

Hype Cycle for K-12 Education, 2023

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Initiatives: [Education Digital Transformation and Innovation](#); [Education Technology Optimization and Modernization](#); [Governmentwide Digital Innovation and Application Modernization](#)

A rising wave of AI breakthroughs has impacted nearly every industry, with K-12 education being no exception. These are new or improved capabilities that can potentially address K-12's challenges. This research highlights CIOs' innovations that move quickly into real-world K-12 organizations.

More on This Topic

This is part of an in-depth collection of research. See the collection:

- [2023 Hype Cycles: Deglobalization, AI at the Cusp and Operational Sustainability](#)

Analysis

What You Need to Know

The challenges facing primary and secondary education (K-12) in the last three years continue to demand “outside the box” thinking and solutions. Economic uncertainties, labor changes, and new internal and external drivers exert a powerful push on K-12 organizations seeking to adapt. Traditional strategies, practices and resources of the past simply are not available or do not offer useful solutions to help. Innovative solutions are emerging to tackle new ways to approach resourcing, enrollment, learning and staffing challenges.

This Hype Cycle highlights key technologies and artificial intelligence (AI) innovations that hold potential for significant — even transformative — impacts on education. The right innovations, designed to optimize instructional and business practices while freeing up time, money and people resources, can make all the difference.

This Hype Cycle will identify those innovations appropriate to:

- Evaluate fit and function
- Accelerate adoption
- Expand the organization’s capabilities

CIOs can explore this research and plan to leverage those with the most impact for their organization.

The Hype Cycle

K-12 education continues its journey up a new road created by the massive impacts of the COVID-19 pandemic, which are still being felt to this day. Those impacts have introduced not only speed and momentum toward the process of digitizing education in many parts of the world, but also surfaced new and vexing challenges impossible to solve using long-standing educational practices and models.

As is often the case, crises provide opportunities for transformation. K-12 CIOs are recognizing this time as one of those moments. A new, rapidly moving wave of multitude types of AI, including generative AI tools, has appeared across industries, dismissing long-standing practices for options that run on an entirely new set of rules. K-12 institutions must rethink their challenges in light of opportunities and risks of digital innovations that run solutions which were simply impossible before. These solutions address challenges such as how to help manage learning losses, faculty shortages, well-being challenges, barriers to personalized learning and more.

Given these momentous changes, organization leaders must continue to ask: How do we leverage this momentum to build a road forward? Toward what future? How can we best prepare our students for the new, AI-driven world they will live in? How do we avoid inertia from moving us backward? How do we find investments that create meaningful improvement in administrative, business and learning outcomes for our organization and its stakeholders? How ready are we for what's here, and what's coming next?

As education CIOs read through the innovations, they should focus on several factors for advancing digital capabilities while also recognizing new AI-based or enhanced solutions that enable:

