



THE INTERACTIVITY MATURITY MODEL

WHITE PAPER

The Evolution of Interactivity

Why the Future of Learning Is About Richer Experiences, Not More Content

By Ahmar Abbas

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01 Looking Back to Look Forward

In 2019, I published the Learning Labs Maturity Model (L2MM), a framework describing the evolution of hands-on technical learning from basic sandbox environments toward Guided Learning experiences that combined realistic practice, instructional design, and measurable outcomes.¹ At the time, virtual labs were beginning to transform technology education. Organizations increasingly recognized that technical competence could not be developed solely through reading documentation, attending lectures, or watching demonstrations. Learners developed skills more effectively when they interacted directly with technology.

The Learning Labs Maturity Model attempted to describe that transition. It argued that the future of technical learning would not be defined by access to virtual environments alone, but by thoughtfully designed experiences that combined practical exercises with instructional guidance and structured learning objectives. Its central premise was simple: people learn technology by doing.

People learn technology by doing.

The founding premise of the Learning Labs Maturity Model, 2019

Looking back seven years later, I believe that premise has been validated. Hands-on learning has moved from a differentiator to an expectation. Certification providers routinely incorporate practical exercises into learning paths, from foundational credentials such as AWS Certified Cloud Practitioner and CompTIA A+ to role-based tracks like Microsoft's AZ-104 (Azure Administrator). Universities increasingly emphasize experiential learning. Enterprises invest heavily in practical workforce development because they recognize that capability is built through application rather than observation. In many respects, the journey described by the Learning Labs Maturity Model became reality.

Yet time also provides perspective. What I failed to recognize in 2019 was that learning labs were not the destination. They represented one milestone within a much longer evolution. The most important lesson from the past decade was not the success of virtual labs themselves. It was the emergence of interactivity as the organizing principle of effective learning.

Learning labs succeeded because they fundamentally changed the learner's role. Instead of observing technology, learners participated in it. They experimented, made mistakes, solved problems, and built confidence through experience. The technology mattered, but the interaction mattered more.

That realization has become increasingly significant because learning is entering another period of profound transformation. Artificial intelligence is making information instantly accessible. Conversational systems are creating new forms of coaching. Simulations are becoming increasingly realistic. Adaptive environments can respond dynamically to individual learners. Decision-based scenarios are replacing isolated exercises. Across the learning industry, interaction itself is becoming richer, more personalized, and more consequential.

Viewed together, these developments suggest something larger than another technology cycle. They suggest that learning is evolving through increasingly sophisticated forms of interaction. The future will not be defined by who delivers the most content or even who builds the most advanced technology. It will be defined by who designs the richest learning experiences.

02 The Hidden Lesson

For most of human history, education was constrained by scarcity. Books were expensive. Teachers were few. Expertise was concentrated in small communities. Educational innovation therefore focused primarily on expanding access to knowledge. The printing press democratized books. Universities institutionalized scholarship. Public libraries broadened access to information. The internet connected learners to unprecedented volumes of content. Today, generative artificial intelligence has made explanations, technical documentation, and expert guidance available within seconds.

Each of these innovations addressed essentially the same challenge: reducing the cost of acquiring information. That challenge has largely been solved.

Information is no longer scarce. It is abundant. A learner can retrieve almost any fact, tutorial, research paper, or technical explanation almost instantly. In many fields, obtaining knowledge has become easier than deciding which knowledge deserves attention.

This abundance fundamentally changes the purpose of learning. When information is scarce, educational success depends on improving access. When information becomes abundant, educational success depends on helping learners transform information into understanding, judgment, and expertise.

