The Future Tech Stack: Reimagining Requirements for Learner-Centered Futures

Prepared by Techademics for LearnerStudio

techademics

LearnerStudio

SEPTEMBER 2025

Introduction

Today the education technology landscape is fragmented, compliance-driven, and misaligned with what learners need. Schools juggle dozens of siloed tools. AI is layered onto outdated models. Learners across all backgrounds report low engagement and limited relevance. These disjointed systems make it hard to navigate progress, access insights, or make informed decisions—undermining trust, coherence, and the promise of personalized learning.

The Future Tech Stack: Reimagining Requirements for Learner-Centered Futures introduces a modular, open, and interoperable architecture designed to support lifelong learning and learner agency. Co-created with educators, technologists, funders, and institutional leaders, this framework helps organize tools, data, and experiences into a connected ecosystem that empowers learners, equips educators, and enables responsive systems. It does not prescribe a new platform.

At the core of the requirements are **key integrated components**—each designed to work together while remaining flexible, standards-based, and adaptable to local context. All of these components are powered by Agentic AI and strengthened through human connection.

Building this future requires more than technology, it demands enabling conditions:

- **Comprehensive interoperability** through open standards and aligned procurement
- **Governance of Agentic AI** ensuring accountability and transparency
- **Shared governance** and public-purpose alignment across infrastructure and procurement

Making the vision real will take collective action. Policymakers must align incentives with interoperability. Builders must prioritize modular, ethical design. Educators and communities must shape real-world use. Funders must invest in shared infrastructure that enables coherence, personalization, and long-term resilience. Learners and families must articulate needs, provide feedback, and push for tools that reflect their lived realities.

Contents

The Case for Change: Where Today's EdTech Falls Short

Learners and families are no longer passively accepting what institutions deliver. They're calling for something fundamentally different: learning experiences that are more relevant to their own aspirations and contexts, connected across the full range of educational and community settings, and adaptable as their goals and circumstances evolve. Learners want learning experiences that connect to real life, offer choice without chaos, and pair freedom with guidance[1]. They seek pathways through education systems that propel them toward futures of their choosing.

Most educational systems, from K-12 to postsecondary education and workforce, are optimized for compliance, not for learner progress. They reflect institutional priorities more than individual needs and remain fragmented, unable to adapt to the complexities of learners' lives today.

The current EdTech landscape is highly **fragmented and siloed**. Most institutions rely on a patchwork of disconnected tools, including student information systems (SIS), learning management systems (LMS), assessment platforms, and communication apps, each addressing narrow functions. No single company holds more than 10% of the market, creating redundancy and operational inefficiencies[2]. This fragmentation produces siloed data systems that prevent a comprehensive view of the learner and the learner's progress. Learners navigate confusing and inconsistent pathways between learning experiences, while educators and administrators duplicate effort across incompatible platforms[3]. This fragmentation affects all learners in some way as they move across K-12, higher education, and the workforce. For youth who move frequently between schools or systems—such as those in foster care, members of military families, or those experiencing homelessness—this fragmentation can be particularly acute; learning data and progress records are lost or inaccessible during transitions.

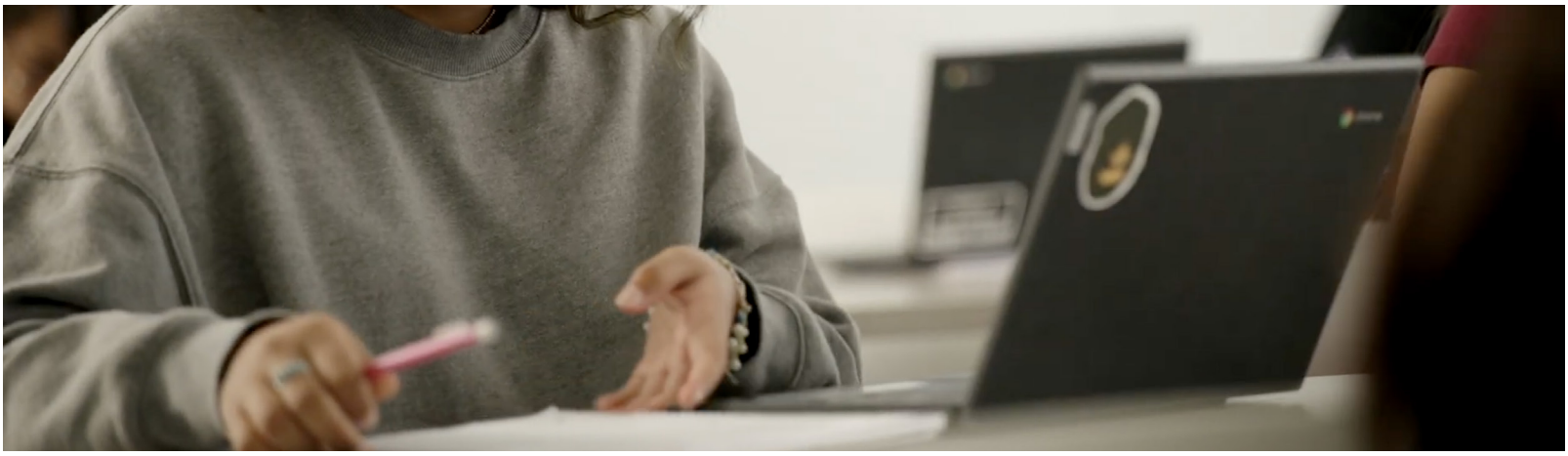
The tech stack of the future's **modular architecture and open standards**, enable data to flow securely across platforms and **provide a holistic view of a learner's entire journey** across K-12, postsecondary education, and the workforce.

Many existing education systems prioritize institutional compliance over learner empowerment when

[1] Focus groups were conducted by Techademics in spring 2025 with middle and high school students across five U.S. regions, including urban, suburban, and rural districts. Participants represented diverse racial, linguistic, and socioeconomic backgrounds.

[2] HolonIQ. (2023). 2023 Global Education Outlook: EdTech Market Size & Forecast [Extract]. https://www.holoniq.com/edtech

[3] Smith, K., & Holleran, J. (2023). Building the Future of Learning: Funding Opportunities for a New Paradigm [Version 1.4]. Learner Studio and Holleran Impact Advisors. https://thelearnerstudio.org/wp-content/uploads/2025/09/Building-the-Future-of-Learning_For-Web.pdf



utilizing technical tools. While essential regulations like Children's Online Privacy Protection Act (COPPA), Children's Internet Protection Act (CIPA) and Family Educational Rights and Privacy Act (FERPA) protect privacy and safety, design choices often prioritize reporting and control rather than enabling agency, exploration, or real-time feedback[4]. For example, filtering mechanisms designed for compliance can over-restrict access to valuable learning resources, while dashboards optimized for reporting often obscure insights that learners themselves could use to make informed choices. High school and college aged learners, in particular, are left to navigate platforms, including social media, without sufficient support for exercising agency or managing their own privacy. Often, there is an assumption that this age group can be successful with limited training and resources.

The tech stack of the future embeds **ethical governance and learner-owned data controls** into infrastructure design, shifting focus from institutional control to individual agency and creates adaptive pathways that evolve with learners' needs.

Current platforms often fail to address access needs and realities. Many tools are not designed for low-bandwidth environments, limiting usability in rural or under-resourced communities. Similarly, limited multilingual support and non-inclusive user interfaces exclude learners from non-dominant language groups, disproportionately impacting immigrant, Indigenous, and multilingual students[5]. These barriers compound inequities, especially when access to digital tools is assumed as a prerequisite for participation in learning.

In the tech stack of the future, **accessibility and inclusion are foundational**. Features like offline operability, low-bandwidth optimization, and multilingual interfaces ensure that learners everywhere—regardless of geography, language, or connectivity—can benefit from high-quality digital experiences.

Oversight of current systems is fragmented and often disconnected from long-term public goals and governance is an afterthought. Responsibility is scattered across agencies and vendors, leaving learners and communities with little influence over how their data is governed or how technologies evolve.

With the tech stack of the future, **shared governance models** are embedded directly into the infrastructure, building trust through transparency, cross-sector coordination, and alignment to public purpose.

In many cases, artificial intelligence has been added to legacy systems as an afterthought; the AI is bolted on. Instead of reimagining learning, these systems simply automate outdated practices, reinforcing compliance-oriented models and limiting innovation.

The tech stack of the future is an **AI-native architecture that enables real-time feedback**, guidance, and dynamic learning experiences, embedding intelligence throughout the stack.

---

[4] U.S. Department of Education. (n.d.). Protecting Student Privacy. https://studentprivacy.ed.gov/

[5] Office of Educational Technology, U.S. Department of Education. (2017). Reimagining the role of technology in education: 2017 National Education Technology Plan update. https://tech.ed.gov/netp/

A New Vision: Defining the Future Tech Stack

This report sets out a clear blueprint: **what the tech stack is, the design principles that guide it, and the requirements needed to build it.** Unlike existing conversations focused narrowly on personalization or platform upgrades, this vision calls for a technology backbone that will prepare young people to flourish in the age of AI—as individuals, as workers, and as civic participants. The tech stack of the future re-imagines the digital foundation of a human-centered system of learning designed for usability, empowering learners to adapt to changing contexts, ensuring relevance across settings.

