFApi6`
[2] Faculty Survey: `https://forms.gle/LYzLrMTRDL52q49s5`
[3] Community Survey: `https://forms.gle/HmgmT1zPUsur3PGt5`
[4] Industry Survey: `https://forms.gle/XqnZ6JbUxZLQr2sY6`

Student responses also revealed differences across academic backgrounds. While all groups rated AI mindset as highly important, perceptions of career relevance and support for PBL varied by major, underscoring the need for scaffolding and discipline-sensitive instructional design.

For instance, while we found those in STEM- and business-related fields largely found AI to be relevant to their careers (4.32/5) and to be in overwhelmingly in support of PBL (93.3%), students who fell into the category of Social Sciences and Humanities & Arts were less likely to feel AI was relevant to their careers (2.63/5) and less open to supporting a PBL curriculum (65.0%), albeit still favoring it by a majority.

Table 2: Student perspectives on AI literacy needs and learning preferences (n=27).

Category / Measure	**Key Finding**
Background and Perceived Relevance	
AI familiarity	100% $\geq$ "familiar", 55.6% "Very familiar"
Career relevance of AI (mean)	4.00 / 5
Importance of AI Competencies	
AI mindset importance (mean)	4.48 / 5
Top desired outcome	Evaluating AI-generated information (66.7%)
Secondary desired outcome	Ethical and social understanding (63.0%)
Third desired outcome	Effective tool usage (59.3%)
Learning Preferences	
Preferred learning format	Real-world case studies (92.6%)
Traditional lectures	44.4% preference
Project-based learning (PBL)	74.1% endorse PBL for responsible learning
Primary Concerns	
Raised in open-ended responses	Over-reliance / skill atrophy (33.3%)
	Ethical concerns (29.6%)

In general, students' learning preferences strongly favored experiential approaches. Almost all respondents (92.6%) preferred real-world case studies over traditional lectures (44.4%), and a clear majority (74.1%) endorsed project-based learning as an effective way to understand responsible AI use. Open-ended responses revealed recurring concerns about over-reliance on AI and the potential erosion of critical thinking, suggesting that students value guidance on *how* and *when* to use AI, not only how to operate tools. Many students also commented on their concerns regarding ethical uses of AI within open responses, citing case studies mentioned in courses and worries about its environmental impact, suggesting that students would also appreciate discussion on how to ensure ethical and fair usage of AI across various domains and use cases.

3.3 Perspectives from Faculty, Community, and Industry Stakeholders

Faculty respondents (n=9) emphasized judgment-oriented competencies over technical depth. A majority (66.6%) rated AI mindset as more important than tool proficiency, with the remainder viewing them as equally important. No faculty respondents rated technical tools as more important than mindset. Faculty respondents also unanimously agreed that an AI4ALL course should focus on critical evaluation of AI-generated content and the ethical and responsible use of AI as learning outcomes, echoing sentiments shared by students about learning responsible AI usage.

Table 3: Faculty prioritization of AI mindset vs. technical tool proficiency (n=9).

Response	Count	Percent
Much more important than tools	4	44.4%
More important than tools	2	22.2%
Equally important	3	33.3%
Less important than tools	0	0.0%

Table 4: Faculty consideration of learning outcomes for an AI4ALL course (n=9).

Response	Count	Percent
Understanding AI capabilities / limits	7	77.8%
Practical use of AI tools	5	55.6%
Evaluating AI-generated content	9	100.0%
Ethical / responsible AI use	9	100.0%
Judgment of when to use AI	8	88.9%
AI applications per discipline	0	0.0%
Technical details of AI models	2	22.2%

Note: Faculty respondents were asked to choose up to five outcomes from the given options.

Community stakeholders (n=7) near unanimously (85.7%) rated the development of an AI mindset as highly important, emphasizing skepticism toward and the ability to recognize AI-generated content, ethical reasoning, and equitable access to AI education. Community stakeholders also unanimously agreed that PBL would help students better understand the societal aspects of AI. Open-ended responses echoed faculty concerns about over-reliance on AI and the erosion of human judgment.