This distinction explains why decades of investment in educational technology have produced uneven results. The United States alone spends tens of billions of dollars annually on educational technology, yet improvements in learning outcomes have often failed to match expectations.² Neuroscientist Jared Cooney Horvath has argued that simply replacing textbooks with laptops or moving instruction onto digital platforms does not inherently improve learning. Technology changes the medium, but not necessarily the learning experience.²

● THE CORE MISDIAGNOSIS

The problem is not technology, or even artificial intelligence, but the **habit of confusing access with learning.**

A textbook displayed on a tablet remains a textbook. A recorded lecture streamed through a learning platform remains a lecture. Digitization undoubtedly improves convenience, distribution, and accessibility, but it does not automatically create deeper understanding. Research in cognitive science consistently demonstrates that durable

learning depends upon effortful engagement, retrieval, reflection, and meaningful interaction rather than passive consumption.^{3,4}

This insight is hardly new. John Dewey argued nearly a century ago that education should be grounded in experience rather than passive reception of information.⁵ David Kolb later expanded this work through his theory of experiential learning, describing learning as a continuous cycle of concrete experience, reflection, conceptualization, and experimentation.⁶ Benjamin Bloom demonstrated that individualized tutoring dramatically outperformed conventional classroom instruction, highlighting the extraordinary value of guided interaction between teacher and learner.⁷

Although these theories emerged decades apart, they share a common foundation. At its core, learning is an act of interacting with information rather than passively receiving it.

Viewed through this lens, the major innovations of modern learning begin to look less like independent developments and more like successive stages in a much broader evolution. Learning by doing, guided instruction, simulations, adaptive systems, conversational AI, and intelligent coaching all increase one thing above all else: the quality of interaction between learner and knowledge.

That observation leads to a broader proposition: the history of learning can be understood as the history of increasingly sophisticated forms of interactivity.

If that proposition is correct, then it provides a new way to understand both the past and the future of education. Rather than asking how technology changes learning, we should ask how technology changes interaction. Rather than measuring educational innovation by the amount of content it delivers, we should evaluate it by the richness of the experiences it creates.

This perspective also changes how we think about artificial intelligence. AI is not significant because it generates content. Content is becoming abundant. AI is significant because it enables new forms of interaction that were previously impossible to scale. Personalized dialogue, adaptive coaching, continuous feedback, intelligent challenge, and realistic simulation all become practical because interaction itself has become programmable.

The future of learning, therefore, is not simply digital but interactive, and that evolution is only beginning.

03 The Evolution of Interactivity

If interactivity is the thread that connects the major advances in learning, then it becomes possible to view educational innovation through a different lens. Rather than seeing virtual labs, simulations, adaptive learning, artificial intelligence, and conversational systems as unrelated technologies, we can understand them as successive stages in the evolution of how learners engage with knowledge.

The earliest forms of formal education were largely transactional. Knowledge flowed in one direction from teacher to learner. Books, lectures, demonstrations, and later recorded video all shared the same underlying architecture.

Information was organized, presented, and consumed. Although this model proved remarkably successful for disseminating knowledge, it positioned learners primarily as recipients rather than participants.

Experiential learning represented the first major departure from that paradigm. Dewey argued that education should be grounded in experience rather than passive reception, while Kolb later demonstrated that meaningful learning emerges through a continuous cycle of experience, reflection, conceptualization, and experimentation.^{5,6} These ideas shifted attention away from information itself and toward the learner's interaction with information.

The emergence of virtual laboratories brought these principles into technical education at scale. Learners were no longer limited to watching instructors configure servers, troubleshoot networks, or deploy cloud infrastructure, the very tasks at the heart of courses such as CompTIA Network+ and AZ-104. They performed these activities themselves. This seemingly simple change fundamentally altered the learning experience. Instead of observing technology, learners engaged directly with it. The learner became an active participant.

Yet participation alone does not produce expertise. Most laboratory exercises remain isolated experiences. A learner completes a task, receives feedback, resets the environment, and begins again. While this approach develops procedural competence, it rarely develops professional judgment because professional work is rarely composed of isolated tasks. Decisions accumulate. Constraints emerge. Earlier choices influence later possibilities. Professionals rarely receive the opportunity to press a reset button.

This realization points toward the next stage in the evolution of interactivity: consequence. A defining characteristic of professional expertise is the ability to anticipate downstream effects. An experienced architect, whose judgment is cultivated in tracks like AZ-305 (Azure Solutions Architect) or AWS Certified Solutions Architect, understands that reducing infrastructure redundancy may lower costs today while increasing operational risk tomorrow. A security professional, whether preparing for SC-300 or CompTIA Security+, recognizes that convenience and compliance often exist in tension. An IT manager appreciates that technical decisions inevitably become business decisions because they affect budgets, users, governance, and organizational priorities. Traditional learning environments struggle to teach these realities because they isolate decisions from their consequences.