The future-ready tech stack assumes learners move fluidly across roles and contexts, e.g., student, volunteer, employee, and that the infrastructure that supports them must evolve in parallel. These requirements move beyond where we are today.

Design Principles in the Future Tech Stack

To build a future-ready tech stack, design principles ought to guide design and decision making:

- **Learner-Centered:** Support individuals in navigating, shaping, and owning their learning journeys across time and context.
- **Socially Connected and Relational:** Extend and enhance—not replace—human connection. Components are organized intentionally to integrate opportunities for mentorship, peer learning, and community interaction. Social learning is treated as core infrastructure, not peripheral enrichment.
- **Secure and Privacy-Preserving:** Embed security at every component, and Privacy-Enhancing Technologies (PETs), such as differential privacy, homomorphic encryption, and federated learning (see glossary), enhance trust and protect sensitive data in storage, transit, and use[6].
- **Feedback-Driven:** Support continuous, multi-directional feedback loops, leveraging real-time analytics to inform learner reflection, instructional support, and system adaptation. As systems adapt, learners, educators, and systems all benefit from timely information to adjust goals, resources, or strategies.
- **Accessible by Design:** Embed accessibility features, multilingual functionality, and offline or low-bandwidth operability by default, ensuring the tech stack can operate equitably across diverse environments.
- **Modular and Composable:** Interoperable components and granular learning objects that can be developed, updated, and recombined independently[7]. This enables flexibility and local customization and allows systems to evolve without requiring full replacement.
- **Grounded in Open Standards and Protocols:** Open standards and protocols ensure interoperability, data portability, and compatibility across providers[8]. This prevents vendor lock-in, avoids the risk of data being trapped in one provider's proprietary system, and supports a healthy ecosystem of tools and platforms.
- **AI-Native and Insight-Driven:** Artificial intelligence is embedded throughout—not added as a bolt-on—powering real-time guidance and system learning. These capabilities act as the connective tissue across modular components.

Seven Core Components and Three Cross-Cutting Capabilities of the Future Tech Stack

In the future, learner-centered educational technology must be composed of seven modular, interoperable components, each designed to serve a distinct function, while working in concert as part of a connected infrastructure. When widely integrated and broadly adopted, they support continuous and uninterrupted learning across formal education, workforce, and community contexts.

[6] Future of Privacy Forum. (2020). Privacy enhancing technologies: A review of tools and techniques. https://fpf.org/wp-content/uploads/2020/12/FPF_Privacy_Enhancing_Technologies_Report.pdf

[7] Baldwin, C. Y., & Clark, K. B. (2000). Design rules, vol. 1: The power of modularity. MIT Press.

[8] 1EdTech. (n.d.). Enabling an open, innovative, and trusted education ecosystem. https://www.1edtech.org/

The Future Tech Stack: What Makes Up the Future Tech Stack for Learning?

This framework aligns human connection with technology infrastructure—showing how both sides work together to power responsive, learner-centered journeys.

TECHNOLOGY ENABLEMENT	TECH STACK	LEARNING SYSTEM ENHANCEMENT
Enables secure data exchange and real-time system insights	Data Management	Builds trust through shared goals and data transparency
Stores credentials, skills, and learning artifacts over time	Learner Wallet	Supports learners in collecting and sharing evidence of growth
Maps learning to civic, academic, and workforce skills	Skills Framework	Aligns learning to real-world, transferable competencies
Interfaces (AI, analog, mobile) surface content and recommend next steps	Learner Interface	Facilitates progress tracking and opportunity discovery
Delivers modular content personalized to learners and aligned to skills	Learning Resources	Ensures access to relevant, inclusive, and quality materials
Assesses learner mastery and system performance	Measurement	Creates feedback loops for continuous improvement
Contextual data from the learning process to inform the learner and stakeholders decisions	Guidance	Offers timely feedback, coaching, and personalized navigation

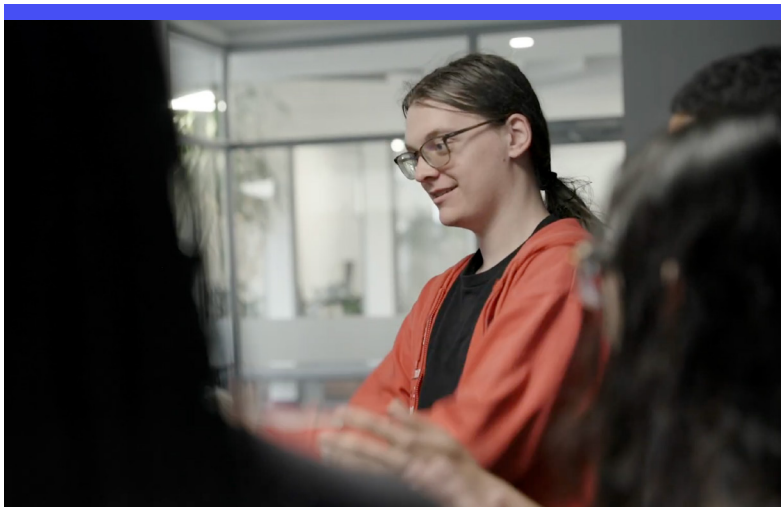
What distinguishes these requirements is orchestration. Instead of a platform- or tool-centric paradigm, individual components can be flexibly assembled, scaled, and adapted while maintaining real-world coherence. The following describes the core components of the tech stack of the future, highlights their key functions and enabling technologies.

1. Data Management

This foundational, standards-based infrastructure component enables secure, portable, and privacy-preserving data exchange across all internal components and with authenticated external systems[9]. Key features include standardized data models (e.g., Ed-Fi, IEEE) to ensure semantic consistency; open APIs for controlled data access; and secure data transport protocols. It incorporates identity management and authentication for granular access control and integrates Privacy-Enhancing Technologies (PETs) like differential privacy and federated learning (see glossary) to allow analysis while protecting individual privacy.[10, 11,12]

2. Learner Wallet

The Learner Wallet is a secure, portable, and learner-owned application for managing and selectively sharing verified achievements, credentials, skills, and experiences[13]. It acts as a dynamic record hub, enabling individuals to validate and share credentials across settings while maintaining ultimate control over their data. Built on standards such as W3C Verifiable Credentials and 1EdTech Open Badges 3.0, the wallet ensures portability and interoperability across diverse platforms.[14, 15] When integrated with the Skills



Framework (below) and paired with Learning and Employment Records (LERs), the wallet makes achievements transparent, meaningful, and portable, ensuring they can be recognized across institutions, employers, and community settings.

3. Skills Framework

In a future-ready ecosystem, skills are defined with precision—from broad competencies to specific, measurable skills—and aligned with learning resources and assessments to create clear pathways for acquisition and validation. The Skills Framework is a modular, portable, and machine-readable system that defines and organizes competencies while mapping them to relevant learning experiences, credentials, and evolving workforce needs. This provides a common lexicon that enables personalization and coherence across K–12, higher education, and workforce contexts.[16, 17]

---

[9] Project Unicorn. (n.d.). The Importance of data Interoperability in K-12 education. https://www.projectunicorn.org/interoperability

[10] Future of Privacy Forum. (2020). Privacy-enhancing technologies: A review of tools and techniques. https://fpf.org/wp-content/uploads/2020/12/FPF_Privacy_Enhancing_Technologies_Report.pdf

[11] Gentry, C. (2009). A fully homomorphic encryption scheme [Doctoral dissertation, Stanford University]. ProQuest Dissertations Publishing.

[12] Kairouz, P., McMahan, H. B., Avent, B., Bellet, A., Bennis, M., Bhagoji, A. N., Richards, D., & Zhao, S. (2021) Advances and open problems in federated learning. Foundations and Trends in Machine Learning, 14(1–2), 1–210.

[13] Digital Promise. (2022). Learner Wallets: A foundation for skills-based hiring and learning. https://digitalpromise.dspacedirect.org/bitstreams/786d1683-1bec-4f66-bdc0-4becdb23dc6d/download

[14] World Wide Web Consortium (W3C). (2022). Verifiable credentials data model v1.1. https://www.w3.org/TR/vc-data-model/

[15] 1EdTech. (2022). Open badges specification version 3.0. https://www.imsglobal.org/spec/openbadges/v3p0/

[16] Open Skills Network. (n.d.). Rich skill descriptors (RSDs). https://rsd.openskillsnetwork.org/

[17] Digital Promise. (2022). Learner Wallets: A foundation for skills-based hiring and learning. https://digitalpromise.dspacedirect.org/bitstreams/786d1683-1bec-4f66-bdc0-4becdb23dc6d/download

A critical enabler of this framework is the knowledge graph: a machine-readable network of interconnected entities (e.g., skills, concepts, resources) and the relationships between them. For example, a knowledge graph can show that "Skill A" is a prerequisite for "Skill B" or that "Competency X" is composed of multiple subskills. When connected to the Learning Resources and Content component, knowledge graphs (rich metadata links learning resources directly to the skills they develop) become especially powerful. This transforms a static list of competencies into a dynamic web that AI can navigate by analyzing a learner's gaps and automatically assembling personalized pathways from among the most relevant resources.