Industry respondents (n=14) expressed more varied views, reflecting differences in sectoral exposure to AI. While respondents from AI-intensive sectors rated AI literacy as highly important, others emphasized balancing judgment-oriented competencies with practical tool readiness. For instance, while those surveyed from the software industry mostly felt it was more important to develop an AI mindset (66.7%) while the remainder felt an AI mindset was as important to develop as tool proficiency (33.3%), those surveyed from the manufacturing and industrial sector largely felt the two were equally important (60.0%) while the remainder felt tool proficiency was more important (40.0%).

3.4 Design-Relevant Requirements for AI4ALL

Taken together, the survey findings reveal a small number of design-relevant requirements for introductory AI education that cut across stakeholder groups. Rather than pointing to specific

Table 5: Industry perspectives on AI mindset vs. tool proficiency (n=14).

Response	**Count**	**Percent**
Much more important than tool proficiency	1	7.1%
More important than tool proficiency	2	14.3%
Equally important	6	42.9%
Slightly less important	4	28.6%
Much less important	1	7.1%

Interpretation: Industry responses emphasize balancing judgment-oriented competencies with tool readiness.

tools or technical content, the results consistently emphasize *how* students should learn to engage with AI and *what kinds of competencies* are likely to remain valuable as AI technologies evolve. Students expressed a strong preference for real-world, discipline-relevant applications and experiential learning approaches, indicating that abstract or tool-centric instruction alone is insufficient. Faculty and community respondents echoed concerns about overreliance on AI and the erosion of critical thinking, while industry stakeholders highlighted the importance of adaptability and judgment in AI-supported work environments. Collectively, these perspectives suggest that cultivating an AI mindset, encompassing critical judgment, ethical reasoning, and reflective awareness, should be treated as a central learning outcome rather than an ancillary topic.

Based on this synthesis, we distill the survey results into a set of concrete design requirements that guide the AI4ALL course. These requirements, summarized in the box below, directly inform the course structure and pedagogical choices presented in Section 4.

Key Survey-Informed Requirements for AI4ALL Design

Requirement 1: AI4ALL should prioritize the development of AI mindset alongside foundational knowledge and skills. Across all stakeholder groups, respondents consistently rated critical evaluation, ethical reasoning, and reflective judgment as important or highly important outcomes of AI education. These responses indicate that an AI4ALL course must explicitly address not only what AI systems can do, but how and when they should be used responsibly.

Requirement 2: Instruction should center on real-world, discipline-relevant applications supported by project-based learning. Students unanimously preferred real-world case studies and strongly endorsed project-based learning as a means of understanding responsible AI use. Faculty and industry stakeholders similarly viewed experiential learning as effective for developing transferable judgment and adaptability, suggesting that project-based learning should serve as a primary pedagogical approach.

Requirement 3: AI4ALL should emphasize durable competencies over tool-specific mastery. Stakeholders across groups expressed caution toward overemphasizing specific AI tools or rapidly changing technologies. Instead, the survey results support a focus on conceptual understanding, critical evaluation, and adaptability, which are competencies that remain relevant as AI systems and platforms evolve.

3.5 Limitations

While the student survey achieved target participation, response rates from faculty, community, and industry stakeholders were smaller, limiting generalizability. In addition, the student sample was weighted toward computing-related majors, which may bias perceptions of AI familiarity and relevance. These limitations are considered when interpreting the findings and motivate continued data collection in future iterations of AI4ALL.

4 AI4ALL Course Design

Guided by prior literature on interdisciplinary AI education and the design-relevant requirements identified through our multi-stakeholder survey analysis, we designed AI4ALL as a first-year, credit-bearing course aimed at establishing AI literacy as a baseline competency for students from all disciplines. As illustrated in Fig. 2, the course integrates three complementary learning dimensions—AI knowledge, AI skills, and AI mindset—through a scaffolded structure that connects concise conceptual instruction, guided practice, project-based exploration, and reflection-centered assessment. Rather than positioning AI as a purely technical subject, the course treats AI as a sociotechnical system and emphasizes conceptual understanding, reflective judgment, and responsible use. AI4ALL assumes no prior technical background and intentionally balances concise conceptual instruction, guided practice, and project-based reflection.