Imagine a cloud architect responsible for designing a new infrastructure environment. Early in the project, the learner decides to reduce backup redundancy to minimize costs. In a conventional exercise, the system immediately explains why that decision introduces risk before allowing the learner to try again. Valuable feedback is provided, but the decision itself carries little weight.

A richer learning environment would allow the decision to persist. Several stages later, an unexpected service interruption occurs. Recovery is slower because redundancy was removed. Downtime increases. Customers experience disruption. Executives begin asking difficult questions. The savings achieved early in the project disappear beneath the costs of incident response. The learner experiences the decision not as an abstract principle but as an unfolding sequence of interconnected consequences.

Knowledge teaches learners what might happen. Consequence teaches them why it matters.

The evolution of interactivity extends beyond consequence into conversation. For centuries, personalized dialogue represented one of education's greatest strengths and one of its greatest limitations. Individual tutoring consistently produces superior learning outcomes because it allows instructors to ask questions, challenge assumptions, diagnose misconceptions, and adapt explanations to individual learners.⁷ Bloom famously demonstrated this advantage in his "2 Sigma Problem," concluding that one-to-one tutoring dramatically outperformed conventional classroom instruction.⁷

Historically, however, personalized dialogue has been difficult to scale, but generative artificial intelligence changes that equation.

For the first time, learners can engage in continuous conversations that adapt to their questions, prior knowledge, and reasoning. More importantly, these conversations need not merely provide answers. Their greatest educational value lies in their ability to deepen thinking. Rather than confirming learner assumptions, conversational systems can present competing perspectives, expose hidden risks, question incomplete reasoning, and encourage reflection. In this role, AI functions less as an answer engine than as an intellectual sparring partner, encouraging learners to think more critically about their own decisions.⁸

The final stage in this progression is adaptation. Every learner brings different experiences, strengths, motivations, and misconceptions into the learning process. Yet traditional instruction generally assumes that every learner should follow the same sequence at the same pace. Advances in adaptive learning challenge that assumption. Rather than presenting identical experiences to every learner, adaptive systems respond dynamically to demonstrated competency. Feedback becomes individualized. Future scenarios evolve according to learner performance. Additional practice is introduced where misconceptions persist, while unnecessary repetition is reduced for learners who have already demonstrated mastery.⁹

The significance of adaptation extends beyond efficiency. It transforms learning from a standardized process into a responsive partnership between learner and environment. Instead of asking learners to conform to a fixed curriculum, the curriculum increasingly responds to the learner.

Taken together, participation, consequence, conversation, and adaptation are not isolated innovations. They represent increasingly sophisticated forms of interaction between learners and knowledge. Each stage asks more of the learner while providing richer opportunities for growth. More importantly, each stage moves education further from content delivery and closer to capability development.

04 The Interactivity Maturity Model

This progression suggests a broader framework for understanding the future of learning. The Learning Labs Maturity Model described the evolution of hands-on technical education from sandbox environments toward guided learning.¹ Looking across today's learning landscape, however, a larger pattern becomes visible. The same forces that transformed technical training are beginning to reshape education more broadly. Learning is evolving through progressively richer forms of interaction.

I refer to this framework as the Interactivity Maturity Model. The model consists of five progressive levels.

FRAMEWORK

The Interactivity Maturity Model

1

Consumption

Information is delivered primarily through reading, lectures, demonstrations, or multimedia. Interaction is limited, and learning is largely measured by exposure to content. Although consumption remains essential for acquiring foundational knowledge (the conceptual grounding a learner first meets in an AWS Certified Cloud Practitioner or SC-900 course), it rarely produces professional competence by itself.

2

Participation

Learners actively engage through laboratories, exercises, projects, simulations, and guided practice, such as the hands-on administration tasks that anchor a course like AZ-104. Knowledge is reinforced through application rather than observation, allowing learners to translate concepts into procedural skills. This level encompasses much of today's experiential learning and reflects the transition described by the Learning Labs Maturity Model.^{1,6}

3

Enrichment

Learning environments begin to mirror the complexity of professional practice. Decisions carry consequences that persist over time rather than disappearing at the conclusion of an exercise. Authentic constraints, competing priorities, stakeholder expectations, and interconnected systems create experiences that extend beyond procedural competence toward contextual understanding.