4. Learner Interface

The Learner Interface component, often embodied by a Learning Experience Platform (LXP), is a customizable, AI-native interface that provides learners with unified and intuitive access to content, progress tracking, support services, and opportunities from diverse providers. AI-native LXPs serve as intelligent orchestrators of the journey, moving beyond passive repositories and use AI to understand needs, curate resources, and recommend inquiry pathways. Key features include personalized dashboards, AI-driven aggregation and curation, discovery tools, and seamless integration of assessments and feedback, all within a coherent experience that foregrounds agency and discovery. LXPs can support learning experiences that leverage emerging consumer wearable technologies and content that uses augmented and virtual reality (AR/VR).

5. Learning Resources

The Learning Resources component serves as the rich library of learning experiences, supports, and services that learners can access across contexts. It includes a wide range of digital and analog resources (e.g., online simulations to internships, service projects, maker spaces). This component is defined by the granularity of Learning Objects (small, reusable learning elements); the modality of the resources (online, place-based); and the discoverability enabled by modern metadata standards.

When the Learning Resources component connects to the Skills Framework, there is the ability to measure the impact of each resource and leverage high impact resources in other learning interfaces and experiences. Critical to usability is the integration of resources with metadata standards such as IEEE P2881 and the Learning Resource Metadata Initiative (LRMI). These standards and initiatives help to ensure both humans and AI agents can discover, adapt, and assemble resources aligned to skills frameworks and learner needs.[18, 19]

[18] IEEE Learning Technology Standards Committee. (2023, August 6). P2881 draft standard for learning technology — August 6, 2023 version [Draft standard]. IEEE Open Source.

[19] eLearning Industry. (n.d.). Unleashing the potential of OER: The advantages and challenges of open learning materials.

6. Measurement

The Measurement component continuously captures and analyzes learning interactions to generate personalized insights and support adaptive learning. It moves beyond traditional, summative tests to a model of real-time, embedded assessment. By capturing multi-modal data inputs (e.g., learner responses, submitted evidence and work products, biometric sensor data from wearables), the Measurement component creates a rich, dynamic picture of a learner's progress and engagement. Analysis of the data and large datasets enabled by machine learning yields insights that can be shared across the learning system.

The Measurement component is a continuous feedback loop that informs learners, educators, and the broader system of what is being mastered, what gaps may be present, where and how to manage resources to support the learning experience. Measurement enables timely course correction and personalization, while also laying the foundation for research[20].

7. Guidance

The Guidance component uses measurement component insights to provide timely navigation, scaffolding, and support. Its purpose is to help learners make informed decisions, sustain motivation, and connect to meaningful opportunities.

In the future tech stack, Guidance is multifaceted and may include recommendation engines, analytics dashboards, and intelligent tutoring systems. At more advanced levels, agentic AI systems can proactively perform tasks, such as recommending mentors, nudging learners toward opportunities, or even scheduling peer study groups, while always keeping human judgment in the loop. Effective Guidance empowers and augments educators, mentors, and peers, keeping human connection central to the learning journey.

[20] Mainstay. (n.d.). AI-powered student engagement platform. https://mainstay.com

Summary of Core Components of the Future Tech Stack

COMPONENT	DEFINITION & PURPOSE	KEY FEATURES & FUNCTIONALITIES	ENABLING TECHNOLOGIES & STANDARDS
1. Data Management	A privacy-preserving data exchange (securing, organizing, using, storing) across all components and external systems.	Standardized data models, open APIs, secure data transport, identity/authentication management, and Privacy-Enhancing Technologies (PETs).	IEEE LTSC standards, 1EdTech suite (LTI, Caliper, OneRoster), Ed-Fi Data Standard, CMI5, and PETs (Differential Privacy (DP), Homomorphic Encryption (HE) and Federated Learning (FL)).
2. Learner Wallet	A secure, portable, and learner-owned digital application that manages and selectively shares verified credentials, skills, and artifacts across tools and experiences.	Credential storage and sharing, learner-controlled consent, skills framework integration, and cross-platform portability.	W3C Verifiable Credentials, Open Badges 3.0, and 1EdTech CLR 2.0.
3. Skills Framework	A machine-readable system that defines, organizes, and relates skills and competencies across contexts.	Granular skill definitions, knowledge graph relationships, alignment with experiences and credentials, and dynamic updates responsive to needs. Continuously updated using version tracking, enabled by usable and intuitive cross walks.	1EdTech CASE[21], W3C OSMT, Rich Skill Descriptors (RSDs), and CTDL.
4. Learner Interface	A customizable, AI-native interface that provides unified access to content, tools, progress tracking, and guidance.	Personalized dashboards, AI-driven content aggregation and curation, embedded assessments, discovery tools, and seamless user experience.	LTI, AI/ML for personalization, and APIs for data exchange. Wearable technology experiences including AR/VR learning environments.

COMPONENT	DEFINITION & PURPOSE	KEY FEATURES & FUNCTIONALITIES	ENABLING TECHNOLOGIES & STANDARDS
5. Learning Resources and Content	An infrastructure that curates and delivers high-quality, granular, and reusable learning objects aligned to skills frameworks and personalized pathways.	Metadata tagging, multilingual content and experiences, recommendations, and Lego-like architecture for content assembly.	IEEE P2881[22], LRMI[23], and Creative Commons licensing for open resources.
6. Measurement, Metrics, and Assessment	Continuously capture and analyze multi-modal evidence of learning to generate personalized insights and support adaptive learning.	In-line assessments, biometric and behavioral data inputs, skill alignment, and multi-directional feedback mechanisms.	AI/ML models for predictive analytics and learning pattern recognition, event stream data standards (xAPI, Caliper), and PETs for protecting privacy in sensitive contexts.
7. Guidance	A synergistic blend of expertise and AI-powered systems that provide timely feedback, navigation, and support.	AI-powered recommendations, learning nudges, mentor matching, progress analytics and dashboards, intelligent tutoring.	AI/ML data from Data component and integration with Learner Wallet and Skills Framework.

[21] 1EdTech. (n.d.). Competencies and Academic Standards Exchange (CASE). https://www.1edtech.org/standards/case

[22] IEEE. (2023). P2881: Standard for learning metadata terms. https://standards.ieee.org/ieee/2881/11719/

[23] LRMI. (n.d.). Learning Resource Metadata Initiative. https://www.lrmi.net/

Cross-Cutting Capabilities

Every component of the stack is reinforced by three overarching capabilities that act as the connective tissue:

Agentic AI

Orchestrates learning by deploying autonomous and semi-autonomous agents that connect learners to content, opportunities, and people. Uses role-based agents, collaborative workflows, and human-in-the-loop safeguards to carry out complex tasks. Underpinned by open-source frameworks and interoperability standards, agentic AI avoids vendor lock-in and enables diverse agents to collaborate seamlessly. See 'Agentic AI and Human Connection in Practice' for illustrations of how these capabilities function.

Community Ecosystem

Ensures learning extends beyond traditional institutional walls by integrating experiences from museums, nonprofits, employers, and cultural partners, making them visible and portable through interoperable credentials and shared data agreements. Micro-credentials and digital badges, built on open standards such as Open Badges 3.0, make informal and community-based learning legible and portable. When stored in a learner wallet, a more holistic portrait of skills and experiences emerge.[24]

Human Connection

Embeds mentorship, peer learning, and human-in-the-loop feedback into the stack. Social interaction is treated as core infrastructure, ensuring technology amplifies relationships rather than replacing them. Human-AI collaboration can use one of three approaches:

AI-led	Routine, low-stakes tasks that can be automated for efficiency (e.g., sending reminders, tagging content).[25]
AI-augmented	Tasks where AI generates drafts, analyses, or recommendations for human review and approval (e.g., drafting personalized learning paths).[26, 27, 28]
Human-led	High-stakes or relational decisions where human empathy and contextual judgment remain central, with AI serving as a supportive tool (e.g., mentoring, graduation, or disciplinary decisions).[29]

These connected capabilities ensure AI augments rather than supplants human judgment, preserving trust, accountability, and relational integrity across learning systems.

[24] 1EdTech Consortium. (n.d.). Open Badges. https://openbadges.org/

[25] Takyar, A. (2025, July 7). AI in education: Use cases, solution and implementation [Blog post]. LeewayHertz. https://www.leewayhertz.com/ai-use-cases-in-education/

[26] Tiwari, S. (2024, January 15). Human-in-the-loop framework for AI in education [Web page]. KidsAI. https://kidsai.io/human-in-the-loop-framework-for-ai-in-education-by-dr-sonia-tiwari/

[27] Layton, B. (2024, September 5). What is human in the loop AI? [Blog post]. AI Guardian. from https://www.aiguardianapp.com/post/what-is-human-in-the-loop-ai

[28] Temper, M., Tjoa, S., & David, L. (2025). A framework to regulate the usage of AI in higher education institutions. Frontiers in Education. Advance online publication. https://doi.org/10.3389/feduc.2025.1505370

[29] Sun, J., Du, R., & Feng, L. (2024). Human-AI collaboration in building educational content: Bridging innovation and pedagogy in the classroom. Pakistan Journal of Life and Social Sciences, 22(2), 18349–18368. https://www.pjlss.edu.pk/pdf_files/2024_2/18349-18368.pdf

Enhancing Motivation, Engagement, and Human Connection, and Personalization

The tech stack of the future transforms fragmented tools into a living system that adapts in real time, ensuring technology amplifies relationships and opportunities.