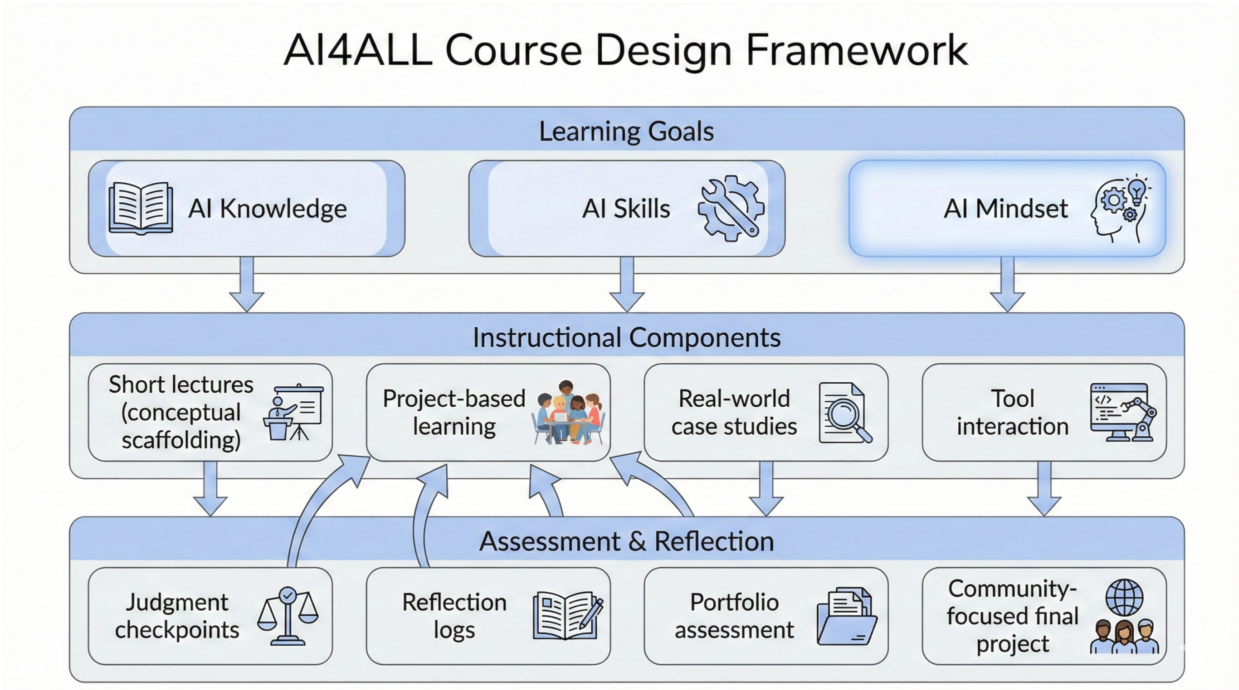

Figure 2: AI4ALL course design emphasizing AI mindset.

4.1 Learning Framework and Design Principles

AI4ALL adopts a three-dimensional learning framework integrating *AI knowledge*, *AI skills*, and *AI mindset*. AI knowledge focuses on foundational concepts such as what AI systems are, how they learn from data, and why they sometimes fail. AI skills emphasize practical interaction with contemporary AI tools, including interpreting outputs, prompting effectively, and recognizing limitations. AI mindset, treated as a primary and enduring learning outcome, encompasses critical judgment, ethical reasoning, reflective awareness, and appropriate reliance on AI.

Given the rapid evolution of AI tools and models, the course deliberately avoids deep algorithmic or mathematical coverage (e.g., detailed model architectures or optimization techniques). Instead, it prioritizes conceptual understanding and application-level reasoning that can transfer across tools, disciplines, and future contexts.

4.2 Role of Lectures: Conceptual Scaffolding

Although AI4ALL is project-centered, short and targeted lectures play a critical scaffolding role. Lectures establish shared vocabulary, mental models, and analytic lenses that students immediately apply in project work. Rather than serving as content delivery endpoints, lectures are designed to prepare students to reason about AI behavior, limitations, and impact.

Lecture topics are organized into thematic modules:

- **Foundations of AI and Machine Learning**: What AI is and is not; differences between rule-based and data-driven systems; common misconceptions about intelligence.