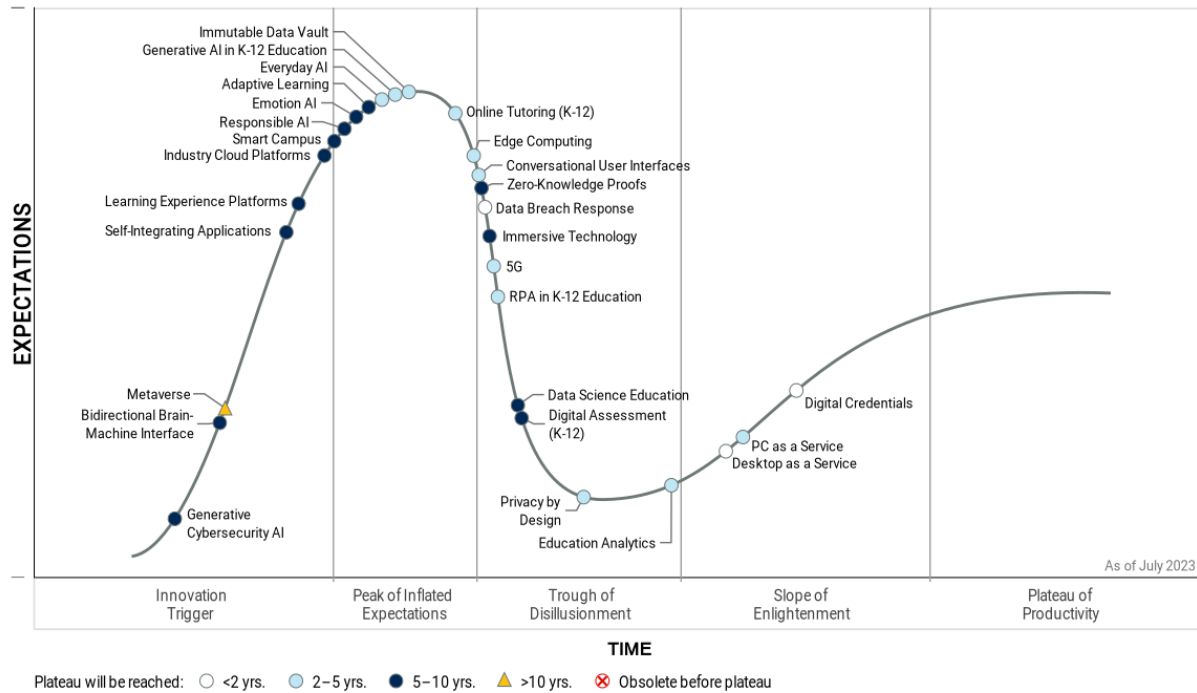
- Personalized learning experiences at scale
- Improving learning outcomes
- Optimizing business processes through automation and AI to free resources elsewhere
- Leveraging data insights to inform decision making

It should also be noted that we previously included general innovations for education Hype Cycles such as "AI in K-12 education." We believe we are now ready to divide up these references to reflect the wide variety of AI types available and evolving, allowing us to focus on how each may potentially be leveraged in education use cases in the future. Additionally, conversational user interface (CUI) has been updated to encompass a broader set of technologies including chatbots and those that are generative-AI-enabled. This change has resulted in a slight backtrack in CUI position and expected time to maturity.

The 2023 K-12 education Hype Cycle introduces new innovations that spotlight individual AI types, innovative categories and innovations impacting other industries that have applicability now (or in the future) to address K-12 challenges.

Figure 1: Hype Cycle for K-12 Education, 2023

Hype Cycle for K-12 Education, 2023



Gartner

The Priority Matrix

Several innovations projecting high or transformational benefits remain on the Hype Cycle. CIOs should note these are all projected to reach full productivity over the next five to 10 years or sooner. Two of these innovations (conversational user interfaces and generative AI), with maximum impact, not only reflect transformative potential, but also rapid movement, reaching maturity in two to five years.

The speed of movement of new innovations for K-12 requires reaction from education CIOs now, making early strategic planning and appropriate action critical to leverage the capabilities they bring.

Several other innovations have a high benefit rating. CIOs seeking to transform or optimize their organizations' digital capacity should focus planning initiatives over the next five years in these areas as well. These also hold potential for meaningful impact academically, administratively and operationally. Education analytics, advances in digital assessment and expanding potential of immersive technologies each play a potentially critical role in addressing hard-to-solve problems for the next several years.

We continue to incorporate non-industry-specific innovations (for example, emotion AI, privacy by design, etc.) to illustrate their overall maturity standing and potential promise to the education community. CIOs should evaluate specific organizational context and general hype or maturity aspects at the point when these technologies are pervasive enough to build new services on top of them.