Bridging Real-World Learning

Learning does not stop at the classroom door. It is a social activity deeply embedded in a rich ecosystem of family, peers, cultural institutions, and local communities[30]. In this context, technology acts as a conduit and connector between interests, peers, and opportunities. For example, a young person exploring video game design in an online modding forum could have that experience linked to a local coding bootcamp or recognized in a learner wallet[31]. Programs like YOUmedia Learning Labs and Hive Learning Networks demonstrate the potential of these bridges, where informal and community-based learning complement formal education.[32]

Amplifying Human Connection

In an increasingly automated world, relationships remain central. The stack embeds features that extend—not replace—human mentorship, peer-to-peer collaboration, and social learning. Platforms like Perusall and Teachfloor show that tools can transform solitary tasks into collective ones, while mentorship networks such as MentorCruise expand access to trusted guides[33]. By treating social connection as core infrastructure, the tech stack ensures that technology strengthens—not weakens—the bonds that shape learning and development pathways.

Facilitating Mentorship and Peer Learning:

AI-enabled tools make it possible to scale mentorship and peer learning across geography and networks. Matching algorithms already power platforms like Kindred, ADPList or Upnotch, connecting learners with mentors based on shared interests and goals[34]. In the stack, these functions become interoperable services that are integrated into guidance components, learner wallets, and data systems. Mentorship becomes a built-in pathway rather than an add-on.

Navigating Opportunity:

Agentic AI—a cross cutting capability of the stack—goes beyond recommendations to act as an intelligent navigator. Drawing from the measurement, skills, and guidance components, AI agents can identify learning gaps, connect them to relevant opportunities, and facilitate human-to-human connections such as study groups or mentorship. Unlike legacy systems where AI is bolted on, agentic AI is native and can conduct reasoning, planning, and orchestrating across the ecosystem to proactively support learners' evolving goals.

Intelligent Tutoring and Scaffolding

Acting as an autonomous tutor, an agent can provide 1:1 support, offer real-time feedback, adapt the difficulty of problems, and explain complex concepts using different modalities, ensuring the learner is appropriately challenged[35].

[30] Digital Promise. (n.d.). Online platform for school-community connections [Web page]. https://digitalpromise.org/snapshots/online-platform-for-school-community-connections/

[31] Digital Media and Learning Research Hub. (2013). Connected learning: An agenda for research and design [PDF report]. University of California Humanities Research Institute. https://dmlhub.net/wp-content/uploads/files/Connected_Learning_report.pdf

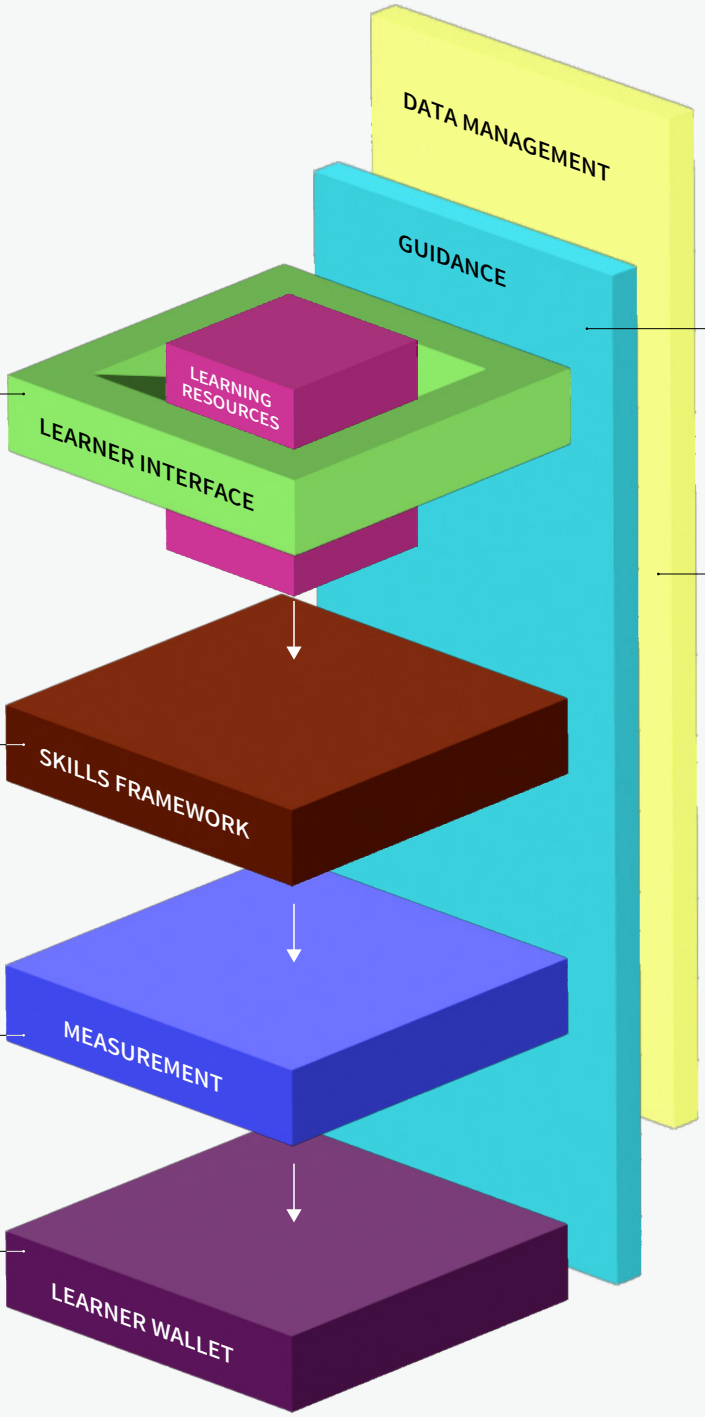
[32] MacArthur Foundation. (2012, September). Digital media and learning. https://www.macfound.org/media/article_pdfs/digital_media_learning_info_sheet.pdf

[33] Perusall. (n.d.). Perusall: Increase student engagement with social learning [Web page]. https://www.perusall.com/

[34] Upnotch. (n.d.). AI-powered mentorship platform [Web page]. https://www.upnotch.com/

[35] Talukdar, Autonomous AI Agents.

Tech Stack in Action



Unified and intuitive access to learning resources, support services, and opportunities

Nudges, coaching, navigation support guiding learning and decision making

Real-time insights and adaptive recommendations through secure, privacy-respecting data infrastructure

A modular, portable, and machine-readable system that defines and organizes skills competencies

Continuous feedback loops and visualizations surfacing learner progress and system performance

Container of personalized path-ways and journeys, credited learning and credentials

Enabling Lifelong Learning

The tech stack of the future supports continuous, personalized learning across life stages. From early schooling to career transitions, the stack adapts to evolving goals and contexts, connecting modular content, verifiable skills evidence, and real-time guidance. As learners progress, the stack scaffolds new opportunities. A middle school interest in biology could evolve into a high school internship in health care, while a part-time job in a community clinic could become the foundation for a career in public health. The new requirements ensure continuity, coordination, and learner agency across time and place.

The following illustrates one learner's journey. Following Jordan from early childhood through career, it shows how the tech stack evolves alongside changing goals and contexts, providing continuity, relevance, and agency across a lifetime. This example anchors the larger vision in a real learner experience, demonstrating how abstract components translate into meaningful support.

How the Tech Stack Supports a Learner Over Time

The tech stack evolves alongside the learner—powering growth from childhood to adulthood across changing goals,environments, and support needs.

	 Early Years (5)	 HS/College(20)	 Career (40)
	A curious, tech-savvy kindergartener.	A graduating senior attending a local college and contributing to open-source accessibility tools.	A skilled developer building tech products and mentoring youth.
Data Management	Unifies data across IEP goals, engagement, and SEL development, ensuring privacy while helping personalize learning.	Connects data across courses, certifications, and college projects to guide support and track skills.	Aggregates workplace, learning, and credentialing data to support growth and career progression.
Learner Wallet	Stores reading milestones, speech therapy achievements, and project-based learning artifacts.	Collects microcredentials, internships, accessibility projects, and skill badges from various experiences.	Organizes professional credentials, open-source contributions, and leadership experiences in a portable, verifiable format.
Skills Framework	Maps foundational skills—like collaboration, curiosity, and communication—into early competencies.	Aligns learning pathways to civic, academic, and workforce skills.	Tracks ongoing skill development in leadership, technical innovation, and community impact.
Learner Interface	Presents gamified recommendations to engage Jordan and recommend speech-boosting exercises.	Integrates course platforms, career exploration tools.	Delivers personalized career learning experiences and just-in-time tools through mobile-first user interfaces.
Learning Resources	Offers personalized motivating and engaging content—including speech tools, videos, and read-alouds.	Curates modular learning materials aligned to Jordan's interests.	Provides flexible, stackable modules for leadership, mentoring.
Measurement	Visualizes growth in learning.	Assesses mastery across civic, technical, and teamwork skills and competencies.	Tracks progress in career, leadership, and mentoring goals to inform reskilling and advancement.
Guidance	Jordan has stakeholders deliver key supports across critical foundational subjects.	Analyzes data and blends guidance across multiple roles to guide academic and career navigation.	Connects Jordan with professional networks and coaching supports to enable career advancement.