- **How AI Learns and Fails**: Training data, generalization, bias, overfitting, and sources of error.
- **Human–AI Interaction and Generative AI**: Prompting as specification, iteration, evaluation, hallucination, and uncertainty.
- **Ethics, Bias, and Responsibility**: Fairness, privacy, accountability, transparency, and intellectual property.
- **AI and Human Behavior**: Trust, persuasion, behavioral adaptation, and feedback loops.
- **Interpreting AI-Generated Media**: Authorship, authenticity, meaning-making, and misinformation.

Collectively, these lectures equip students with conceptual tools needed to evaluate AI outputs rather than accept them uncritically, reinforcing AI mindset development throughout the course.

4.3 Project Sequence and Learning Progression

The AI4ALL project sequence is intentionally grounded in students' everyday encounters with AI systems. Rather than treating projects as abstract exercises, each activity begins with familiar AI behaviors (such as classification errors, generative responses, recommendations, or creative outputs) and uses these encounters as entry points for conceptual understanding, ethical reflection, and judgment development. This progression directly reflects survey findings indicating strong student preference for real-world, discipline-relevant applications of AI.

Early projects focus on helping students recognize how AI systems behave differently from human expectations. In *Exploring How AI Learns*, students interact with a simple, visual AI model (e.g., an image or text classifier) to observe how training data shapes behavior. Students document which inputs the model handles well, which inputs cause confusion, and where human assumptions about intelligence diverge from AI behavior. Guided reflection prompts encourage students to consider how these differences influence trust, over-reliance, and interpretation of AI errors.

Mid-semester projects emphasize sociotechnical reasoning and responsible practice. In *Analyzing an AI Limitation or Failure Case*, students examine a real or constructed instance of AI failure, such as biased outputs or ungrounded responses. Students analyze both technical factors (e.g., data limitations) and social or institutional factors (e.g., deployment context, user expectations), and propose guidelines for responsible use. This project explicitly connects AI behavior to human and organizational decision-making.

Later projects foreground meaning-making, creativity, and behavioral impact. In *Creative or Expressive Use of AI*, students use generative AI tools to produce a small creative artifact and reflect on authorship, interpretation, and the human–AI creative process. In *AI and Human Behavior*, students analyze an everyday AI system (e.g., a recommender or chatbot) to examine how AI assumptions about human behavior shape user actions, trust, and decision-making.

The course culminates in a final integrative project, *Creating Value with AI in Your Community or*

Table 6: Alignment between lecture modules and course projects in AI4ALL.

Lecture Module	Core Concepts	Associated Project
Foundations of AI	Everyday AI systems; misconceptions	P1: Everyday AI Audit
How AI Learns and Fails	Data-driven learning, bias, errors, limitations	P2: Exploring How AI Learns
Human–AI Interaction	Prompting, iteration, evaluation, uncertainty	P3: Prompt Iteration in Everyday Tasks
Ethics and Responsibility	Fairness, privacy, accountability, IP	P4: Responsible AI Use Guidelines
AI and Human Behavior	Trust, persuasion, behavioral adaptation	P5: AI Influence on Human Behavior
AI-Generated Media	Authorship, authenticity, misinformation	P6: Interpreting AI-Generated Media
Value Creation and Transfer	Cross-disciplinary application	Final: Creating Value with AI

Field, in which students design a small AI-assisted solution relevant to their personal interests, academic discipline, or community context. Students must articulate not only technical feasibility, but also how their solution influences human behavior, what values it promotes or challenges, and what responsible-use considerations should guide its deployment.

Across the project sequence, reflection and judgment are continuously reinforced through guiding questions and structured checkpoints, ensuring that students develop the ability to reason about AI systems as sociotechnical artifacts embedded in everyday life.

4.4 Alignment of Instruction, Project, and Assessment

AI4ALL is designed around the principle that alignment is achieved not merely by mapping content to activities, but by making students' reasoning and judgment visible at key moments of AI use. Rather than treating lectures, projects, and assessment as separate instructional components, the course integrates them through a sequence of *judgment checkpoints* that connect conceptual instruction, project work, and evaluation.