Table 1: Priority Matrix for K-12 Education, 2023

(Enlarged table in Appendix)

Benefit ↓	Years to Mainstream Adoption			
	Less Than 2 Years ↓	2 - 5 Years ↓	5 - 10 Years ↓	More Than 10 Years ↓
Transformational	Digital Credentials	Conversational User Interfaces Edge Computing Everyday AI Generative AI in K-12 Education	Adaptive Learning Emotion AI Generative Cybersecurity AI Industry Cloud Platforms Responsible AI Self-Integrating Applications	Metaverse
High	Data Breach Response Desktop as a Service	5G Education Analytics Immutable Data Vault PC as a Service	Bidirectional Brain-Machine Interface Data Science Education Digital Assessment (K-12) Immersive Technology Smart Campus	
Moderate		Online Tutoring (K-12) Privacy by Design RPA in K-12 Education	Learning Experience Platforms Zero-Knowledge Proofs	
Low				

Source: Gartner

Off the Hype Cycle

A few innovations will be coming off the K-12 Hype Cycle this year, either because they are being moved under a different umbrella of innovations, or because we are taking a new approach to cover that topic:

Chatbots in K-12:

Increasingly, chatbots have become a foundational delivery model for several types of tools enhanced with AI (or which will be enhanced with generative AI tools). To reflect these changes, chatbots will be referenced directly in each area where they are in use. For example, the CUI innovations now cover how use cases for chatbots are rapidly evolving to incorporate CUI capabilities.

AI in K-12 Education:

We previously included general innovations for education Hype Cycles such as “AI in K-12 education.” We believe we are now ready to divide up these references to reflect the wide variety of AI types available and evolving, allowing us to focus on how each may potentially be leveraged in education use cases in the future.

On the Rise

Generative Cybersecurity AI

Analysis By: Jeremy D'Hoinne, Avivah Litan, Mark Horvath, Wilco van Ginkel

Benefit Rating: Transformational

Market Penetration: Less than 1% of target audience

Maturity: Embryonic

Definition:

Generative cybersecurity AI technologies generate new derived versions of security-related and other relevant content, strategies, designs and methods by learning from large repositories of original source data. Generative cybersecurity AI can be delivered as a public or privately hosted cloud service or embedded with security management interfaces. It can also integrate with software agents to take action.

Why This Is Important

Enterprises witness many applications leveraging foundation models that can read multimodal objects (such as sensory data and images), following the first applications based on large language models (LLMs).

Cybersecurity technology providers can exploit generative cybersecurity AI to improve existing workflows, be a proxy of existing analytics, and generate security configuration or realistic attack data. Soon, applications will include autonomous agents, which can work using high-level guidance without a need for frequent prompting.

Business Impact

Existing vendors and new startups will add generative cybersecurity AI, expanding or replacing features. They will start implementing it with resource-intensive tasks, such as incident response, exposure or risk management, or code analysis.

Organizations will benefit from generative cybersecurity AI as it can improve efficiency and shorten response times to cybersecurity risks and threats. The pace of adoption will vary across industries and geographies due to security and privacy concerns.

Drivers

- ChatGPT is one of the most hyped and fastest-adopted AI technologies ever. It relies on generative AI foundation models, which are largely trained on massive internet datasets.
- Security operations center (SOC) teams cannot keep up with the deluge of security alerts they must constantly review, and are missing key threat indicators in the data.
- Risk analysts need to speed up risk assessments, and be more agile and adaptable through increased automation and prepopulation of risk data in context.
- Organizations continue to experience skill shortages and look for opportunities to automate resource-intensive cybersecurity tasks. Use cases for the application of generative AI include: synthesizing and analyzing threat intelligence; generating remediation suggestions for application security, cloud misconfigurations and configuration changes to adjust to threats; generating scripts and codes generation; implementing secure code agents; identifying and graphing key security events in logging systems; conducting risk and compliance identification and analysis; automating the first steps in incident response; tuning of security configuration adjustment; creating general best practice guidance.
- Generative cybersecurity AI augments existing continuous threat exposure management (CTEM) programs by better aggregating, analyzing and prioritizing inputs. It also generates realistic scenarios for validation.
- Generative AI offerings include the ability to fine-tune models, develop applications using prompt engineering and integrate with prepackaged tools and plugins through APIs. These possibilities open up a path for providers to add generative cybersecurity AI.
- Microsoft has already demonstrated a preview version of its security co-pilot feature, which is expected to drive competitors to embed similar approaches.
- Security program performance solutions and activities can solve their increasing demand for business alignment. Further, they can perform scenario planning for budget (re)allocation, and efficiency and effectiveness indicators and corrections.