Key Conditions for Change

Progress to date is promising, but several critical gaps must be addressed before the tech stack can scale.

Continuous Learning

Today, few tools integrate AI and human advising in seamless, relational, and context-aware ways; current solutions often silo recommendation engines from human support, missing opportunities for comprehensive guidance. Most systems also lack embedded, multi-modal assessments that enable real-time personalization. Innovations like adaptive learning and biometrics, widely used elsewhere, remain underutilized in education. The connective infrastructure to manage AI-human workflows is still nascent. Intelligent middleware and user-friendly administrative interfaces are needed to coordinate components and empower learners and communities to shape personalized experiences.

Advancing technologies to address holistic guidance, measurement, and orchestration will require experimentation and continuous learning through pilots, R&D, and field-wide collaboration. These experiments will translate the vision of the stack into system-level coherence.

Comprehensive Interoperability

Even the strongest design principles and modular components and tools will fall short if they are not supported by the right technical, institutional, and cultural conditions. To scale, the field must also establish the enabling conditions for change that make coherence durable.

Interoperability has been mentioned throughout this report as a technical requirement. The real challenge is achieving it comprehensively, across tools, sectors, and policies. That means:

- **Standards Adoption and Adherence:** Future-aligned tools must implement widely adopted interoperability standards (e.g., Ed-Fi, 1EdTech such as LTI and CASE, IEEE P2881 for metadata, and emerging agent protocols). The priority is not one standard over another but field-wide adoption of frameworks that enable secure, modular exchange across platforms.[36]
- **Policy Interoperability:** Data-sharing agreements with partners—such as museums, employers, or nonprofit organizations—must balance compliance (e.g., FERPA) with practical access and collaboration.[37] These agreements should allow integration of community-based and offline learning experiences into learner records, ensuring they are discoverable and tied to skill frameworks.
- **Aligned Incentives:** Public agencies and philanthropic funders should prioritize tools that adhere to open standards, support modular integration, and align with future requirements. This shifts market incentives toward coherence and adaptability.

[36] IEEE Open Source. (2023). P2881 Draft [AsciiDoc]. https://opensource.ieee.org/lmt/lmt/-/blob/524509f2d0f2f3fe1744bdd343b00df1ad94f12b/P2881_Draft_August_6_2023.asciidoc

[37] StriveTogether. (2015). Student data privacy: Best practices. https://www.strivetogether.org/wp-content/uploads/2017/04/student-data-privacy-best-practices.pdf

AI and Learning System Governance

While the previous section illustrated how agentic AI supports learning in practice, realizing these benefits responsibly requires clear governance. Because Agentic AI systems initiate actions and make decisions on behalf of learners, they introduce new demands for oversight that go beyond traditional tools. This therefore calls for:

- **Accountability:** Clear assignment of responsibility for agent outputs (developer, deployer, or oversight body).[38]
- **Transparency and Explainability:** Agents must clearly communicate logic and data provenance, especially in high-stakes environments like education.[39]
- **Bias Mitigation:** Continuous auditing, fairness metrics, and representative training data are required to reduce harm.[40, 41]
- **Human-in-the-loop (HITL):** AI should augment, not replace, human roles in instruction, guidance, and assessment; policies should codify this principle.[42]
- **Privacy-Enhancing Technologies (PETs):** Techniques like federated learning[43], differential privacy[44], and homomorphic encryption[45] must be embedded to protect learner data.

To build a future tech stack that reflects shared values and fosters trust, we must embed governance into the stack itself. Embedding governance into the stack means:

- **Emerging Models:** Data trusts[46] and shared stewardship models[47] can distribute responsibility, promote transparency, and reduce dependence on proprietary systems.
- **Inter-Agency Data Frameworks:** Secure data sharing must be enabled across community partners using FERPA-compliant exceptions (e.g., studies or audit clauses).[48]
- **Community Data Sovereignty:** Communities should have meaningful input into how their data is used, interpreted, and governed.[49, 50, 51]
- **Operationalizing Human-in-the-Loop (HITL):** At the system level, roles must be clearly defined for AI-led, AI-augmented, and human-led tasks, with permissions and workflows designed to preserve human judgment.[52]

Governance Signals: Use certifications or trust marks to signal compliance with interoperability, privacy, and learner-agency standards, helping funders, policymakers, educators, and families make informed choices.

---

[38] Turdibayeva, K. (2025, April 23). Ethical Considerations of Agentic AI. ProcessMaker. https://www.processmaker.com/blog/ethical-considerations-of-agentic-ai/

[39] Ibid.

[40] Friedman, B., & Nissenbaum, H. (1996). Bias in computer systems. ACM Transactions on Information Systems, 14(3), 330–347. https://doi.org/10.1145/230538.230561

[41] IEEE. (2016, December 13). Ethically aligned design: A vision for prioritizing human well-being with autonomous and intelligent systems (Version 1). https://standards.ieee.org/content/dam/ieee-standards/standards/web/documents/other/ead_v1.pdf

[42] Wu, C., Zhang, H., & Carroll, J. M. (2024). AI governance in higher education: Case studies of guidance at big ten universities. Future Internet, 16(10), 354. https://doi.org/10.3390/fi16100354

[43] Kairouz, P., McMahan, H. B., Avent, B., Bellet, A., Bennis, M., Bhagoji, A. N., et al. (2021). Advances and open problems in federated learning. Foundations and Trends in Machine Learning, 14(1–2), 1–210. https://doi.org/10.1561/2200000083

[44] Future of Privacy Forum. (2025, March 15). Privacy enhancing technologies: A state education agency landscape analysis. https://fpf.org/wp-content/uploads/2025/03/Privacy-Enhancing-Technologies-An-Education-Landscape-Analysis.docx.pdf

[45] Gentry, A fully homomorphic encryption scheme.

[46] Hardinges, J. (2018, July 10). What is a data trust? The Open Data Institute. https://theodi.org/article/what-is-a-data-trust/

[47] Bauwens, M., Kostakis, V., & Pazaitis, A. (2019). Peer to peer: The commons manifesto. University of Westminster Press.

[48] StriveTogether, Student Data Privacy.

[49] Community Commons. (n.d.). An Introduction to Data Equity.https://www.communitycommons.org/collections/An-Introduction-to-Data-Equity

[50] Casey Family Programs. (2022, November 22). How can data sharing across child- and family-serving systems be implemented effectively? https://www.casey.org/data-sharing-implementation/

[51] Community Commons, An introduction to data equity.

[52] Washington Office of Superintendent of Public Instruction. (2024, June). Human-Centered AI Guidance for K–12 Public Schools. https://ospi.k12.wa.us/sites/default/files/2024-06/comprehensive-ai-guidance.pdf

Looking Ahead: Collectively Building the Tech Stack of the Future

Realizing the potential of the tech stack of the future requires more than technical design. It will depend on stakeholders across the ecosystem— learners and families, builders, funders, policymakers, community organizations, and educators—acting in complementary roles. Each group brings distinct levers: some shape the tools, others align incentives, and still others ensure governance and local relevance. Taken together, these early actions create the enabling environment that allows the stack to scale and deliver value.

Call to Action for Learners and Families

- **Articulate Needs and Provide Feedback:** Use feedback mechanisms to surface what is working, where barriers remain, and how tools can better reflect diverse aspirations and contexts.
- **Advocate for Agency:** Call for systems that embed transparency, portability, and choice so learners control how their data, achievements, and pathways are represented.
- **Engage in Co-Design:** Participate in pilots, advisory groups, and feedback loops to ensure tools are responsive to the realities of learners' daily lives, including cultural, linguistic, and community contexts.
- **Build Demand for Inclusive Solutions:** Families can amplify adoption of tools that are aligned with ethical governance, accelerating the field's shift toward more equitable infrastructure.