Lectures introduce conceptual lenses, such as how AI systems learn, where they fail, and how they influence human behavior, that students are immediately required to apply when making decisions in project contexts. Projects are structured to surface moments where students must decide how to interact with AI systems, whether to trust outputs, and how to account for limitations, uncertainty, or ethical concerns. Assessment then focuses on evaluating these decisions and the reasoning behind them, rather than evaluating technical correctness alone.

Table 6 illustrates how lecture modules scaffold corresponding projects across the semester. Rather than delivering standalone content, lectures provide the analytic vocabulary and mental models that students draw upon when encountering judgment checkpoints embedded within each project. This structure ensures that projects function as applied reasoning environments, not isolated exercises.

Table 7 shows how the project sequence collectively supports development across AI knowledge (K), AI skills (S), and AI mindset (M). While individual projects may emphasize particular dimensions, AI mindset is intentionally reinforced across all projects through repeated judgment checkpoints. This repetition enables instructors to observe growth in students' critical evaluation, reflective awareness, and responsible AI use over time, rather than assessing mindset through a single ethics-focused assignment.

A defining feature of AI4ALL's assessment strategy is therefore the systematic use of *judgment checkpoints*, structured prompts embedded at consequential decision points in each project, such

Table 7: Coverage of AI knowledge (K), skills (S), and mindset (M) across course projects.

Project	K	S	M
Everyday AI Audit	✓	✓	✓
Exploring How AI Learns	✓	✓	✓
Prompt Iteration		✓	✓
Responsible AI Use Policy	✓		✓
AI and Human Behavior Analysis	✓		✓
Interpreting AI Media	✓	✓	✓
Final Project: Creating Value with AI	✓	✓	✓

as before finalizing prompts, accepting AI-generated outputs, or proposing real-world applications. These checkpoints require students to explicitly articulate assumptions, evaluate uncertainty, and justify reliance on AI systems in context.

By embedding assessment directly within moments of AI interaction, judgment checkpoints serve both formative and summative purposes. They guide students' learning during project execution while also providing instructors with concrete evidence of how students reason about AI behavior, limitations, and societal implications. In this way, alignment in AI4ALL is achieved through a continuous loop linking instruction, action, reflection, and evaluation.

Example Judgment Checkpoint. In the prompt iteration project, students respond to the following questions before final submission: (1) What assumptions did you make about what the AI system could do before using it? (2) Which parts of the AI-generated output did you trust, and why? (3) Identify one limitation, error, or source of uncertainty in the output. How did this influence your next action? (4) Would you rely on this output in a real academic, professional, or personal context? Justify your answer.

Students submit brief written responses alongside prompt logs or annotated outputs. Similar checkpoints appear throughout the course, enabling repeated practice in reflective judgment rather than a single, isolated ethical exercise. Over time, this repeated engagement helps students internalize habits of critical evaluation and appropriate reliance on AI systems.

The final project culminates in a portfolio-style submission that integrates selected artifacts and judgment checkpoint reflections, allowing students to document how their understanding of AI capabilities, limitations, and responsibilities evolved across the semester and to communicate these insights to a non-expert audience.

Assessing AI Literacy and AI Mindset Development The AI4ALL course adopts a process-oriented assessment strategy in which judgment checkpoints and project-based portfolios make students' reasoning visible during their interaction with AI systems. These mechanisms provide rich formative evidence of how students evaluate AI outputs, justify reliance decisions, and reflect on ethical implications throughout the semester. However, to maintain alignment between the course learning objectives and evaluation, it is also important to incorporate a summative perspective that measures students' overall development of AI literacy competencies at the end of the course.

Such summative assessment serves two complementary purposes. First, at the course level, it allows instructors to evaluate whether the intended learning outcomes—AI knowledge, AI skills, and AI mindset—have been achieved and to use the results to guide iterative improvement of course design. Second, at a broader educational level, a well-defined assessment framework could enable comparison across different AI literacy courses and contribute to the emerging effort to define AI literacy as a baseline competency for university graduates.

Importantly, because expectations about AI literacy span academic, professional and societal contexts, the development of such assessment instruments should involve multiple stakeholders, including educators who design and teach AI literacy courses, researchers studying AI education, and industry professionals who will employ graduates in AI-mediated workplaces. Incorporating these perspectives can help ensure that the competencies measured reflect both pedagogical objectives and real-world expectations for responsible and effective AI use.