4

Judgment

Learners move beyond executing tasks to making decisions under uncertainty. Multiple solutions may be technically correct, yet each carries different trade-offs. Learners evaluate alternatives, defend their reasoning, reconcile competing objectives, and respond to legitimate challenges from instructors, peers, or intelligent systems. The objective is no longer simply acquiring skills but developing professional judgment.

5

Adaptive Intelligence

The learning environment continuously responds to the individual learner. Artificial intelligence enables personalized dialogue, adaptive scenarios, intelligent feedback, and continuous coaching informed by demonstrated performance. Rather than presenting identical experiences to every learner, the environment evolves alongside the learner, creating increasingly personalized pathways toward expertise.

These five levels should not be viewed as competing instructional approaches. Each builds upon the capabilities of the previous one. Consumption remains essential because expertise begins with knowledge. Participation transforms knowledge into experience. Enrichment introduces authentic complexity. Judgment develops professional reasoning. Adaptive intelligence personalizes the journey. Together they describe a broader trajectory for learning itself.

The significance of the Interactivity Maturity Model lies not in prescribing a single instructional strategy but in providing a framework for evaluating educational innovation. New technologies will continue to emerge. Artificial intelligence will continue to evolve. Immersive environments will become more sophisticated. Yet the central question remains remarkably stable:

Does this innovation create richer interactions between learners and knowledge?

The single question that evaluates any learning innovation

If the answer is yes, it advances learning along the continuum of interactivity. If the answer is no, it merely changes the medium through which information is delivered.

Viewed in this way, the future of learning is unlikely to be defined by any individual technology. It will be defined by the continued evolution of interaction itself.

05 Why AI Changes Everything

Artificial intelligence is frequently described as the technology that will transform learning. While that prediction is almost certainly correct, it is also incomplete. AI is not transformative simply because it generates content faster than humans or answers questions more quickly than search engines. Its true significance lies elsewhere. Artificial intelligence dramatically expands the possibilities for interaction.

For the first time, many of the characteristics that made exceptional teachers effective can be delivered at scale. Learners can engage in continuous dialogue rather than waiting for scheduled instruction. Feedback can be immediate rather than delayed. Explanations can be tailored to individual backgrounds rather than presented generically. Most

importantly, learning experiences can become increasingly responsive to how learners think rather than simply what they know.

This distinction is critical because information itself is rapidly becoming a commodity. Every major language model can summarize a chapter, explain a concept, write code, or answer factual questions. As these capabilities become ubiquitous, competitive advantage shifts away from content creation and toward experience design. The question is no longer who can produce the best learning materials. It is who can create the richest interactions around those materials.

Perhaps the most powerful capability AI introduces is the ability to challenge learners rather than simply assist them. Jeremy Caplan argues that AI is most valuable when it functions as an intellectual sparring partner instead of an answer engine.⁸ Rather than confirming a learner's assumptions, it asks difficult questions, presents alternative perspectives, identifies weaknesses in reasoning, and forces deeper reflection. In professional practice, expertise is developed not by accumulating answers but by refining judgment. AI has the potential to accelerate that process by making thoughtful challenge continuously available.

The same principle applies to adaptive learning. Historically, instructors adjusted their teaching based on classroom observation, identifying misconceptions, providing additional examples, or increasing the level of challenge when appropriate. Artificial intelligence extends this capability beyond traditional classrooms. Modern learning environments can recognize recurring patterns in learner performance, identify persistent misconceptions, recommend targeted practice, and introduce increasingly complex scenarios as competency develops.⁹ Adaptation is no longer limited by instructor availability; it becomes an inherent characteristic of the learning environment itself.

Yet AI should not be viewed as replacing educators. Bloom's seminal work on one-to-one tutoring demonstrated that individualized guidance dramatically improves learning outcomes.⁷ Artificial intelligence narrows the gap by extending elements of personalized coaching to far larger populations, but it does not eliminate the need for human expertise. The most effective learning environments will combine intelligent systems with experienced instructors who provide context, mentorship, ethical judgment, and professional wisdom that technology alone cannot replicate.