Obstacles

- The cybersecurity industry is already plagued with false positives. Early examples of “hallucinations” and inaccurate responses will cause organizations to be cautious about adoption or limit the scope of their usage.

- Best practices and tooling to implement responsible AI, privacy, trust, security and safety for generative AI applications do not fully exist yet.
- Privacy and intellectual property concerns could prevent sharing and usage of business- and threat-related data, reducing the accuracy of generative cybersecurity AI outputs.
- As generative AI is still emerging, establishing the trust required for its wider adoption will take time. This is especially true for the skill augmentation use cases, as you would need the skills you are supposed to augment, in order to ensure the recommendations are good.
- Uncertainty on laws and regulations related to generative AI may slow down adoption in some industries, for example regulated industries in EU countries subject to GDPR compliance.

User Recommendations

- Pick initial use cases carefully. First implementations might have a higher error rate than more mature techniques already in place.
- Monitor the addition of generative AI features from your existing providers and beware of “generative AI washing.” Don’t pay a premium before obtaining measurable results.
- Choose fine-tuned models that align with the relevant security use case or fine-tune in-house models from base models offered by the providers.
- Refrain from sharing sensitive and confidential data with hosted models until verifiable privacy assurances are provided by the host.
- Apply AI security frameworks, such as AI TRiSM. Work with your legal team on data privacy and copyright issues.
- Implement a documented approval workflow for allowing new generative cybersecurity AI experiments.
- Make it mandatory from a policy standpoint that any content (that is, configuration or code) generated by an AI is fully documented, peer-reviewed by humans and tested before it is implemented. If not possible, consider any AI-generated content as “Draft Only” when used for critical use cases.

Gartner Recommended Reading

4 Ways Generative AI Will Impact CISOs and Their Teams

Innovation Insight for Generative AI

Market Guide for AI Trust, Risk and Security Management

Bidirectional Brain-Machine Interface

Analysis By: Sylvain Fabre, Annette Jump

Benefit Rating: High

Market Penetration: Less than 1% of target audience

Maturity: Adolescent

Definition:

Bidirectional brain-machine interfaces (BMIs) are brain-altering neural interfaces that enable two-way communication between a human brain and a computer or machine. Bidirectional BMIs not only monitor the user's EEG and mental states, but also allow some action to be taken to modify the state of the brain based on analytics and insights. Brain state modification occurs via noninvasive electrostimulation through a head-mounted wearable or an invasive implant.

Why This Is Important

BMI wearables can be as simple as a noninvasive, affordable headband, yet they can provide a massive net societal impact and benefit in terms of illness and accident prevention, comparable to a simple vaccination program. Therefore, this is not only a futuristic, expensive, invasive solution for the few, like Neuralink, but also a simple gadget for the benefit of the many, provided adequate security and privacy measures are in place. When connected, these enable the Internet of Brains (IoB).

Business Impact

Over the next 3 to 10 years, BMIs will enable business use cases, including authentication, access and payment, and support immersive analytics and workplaces; interactions in the metaverse; and control of power suits or exoskeletons. What is unique about "bidirectional" BMIs versus other classes of wearables/ingestibles is their brain-altering capability. Examples may include boosting alertness in response to a pilot's EEG markers of fatigue or applying relaxing cortical currents to the brain of a harried nurse.