Call to Action for Builders (e.g., EdTech Companies, Developers, and Open Source Communities)

- **Design for Community and Connection:** Move beyond solo learning models. Build features that promote human connection, such as peer collaboration, mentorship matching, and links to local learning opportunities, while embedding continuous feedback loops.[53] Platforms should surface learner and educator perspectives in real time, enabling tools to evolve responsively. Ensure user data remains under learner control and that platforms support multilingual access and low-bandwidth environments to broaden reach and access.
- **Adopt Common Protocols and Prioritize Interoperability:** Design tools with interoperability as a core principle. Adhere to open standards like CASE, LTI, Open Badges, W3C Verifiable Credentials, and Ed-Fi.[54] Expand adoption to include emerging protocols like A2A for agent interoperability, ensuring tools can function within an intelligent, modular ecosystem.[55] Favor modular, API-first architectures that support granular Learning Objects and enable seamless integration across the stack.
- **Embed AI Natively and Ethically:** Integrate agentic AI as a native element of the platform experience. Prioritize explainability (XAI), context awareness, and bias mitigation from the ground up.[56] Design with Human-in-the-Loop (HITL) principles to ensure that AI augments human judgment rather than replacing it, reinforcing trust, transparency, and learner agency.[57]
- **Contribute to Open Source and Standards Development:** Contribute to open-source tools, agentic frameworks, and standards development. Collective investment in public-purpose technologies creates a more stable, sustainable foundation for all actors in the ecosystem.
- **Coordinate Across the Ecosystem:** Ensure that tools and platforms are not developed in silos. Collaborate with peer builders, educational institutions, and initiatives to align on standards, share knowledge, and drive coherent, mission-aligned innovation.

Call to Action for Funders (e.g., Philanthropy, Public Sector, and Private Investors)

- **Offer Long-Term Capital:** Infrastructure investment should prioritize long-term transformation over short-term return. Blended finance models combining philanthropy, public funds, and values-aligned capital can diminish risk and accelerate scale.[58]
- **Invest in Capacity Building:** This includes professional development for educators in AI and data use, governance training for administrators, and staffing for community partnership management.
- **Prioritize Catalytic Infrastructure:** Direct funding toward foundational components that will function as public-purpose utilities. This includes interoperable data, credential registries, open-source agentic AI frameworks, and shared Learning Object Repositories. These elements are

---

[53] Digital Promise, Online Platform for School-Community Connections.

[54] 1EdTech, Enabling an open, innovative, and trusted education ecosystem.

[55] Littlejohn, A., & Cook, J. (2013). Learning objects and repositories. Association for Learning Technology. https://repository.alt.ac.uk/2300/1/Learning_objects_and_repositories.pdf

[56] Umoke, C. C., Nwangbo, S. O., & Onwe, O. A. (2025). The governance of AI in education: Developing ethical policy frameworks for adaptive learning technologies. International Journal of Applied Science and Mathematical Theory, 11(2), 71–88. https://www.iiardjournals.org/get/IJASMT/VOL.%2011%20NO.%202%202025/The%20Governance%20of%20AI%20in%20Education%2071-88.pdf

[57] Tiwari, Human-in-the-loop framework for AI in education.

[58] Smith, K., Heitz, C., Petersen, J., Fehrman, R., & Sisnett, D. (2025). Fuel for the moment: Catalytic capital and the future of learning. LearnerStudio. http://thelearnerstudio.org/wp-content/uploads/2025/03/Updated_-Part-1-Fuel-for-the-Moment_-Catalytic-Capital-and-the-Future-of-Learning-2024.pdf

essential to universal access, interoperability, and innovation, but they will not emerge from market forces alone. Philanthropy can play a catalytic role, using flexible capital to derisk innovation and accelerate field-wide infrastructure.

- **Champion Inclusive Pilots:** Support pilots that test the full stack in diverse learning contexts, particularly those that serve multilingual learners, adults, incarcerated individuals, those reentering from military service, and communities with low bandwidth or limited access. Inclusive field testing helps ensure that the infrastructure delivers real value across real-world conditions.
- **Accelerate R&D in Agentic and Ethical AI:** Invest in explainable, privacy-preserving, open-source models that enhance learner agency. Keep the Agentic AI capability aligned to public-purpose goals.[59, 60]
- **Invest in Technical and Adaptive Leadership:** Fund leadership development programs that build the capacity to navigate AI-native infrastructure and advance systems-level change. Many education organizations lack leaders trained to bridge technical, educational, and human-centered design[61]. Sector-wide, institutions report persistent talent shortages in roles that blend technology and learning, particularly in high-demand areas like IT and STEM. Coordinated action to build this bench is essential.[62]

[59] Tiwari, Human-in-the-loop framework for AI in education.

[60] Bhati, A. (2025, February 20). Open-source AI agents: Exploring best AI agents. Keploy. https://keploy.io/blog/community/top-open-source-ai-agents

[61] Organisation for Economic Co-operation and Development. (2024, September 24). Bridging talent shortages in tech. OECD Publishing. https://doi.org/10.1787/f35da44f-en

[62] dvance CTE (2025, April 10). Bridging the talent pipeline gap: How state CTE leaders can leverage systematic CCR and WBL implementation. Advance CTE. https://careertech.org/blog/bridging-the-talent-pipeline-gap-how-state-cte-leaders-can-leverage-systematic-ccr-and-wbl-implementation/

Call to Action for Policymakers (at the Federal, State and Local Levels)

- **Align Procurement and Incentives to Advance Interoperability:** Reform procurement processes to prioritize modular, interoperable solutions. Require adherence to open standards (e.g., Ed-Fi, 1EdTech CASE and LTI, IEEE P2881, A2A) in all publicly funded EdTech. This alignment reduces fragmentation, promotes adaptability, and strengthens long-term public value.[63]
- **Advance Future-Ready Data and AI Governance:** Develop clear, forward-looking governance for both data and AI. This includes comprehensive state-level AI ethics guidelines focused on transparency, bias mitigation, and accountability in autonomous systems.[64] Policy frameworks must also enable secure, ethical data sharing between schools and vetted community organizations, laying the groundwork for a thriving education ecosystem.[65]
- **Invest in Shared Digital Infrastructure:** Direct public resources—such as remaining ESSER funds, technology bonds, or state block grants—toward durable, public-purpose infrastructure. Priorities include state-level data systems, credential registries, and interoperable Learner Employment Record (LER) platforms that make learning portable, visible, and actionable across systems.
- **Incentivize Cross-Sector Collaboration:** Create enabling conditions for collaboration across K–12, higher education, workforce, and community partners. Support shared standards and

[63] IEEE Learning Technology Standards Committee, P2881 draft standard for learning technology..

[64] AI for Education. (2025). State AI Guidance for K12 Schools. Retrieved June 22, 2025. https://www.aiforeducation.io/ai-resources/state-ai-guidance

[65] StriveTogether, Student data privacy.

infrastructure that make lifelong pathways visible and navigable.

- **Develop Translational Policy Leadership:** Support leaders who can act as translators between the technical and educational domains, ensuring policy keeps pace with innovation.

Call to Action for Community Organizations and Educators

- **Shape Governance and Define Use Cases:** Engage in the governance of future-ready tools and data systems to ensure that community values and diverse learner needs shape development. Co-design use cases that are grounded in real-world learning and responsive to local context.
- **Champion Holistic Success and Learner Voice:** Redefine what counts as success. Advocate for metrics that reflect learner agency, well-being, and lifelong growth, not just test scores or engagement statistics. Center learners' lived experiences in design and implementation through inclusive, continuous feedback loops.
- **Advance Professional Learning and AI Literacy:** Invest in professional learning that builds the capacity to engage with AI and emerging technologies ethically and effectively. Ensure educators and community leaders have the tools to adapt, guide, and govern technology use in service of learners.
- **Partner in Piloting and Validation:** Act as implementation partners for new tools, testing functionality and validating impact in real-world learning environments. Use mechanisms like Digital Badges to recognize learning happening in community programs and make it visible to the broader ecosystem.[66]
- **Invest in Boundary-Spanning Leadership:** Develop educators and organizers who can connect across institutional silos, linking schools, community programs, employers, and technology providers.

The table below summarizes how different stakeholder groups can prototype, pilot, and implement the tech stack of the future. It highlights their key roles, immediate actions, and the potential impact of their leadership.

STAKEHOLDER GROUP	KEY ROLE IN ECOSYSTEM DEVELOPMENT	ACTIONS TO TAKE NOW	POTENTIAL IMPACT
Learners & Families	Articulate needs and provide feedback	Demand the use of learner wallets to manage credentials, engage in feedback loops, advocate for personalized and agentic tools	Ensures tools reflect real needs, validates design, drives demand for inclusive solutions
Funders	Catalyze shared infrastructure and ethical innovation	Invest in public-purpose utilities (e.g., open LORs, agentic AI frameworks); fund AI literacy and leadership development; support inclusive, full-stack pilots	Establishes durable infrastructure, ensures ethical, equitable AI, enables scalable solutions

[66] Instructure. (n.d.). What are Open Badges? Canvas LMS Community. Retrieved June 22, 2025. https://community.canvaslms.com/t5/Canvas-Badges-Credentials/What-are-Open-Badges/ta-p/528726

STAKEHOLDER GROUP	KEY ROLE IN ECOSYSTEM DEVELOPMENT	ACTIONS TO TAKE NOW	POTENTIAL IMPACT
Policymakers	Create enabling environments and align public investment	Require open standards in procurement, fund shared LER platforms, develop AI ethics and data-sharing governance, incentivize cross-sector collaboration	Accelerates interoperability, sustains public infrastructure, governs AI responsibly
Builders	Design stack-aligned tools and lead human-centered innovation	Adhere to open standards, embed agentic AI with HITL safeguards, design for inclusion and connection, contribute to open-source infrastructure	Builds trustworthy, interoperable tools; advances learner agency; promotes ecosystem coherence
Community Orgs & Educators	Ensure relevance and access and shape governance	Co-design use cases and success metrics, participate in governance (e.g., data trusts), champion badges for informal learning, advocate for holistic definitions of success	Grounds the stack in real-world contexts, strengthens trust and local ownership

Conclusion

Realizing the vision will require an unwavering focus on the real needs of learners and communities. It will also require commitment and dedication, and sustained investment.