The future, therefore, is unlikely to be defined by artificial intelligence replacing educators. It will be defined by artificial intelligence amplifying educators' ability to create richer, more personalized, and more consequential learning experiences.

06 Implications for Learning

If interactivity is becoming the organizing principle of modern learning, its implications extend well beyond educational technology. It challenges many of the assumptions that have shaped curriculum design, corporate training, and instructional practice for decades.

For educational institutions, success will increasingly depend on designing experiences rather than delivering information. Universities have historically measured quality through curriculum, faculty expertise, and academic

content. Those elements remain essential, but they are no longer sufficient. Learners can obtain information from countless sources. The enduring value of formal education increasingly lies in creating environments where knowledge is applied, challenged, debated, and refined through meaningful interaction.

The implications are equally significant for enterprise learning. Organizations invest billions of dollars each year in workforce development, yet many learning programs continue to measure success through completion rates, hours of training, or content consumption. These metrics reveal little about whether employees can exercise sound judgment when confronted with complex situations. As work itself becomes increasingly dynamic, organizations will need learning experiences that prepare employees to make decisions under uncertainty rather than simply recall procedures. This requires environments where learners experience realistic consequences, evaluate competing priorities, and receive continuous coaching as they develop expertise.

Learning technology providers face a similar transition. For many years, innovation centered on digitizing existing instructional materials or making learning content more accessible. That work remains valuable, but future differentiation will come from designing richer interactions rather than publishing larger libraries. Platforms that enable learners to explore scenarios, converse with intelligent coaches, defend decisions, and receive adaptive guidance will create greater educational value than platforms whose primary contribution is delivering information more efficiently.

The role of instructors will also evolve. Predictions that artificial intelligence will replace teachers misunderstand the nature of expertise. As information becomes abundant, the instructor's role shifts away from transmitting knowledge and toward cultivating judgment. Effective educators will increasingly function as coaches, mentors, facilitators, and intellectual challengers. They will help learners navigate ambiguity, question assumptions, and integrate technical competence with professional reasoning. In many respects, artificial intelligence increases rather than diminishes the value of exceptional educators because it allows them to focus on the aspects of learning that remain uniquely human.

Taken together, these developments suggest that the future of learning will not be determined by who possesses the most content or the most sophisticated technology. It will be determined by who creates the richest interactions between learners, knowledge, and expert guidance.

07 Conclusion

When I introduced the Learning Labs Maturity Model in 2019, I believed I was describing the evolution of hands-on technical learning.¹ Looking back, I now believe that work captured only one chapter of a much larger story. The broader story is the evolution of interactivity.

Throughout history, educational innovation has steadily increased the ways learners engage with knowledge. Reading gave way to demonstration. Demonstration expanded into participation. Participation evolved into guided practice. Today, consequence-driven scenarios, conversational AI, adaptive learning, and intelligent coaching are extending that

progression even further. Each step has moved learners away from passive consumption and toward increasingly authentic participation in the learning process.

Viewed through this perspective, artificial intelligence is not the destination. It is an accelerator. Its greatest contribution is not generating more content but enabling richer forms of interaction that were previously impossible to deliver at scale. As these capabilities mature, the distinction between learning and doing will continue to diminish. Learning environments will become places where learners experiment, make decisions, experience consequences, receive guidance, defend their reasoning, and continually adapt. In short, they will increasingly resemble professional practice itself.

This evolution suggests a broader principle for the future of education. Information will continue to become more abundant, less expensive, and more accessible. Interaction, however, will become the scarce resource that differentiates exceptional learning from ordinary instruction. Organizations that recognize this shift will move beyond asking how to deliver knowledge more efficiently. They will instead ask how to create experiences that transform knowledge into judgment, capability, and expertise.

The Learning Labs Maturity Model described one important milestone in that journey. The Interactivity Maturity Model attempts to describe the broader trajectory. It proposes that the future of learning will be defined not by the technologies we build, but by the quality of the interactions they enable.

In the years ahead, new technologies will undoubtedly emerge. Some will succeed, others will disappear, and many will be replaced. The central principle, however, is likely to endure.

THE ENDURING PRINCIPLE

People become experts by interacting with information, not by merely consuming it.



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