Despite growing interest in AI literacy education, existing assessment approaches remain limited. Many studies of introductory "AI for Everyone" courses emphasize formative evaluation of learning processes rather than validated instruments for measuring overall competency development[43,44,45]. As a result, widely accepted and standardized methods for assessing AI literacy in higher education are still emerging.

In this work, we therefore rely primarily on project-based portfolios and judgment checkpoints to evaluate student learning. As a practical interim approach, the course combines the final integrative project with an AI literacy competency examination that evaluates students' understanding and application of key concepts (Bloom's taxonomy levels 1–3), including training versus inference, hallucinations, prompt design, interpretation of AI outputs, and ethical considerations. We view the development of a comprehensive and widely validated AI literacy assessment instrument as an important direction for future research and a potential standalone contribution to the field.

4.5 Summary of Course Design and Dissemination Plan

By combining concept-focused lectures, a scaffolded project sequence grounded in everyday AI encounters, and assessment embedded within project workflows, AI4ALL treats AI literacy as a durable competency rather than a transient set of tool skills. The course integrates AI knowledge, AI skills, and AI mindset, with judgment checkpoints providing structured opportunities for students to articulate assumptions, evaluate AI outputs, and reflect on responsible use. This design prepares non-CS students to engage with evolving AI technologies with critical awareness, ethical responsibility, and informed agency. As discussed earlier, developing validated and widely applicable summative assessment instruments for AI literacy remains an open challenge, and we view the design of such assessments as an important direction for future work.

We plan to begin offering this course in Fall 2026 and to make all course materials—including the syllabus, assignments, and lecture slides—publicly available to support reuse and adaptation.

5 Conclusion and Future Directions

This paper presented the design of *AI4ALL*, a first-year, interdisciplinary course aimed at establishing AI literacy as a baseline competency for students across all majors. Grounded in prior literature and informed by a multi-stakeholder requirement analysis, AI4ALL treats AI not as a purely technical subject, but as a sociotechnical system that students must learn to engage with critically, ethically, and reflectively. The course design integrates three complementary learning dimensions, which are AI knowledge, AI skills, and AI mindset, through concise conceptual instruction, project-based learning grounded in everyday AI experiences, and structured judgment checkpoints that make students' reasoning explicit and assessable.

Insights from both prior literature and our multi-stakeholder surveys reveal strong alignment around the importance of real-world relevance, experiential learning, and the cultivation of critical judgment in AI use. Across studies and stakeholder perspectives, there is consistent emphasis on helping students understand AI limitations, critically evaluate AI-generated outputs, and reason about ethical and societal implications. Together, these findings reinforce the central role of AI mindset as a durable and transferable learning outcome, particularly for non-CS students navigating rapidly evolving AI technologies. By embedding reflection and evaluation directly within project workflows, AI4ALL operationalizes AI mindset as a set of observable practices rather than an abstract or standalone ethical topic.

At the same time, the AI4ALL design highlights several open challenges for introductory AI education. One challenge concerns *scalability*. As AI literacy courses expand to serve broader and more diverse student populations, providing timely, meaningful feedback on students' reasoning, judgment, and responsible AI use becomes increasingly difficult. Project-based learning and reflective assessment are pedagogically powerful, but also resource-intensive when implemented at scale. A second challenge concerns the development of validated and widely applicable *summative assessment instruments* for measuring AI literacy competencies. While process-oriented assessments such as judgment checkpoints can effectively capture students' reasoning during project work, standardized methods for evaluating overall AI literacy development across courses and institutions remain limited.

Future work will therefore explore both instructional and assessment directions. On the instructional side, we will investigate how support for reflection, judgment, and responsible AI engagement can be sustained as enrollments grow, including designing scalable feedback mechanisms and instructional structures that preserve AI mindset development in large, interdisciplinary settings. On the assessment side, we aim to explore the design of competency-oriented summative AI literacy assessments that can complement project-based evaluation and support broader comparisons across AI literacy initiatives. Addressing these challenges is essential for ensuring that AI literacy education remains rigorous, inclusive, and responsive to the evolving role of AI in society.

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