Momentum is already visible: early wallet pilots, maturing skills frameworks, and growing adoption of open standards. We also see critical components, such as orchestration, measurement, and holistic guidance, remain nascent.

This moment calls for more than incremental fixes. It is an opportunity to reimagine the foundation of learning so it supports continuity, adaptability, human connection, and meaningful growth across a lifetime. By working together, builders, funders, policymakers, educators, communities, and learners can create a future where technology empowers every learner to chart their own path, supported by a connected, resilient ecosystem that grows alongside them.

Acknowledgements

The development of this report was enriched by the insights, critiques, and contributions of many individuals across the education, technology, workforce, and policy sectors. We are deeply grateful to the practitioners, researchers, builders, funders, and leaders who shared their time, expertise, and experience to help shape this work.

This work draws on a wide range of interviews, research partnerships, and public resources. We extend our sincere thanks to all who informed and challenged our thinking throughout this process.

We offer special thanks to the young learners who participated in our learner focus groups. Their candor, creativity, and clarity helped ground this work in lived experience. Their perspectives reminded us that any future worth building must center the voices and needs of learners themselves.

Domain Experts and Technical Advisors

We are grateful to the following individuals for bringing deep knowledge across education, technology, and policy. Their expertise provided critical perspective on emerging innovations and practical implementation, ensuring the vision remained grounded and actionable.

Shelly Blake-Plock
IEEE Learning Technology Standards Committee

Turner Bohlen
ASU Learning Enterprise

Michael Carter
EMG Worldwide

Brigitte Daniel-Corbin
Wilco

Juliana Finegan
Vivi

Duta Flying Earth
NACA Inspired Schools Network

Andrew Goldin
Advisor

Bernard Green
Google Classroom

Michael Ham
FullScale

Leslie Herod
Colorado State Representative & Policy Advisor

Beth Holland
FullScale

Peter Jones
IBX

Taylor Kendal
Learning Economy Foundation

Daniel Liebeskind
Topia

David Lipkin
LiFT Learning

Tilmon McCullum
AI System Architect

Erin Mote
Innovate EDU

Mark Naufel
AXIO

Paola Peacock-Villada
Peacock García Impact Consulting

Nichole Pinkard
Digital Youth Network

Tanya Ruley-Mayo
Elevate 215

Bryan Setser
Setser Group

Megan Smith
Brownstone PR

Nakia Thomas
Meta

Devin Vodicka
Learner Centered Collaborative

Wilson White
Google Policy

(continued)

We are also grateful to the following individuals who provided early insight and feedback on the report and findings at the Building Together convening in July 2025.

Russ Altenburg,
Leon Levine Foundation

Ben Caufield
Eedi

Jonny Coreson
Learning Economy Foundation

Angela DeBarger
Hewlett Foundation

Sari Factor
Imagine Learning

Kathleen Farley
Google

Donald Fennoy
Cambiar Education

Annee Garton
Vibrant Data Labs

Alison Gazarek
Intentional Futures

Isabelle Hau
Stanford Accelerator for Learning

Jay Hirschton
Vibrant Data Labs

Martin Kurzweil
Ithaka S + R

Sandra Liu Huang
Chan Zuckerberg Initiative

Matt Miller
OKO Labs

George Mu
Eedi

Janis Ortega
Advisor

Matthew Rascoff
Stanford University

Raquel Romano
AERDF

Ian Serlin
Playlab

Cameron White
Newschools Venture Fund

Moni Yupa
Inkwire

Appendix

A. Learner Personas: The Stories Behind the Tech Stack of the Future

This section expands that view by providing full persona profiles for Jordan, Amara and Xavier.

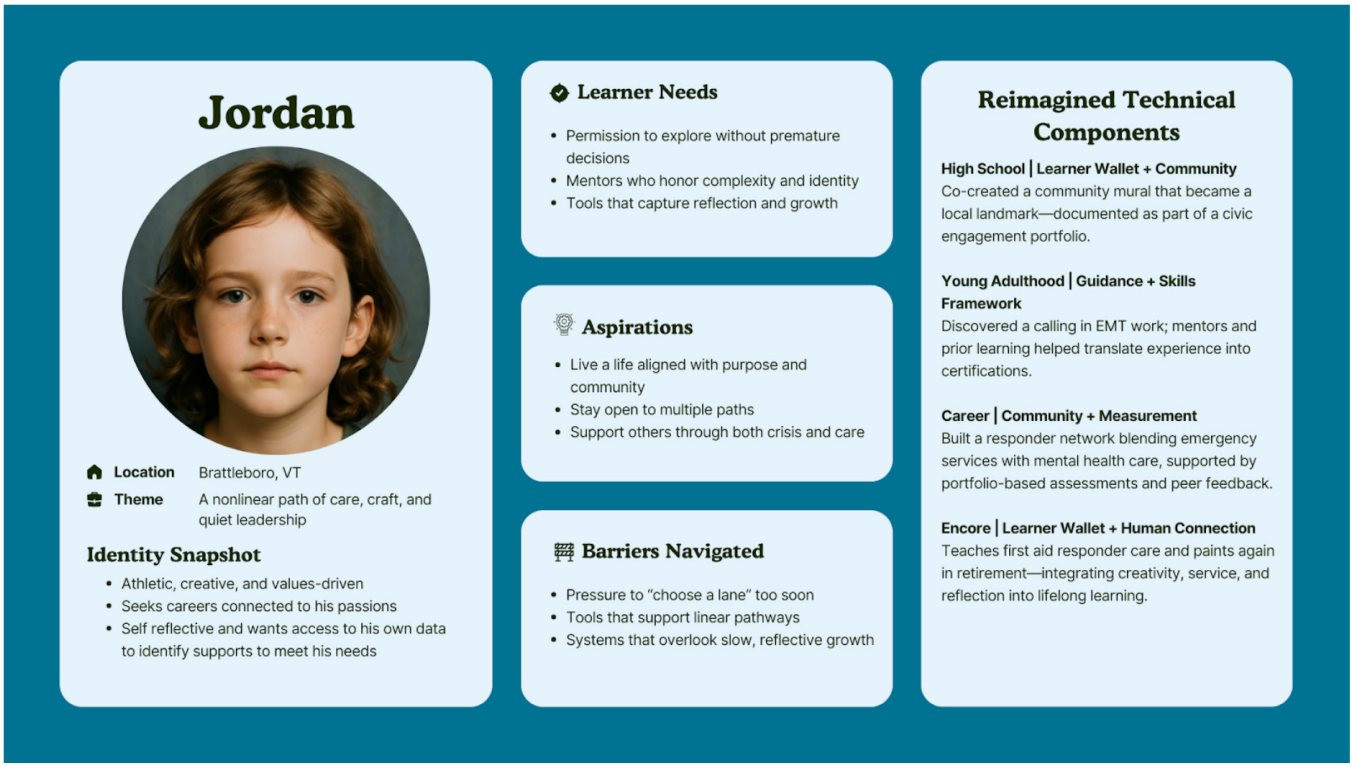
Each persona reflects a distinct context, aspiration, and set of challenges, illustrating how the stack adapts to individual needs.
The profiles include:

- A snapshot of each learner's identity, context, and goals
- Key moments in their journey and how stack components showed up
- Barriers they encountered and the types of support that made a difference

Together, these stories help bring the system design to life, connecting infrastructure to lived experience and highlighting the importance of human-centered, modular design.

D1. Jordan: The Responder and Reflective Leader

Jordan's nonlinear path weaves together art, community engagement, and crisis response, powered by mentorship and reflective, flexible learning systems.



D1. Xavier: The Builder and Climate Advocate

A hands-on problem solver who learns by building, Xavier's journey is shaped by applied STEM experiences, mentorship, and tools that recognize real-world skills.

Xavier

Location Ventura, CA

Theme Structured autonomy, invention, and engineering

Identity Snapshot

- Quiet confidence; shows what he knows through action
- Drawn to real-world problem solving
- Interested in STEM and engineering careers

Learner Needs

- Recognition of skills developed outside of school
- Independent, applied learning opportunities
- Clear feedback and flexible pacing

Aspirations

- Solve real problems through engineering
- Keep learning without "starting over"
- Help younger learners find meaningful paths

Barriers Navigated

- Repetitive content slows momentum
- Tests miss his strengths
- Generic career tools assume a narrow college path

Reimagined Technical Components

Middle School | Learner Wallet + Measurement
Built a robot from salvaged parts—documented through videos and feedback in his digital portfolio, showcasing iterative learning and growth.