Drivers

- Industrial safety, sports performance, marketing and audience testing, as well as consumer wellness, appear to be the most promising early drivers for bidirectional BMIs.
- Demand is growing from large consumer-focused corporations and media companies, as some of these solutions can measure the response and attitude of consumers toward products, content and companies.
- There are already applications of one-way BMI wearables, where the focus is about monitoring the state of the user or using the user's intent to operate some external device. Examples include measuring fatigue and alertness in a driver without trying to externally modify the user's mood.
- Further adoption of consumer and corporate wellness; for example, using neurotechnology to both monitor and stimulate brain function, as well as improve sleep.
- Use of BMIs as a human-machine interface to interact with emerging metaverse environments among consumers and business users.
- Direct read-and-write access to brain activity creates many opportunities for workforce enablement.
- Productivity and neurodiversity initiatives will increase the need for connections between humans, the Internet of Things (IoT) and the IoB.
- Neuralink obtained FDA approval for human trials from implantable chips in May 2023.

Obstacles

- Bidirectional BMI faces some of the same problems linked with smart wearable devices, such as high cost for early products, slow user adoption, high drop-off rates for some smart wearables and the complexity of integration between various data systems.
- Since bidirectional BMIs are a more advanced and extreme form of wearable (in effect, an implant equivalent, with bidirectional connectivity), providers must offer more affordable products with increased functionality, without added invasiveness to improve acceptability
- Bidirectional BMIs create very specific security challenges, because they directly interface with the human brain. This creates new vulnerabilities to individuals and their companies by adding a vector of attack into users' psycho-physical space.
- Social acceptance, especially for the more conspicuous form factors, may be a long way off.
- Bidirectional BMI raises serious ethical concerns, including human factor issues such as altering users' perception of reality, memories or even their personality.

User Recommendations

- Prepare for bidirectional BMI devices creeping into enterprises; "bring your own device" (BYOD) may occur long before specific legislation is in place.
- Ensure customer safety and business security by implementing data anonymity and privacy (beyond current legislation such as General Data Protection Regulation [GDPR]) for brain-wearable data collection and management.
- Highlight trade-offs in wellness solutions: more data may not equate to improved outcomes when looking at complex systems such as the human brain.
- Set up an independent steering board to monitor products sold to consumers and provided for employees. Preempt potential legal liability by regularly reviewing implanted wearables' features, data governance policies and their use cases, and deciding on what is acceptable in terms of read/write from and to users' brains.
- Establish policies for unauthorized implantables: While they cannot easily be removed, users may be prohibited from some roles such as operating vehicles or machinery, or advanced security clearance due to increased hacking risk.

Sample Vendors

Blackrock Neurotech; BrainCo; Kernel; Meta; Neuralink; Neuroelectronics; NYX Technologies; Paradromics

Gartner Recommended Reading

[Maverick Research: “Metasuits” Will Be Key to Compelling Metaverse Experiences](#)

Metaverse

Analysis By: Grace Farrell, Tuong Nguyen

Benefit Rating: Transformational

Market Penetration: 1% to 5% of target audience

Maturity: Embryonic

Definition:

Gartner defines a metaverse as a collective virtual 3D shared space, created by the convergence of virtually enhanced physical and digital reality. A metaverse is persistent, providing enhanced immersive experiences. Gartner expects that a complete metaverse will be device-independent, and will not be owned by a single vendor: It will have a virtual economy of itself, enabled by digital currencies and non-fungible tokens (NFTs).

Why This Is Important

A metaverse is the next level of interaction in the virtual and physical worlds. It will allow learners to replicate or enhance their in-person activities that they typically would perform in a classroom setting. This could happen either by transporting or extending physical activities to a virtual world or by transforming the physical one. Although the goal of a metaverse is to combine many of these activities, there are currently many emerging metaverses with limited functionality.

Business Impact

Institutions can begin to enhance their current academic offerings in unprecedented ways, opening up innovative opportunities. Examples of opportunities that metaverse currently offer to institutions are:

- Interactive learning (e.g., real-time information during anatomy lab for an autopsy).
- Professional training (e.g., empathy-based training for physicians, nurse training).