High School | Skills Framework + Interoperable Data
Earned advanced credit via a energy apprenticeship, with certifications and work data synced across platforms for credit and progression.

Early Career | AI Agent + Guidance
Launched a energy startup while mentoring peers—his AI agent recommended leadership modules, and his long-term plan updated in real-time.

Civic Engagement | Learner Wallet + Community
Now serves on the local school board, using his journey data to advocate for STEM access and community-informed credentialing.

D2. Amara: The Storyteller and Educator

Rooted in family, language, and care, Amara blends creativity and community engagement to pursue a purpose-driven path in education and storytelling.

Amara

Location West St. Paul, MN

Theme Identity, literacy, and community-rooted storytelling

Identity Snapshot

- Warm, observant, and empathetic
- Finds confidence through creative expression
- Anchored by family stories and career experiences

Learner Needs

- Bilingual content
- Encouragement through safe feedback
- Stable, supportive relationships

Aspirations

- Support kids and families through education or care
- Explore global cultures and travel.
- Leverage storytelling and marketing creer opportunities.

Barriers Navigated

- Curriculum that doesn't reflect her learning style and personalized needs
- Systems that separate school from home
- Assessments that miss her voice and care

Reimagined Technical Components

Middle School | Learner Wallet + Community
Created a bilingual documentary, stored in her Learner Wallet and featured at a community event

High School | AI Agent + Guidance
Shared a personal audio diary through the Learner Wallet. A mentor helped her reflect and set goals tied to identity and voice.

College | Learning Experience Layer + Skills Framework
Co-founded a youth storytelling podcast. Her stack tracked growth, collaboration, and creative communication.

Career | Community + Learner Wallet
Built a mobile storytelling lab that hosts intergenerational workshops. Her past projects and learning milestones helped her secure funding and mentor the next generation of storytellers.

Appendix

B. Glossary

This section defines key technical and conceptual terms used throughout our report. We offer citations to give credit for the original terms, however, we've lightly adapted these terms and their definitions for our report.

Agentic AI	AI systems designed with a degree of autonomy to proactively reason, plan, and execute multi-step tasks.[67] In the tech stack of the future, agentic AI operates as an orchestrator: deploying role-based agents, coordinating across the tech stack, and preserving human oversight through human-in-the-loop safeguards.
Agent2Agent (A2A)	An emerging interoperability protocol that allows AI agents from different platforms to securely discover, negotiate, and collaborate. Prevents vendor lock-in by enabling agent-to-agent communication across ecosystems.
Community Data Sovereignty	The principle that a community has the right to own, control, access, and possess data that is derived from and about its people, lands, and resources. Ensures data governance is collaborative, not extractive, and that communities are active partners.[68]
Comprehensive Interoperability:	A holistic approach to interoperability that includes technical, semantic, organizational, and legal dimensions, enabling seamless and trusted data exchange across systems. Requires adoption of open standards and shared protocols.
Connected Learning	An educational framework that posits the most powerful learning is socially embedded, interest-driven, and oriented toward educational, economic, or political opportunity. It connects a learner's peer culture, interests, and academic pursuits.[69]
Data Trust	A legal and governance structure that holds and manages data on behalf of a group of stakeholders, ensuring that data is used ethically, equitably, and transparently. Often supports cross-institutional collaboration.

[67] Agentic AI: Transforming Skilling and Learning in 2025 - Enthral, accessed June 22, 2025, https://www.enthral.ai/blog/agentic-ai-ld-transformation-2025/

[68] An Introduction to Data Equity - Community Commons, accessed June 22, 2025, https://www.communitycommons.org/collections/An-Introduction-to-Data-Equity

[69] Ito, M., et al. (2013). Connected Learning: An Agenda for Research and Design. Digital Media and Learning Research Hub. Retrieved June 22, 2025, from https://dmlhub.net/wp-content/uploads/files/Connected_Learning_report.pdf

Digital Identity	A digital representation of an individual, organization, or device used to authenticate and authorize access to systems, services, or data.[70] In the tech stack of the future, digital identity includes verifiable credentials and learner wallets, enabling secure and learner-controlled participation.
Federated Learning	A Privacy-Enhancing Technology (PET) in which AI models are trained across decentralized devices or servers without transferring raw data. Helps protect privacy while enabling machine learning at scale.
Human-in-the-Loop (HITL)	A model of AI system design where human judgment and oversight are intentionally integrated into the AI's operational cycle for training, validation, or real-time decision-making, ensuring a balance between automation and human control.[71]
Knowledge Graph	A structured, machine-readable network of entities (e.g., skills, concepts, resources) and their relationships. Used in the Skills Framework to map learning progressions, prerequisites, and crosswalks across education and work.
Interoperability	The ability of different systems, tools, and organizations to exchange, understand, and use data and functionality effectively. Requires adoption of shared protocols, open standards and governance agreements. (See also: Comprehensive Interoperability)
Learning and Employment Record (LER)	A comprehensive, interoperable digital record that captures learning achievements, credentials, and work experience across a person's lifetime, supporting mobility and lifelong learning.[72]
Learning Object (LO)	A small, self-contained, reusable digital unit of learning content, media, or interactivity, designed to teach a single concept or learning objective. LOs can be aggregated to form larger lessons and courses.[73]
Learning Object Repository (LOR)	A digital library or database used to store, manage, tag, and share Learning Objects and other educational resources, facilitating their discovery and reuse.[74]
Learner Wallet	A digital tool that allows individuals to store, manage, and share credentials, achievements, and learning records in a secure and user-controlled manner.[75]

[70] Digital Identity in 2025: The Complete Guide, Sumsub, published April 2025, accessed July 2025, https://sumsub.com/blog/digital-identity-in-2025-the-complete-guide/

[71] Tiwari, Human-in-the-loop framework for AI in education.

[72] Learning and Employment Records (LERs), Credential Engine, published April 2025, accessed July 2025, https://credentialengine.org/toolkit/learning-and-employment-records-lers/

[73] Littlejohn and Cook, Learning objects and repositories.

[74] What is Learning Object Repositories for Instructional Designers? Learn the terminology, accessed June 22, 2025, https://www.coursensu.com/instructional-design-terms/learning-object-repositories

[75] What is Learning Object Repositories for Instructional Designers? Learn the terminology, accessed June 22, 2025, https://www.coursensu.com/instructional-design-terms/learning-object-repositories

Micro-Credential/ Digital Badge	A verifiable, portable credential recognizing discrete skills or experiences, often awarded outside traditional academic settings. Stored in a learner wallet for portability.
Modular Curriculum	An approach to curriculum design that breaks down educational content into independent, non-sequential modules or units that can be flexibly combined to create personalized learning pathways.[76]
Open Educational Resources (OER)	Teaching, learning, and research materials in any medium that reside in the public domain or have been released under an open license. They permit no-cost access, use, adaptation, and redistribution by others.[77]
Open Standards	Publicly available technical specifications that ensure compatibility and interoperability across tools and providers. Critical for avoiding vendor lock-in.
Privacy-Enhancing Technology (PET)	A category of tools and methods designed to protect data privacy and security while enabling data analysis and sharing. Examples include federated learning, differential privacy and homomorphic encryption.[78]
Public-Purpose Infrastructure	Foundational systems and technologies, such as interoperable data, open AI frameworks and credential registries, that serve as shared utilities for the public good. Require collective stewardship and investment. (See also: Shared Infrastructure)
Verifiable Credential (VC)	A digital credential using W3C standards that can be cryptographically verified to ensure authenticity, integrity, and user control. Commonly used in learner wallets, LERs, and digital ID systems.
About LearnerStudio	LearnerStudio is a nonprofit intermediary focused on reinventing American education to ensure all young people can flourish in the Age of AI – as individuals, in careers, and for democracy. By seeding transformative ideas, funding innovators with grants and investments, and connecting a growing network of allies, LearnerStudio is helping to build the future-ready solutions that learners deserve, and that we all need to build a thriving economy and society.
About Techademics	Techademics is an education and social impact–focused consulting firm whose mission is to provide technology services to educational institutions, non-profits, social impact entrepreneurs, and philanthropic organizations around the world. The firm specializes in the intersection of technology, learning, and design, delivering tools and practices tailored to each client's needs. Techademics believes in the transformative power of quality education and innovative technology to create a brighter, more equitable future.

[76] Dejene, W. (2019). The practice of modularized curriculum in higher education institutions: Active learning and continuous assessment in focus. Cogent Education, 6(1), Article 1611052. https://doi.org/10.1080/2331186X.2019.1611052

[77] Open Educational Resources | UNESCO, accessed June 22, 2025, https://www.unesco.org/en/open-educational-resources

[78] What are privacy-enhancing technologies?, Decentriq, published April 2025, accessed July 2025, https://www.decentriq.com/article/what-are-privacy-enhancing-technologies