- Personalized learning (e.g., custom student avatars).
- Shared experiences (e.g., live virtual events, student dorm-room meetups).

Drivers

There are three drivers for metaverse:

- **Transport:** The ability to “go and immerse oneself” in a virtual world. That world may be a 3D simulation and/or in virtual reality. This is where we see the most use cases in education today, predominantly with students using headsets for discovery and experiential learning.
- **Transform:** Bringing digital to the physical world. This allows the learner to have access to real-time information, collaboration and experiences in the physical world.
- **Transact:** The economic foundation of the metaverse through the use of cryptocurrency, NFTs and blockchain. This is not prevalent in education at this point in time, but very prevalent in other industries like fashion and virtual real estate.

Some of the main activities for a metaverse that will require one or more of these drivers are:

- **Student Collaboration:** Encouraging collaboration and participation from a diverse group of students, wherever they may be located.
- **Student Engagement:** A metaverse facilitates a feeling of presence (“being there”) as if the students were in-person, turning their focus to the task at hand with less distraction.
- **Student Connectedness:** Metaverse enables learners to connect in a more immersive way with classroom environments, labs and communities of interest — regardless of where or if they exist in the physical world.

Ultimately, the goal of implementing metaverse is that learners will desire to enhance and/or augment their lives in digital and physical realities driving user adoption rates.

Obstacles

- The adoption of metaverse technologies is nascent and fragmented. Be careful when investing in a specific metaverse application, use case or vendor as it is too early to determine which investments have long-term viability. Furthermore, this is a time of learning, exploring and preparing for a metaverse with limited implementation. Financial and reputational risks of early investments are not fully known, and caution is advised.
- Current manifestations of metaverses are siloed, app-based, noninteroperable experiences that do not satisfy the decentralized content and interoperable vision of the metaverse. This current, walled-garden approach also strongly limits users' control of experiences.
- Set realistic expectations for a metaverse. Education institutions often struggle to identify desired outcomes of a metaverse implementation. Key performance indicators like student attendance, engagement, test scores and quality of content should be analyzed routinely through these trials.

User Recommendations

Recommendations for strategic approaches toward the metaverse will vary. In general:

- Identify metaverse-inspired opportunities by evaluating current high-value use cases within their academic institution.
- Work with stakeholders to evaluate the viability of metaverse technologies in terms of learner reach and outcome.
- Develop technology strategies that leverage the built-in infrastructure and participants of the metaverse, and provide digital product or service opportunities.
- Take a cautioned and measured approach when investing in a specific metaverse, as it is still too early to determine which investments will be viable in the long term.

Sample Vendors

Decentraland; Meta; Microsoft; NVIDIA; Roblox; VictoryXR

Gartner Recommended Reading

[Emerging Tech: Top Enabling Technologies for Metaverse](#)

Emerging Tech: Metaverse Providers Must Refine Their Go-to-Market Strategy and Use Cases to Succeed in the Emerging Metaverse

Self-Integrating Applications

Analysis By: Keith Guttridge

Benefit Rating: Transformational

Market Penetration: Less than 1% of target audience

Maturity: Embryonic

Definition:

Self-integrating applications will use a combination of automated service discovery, metadata extraction and mapping, automated process definition, and automated dependency mapping to enable applications and services to integrate themselves into an existing application portfolio with minimal human interaction.

Why This Is Important

Integrating new applications and services into an application portfolio is complex and expensive. Gartner research shows that up to 65% of the cost of implementing a new ERP or CRM system is attributable to integration. The technology for enabling applications to self-integrate exists in pockets, but no vendor has yet combined all the elements successfully. As applications develop the ability to discover and connect to each other, the amount of basic integration work will dramatically reduce.

Business Impact

Self-integrating applications can:

- Improve agility, as the time to onboard applications and services is massively shortened.
- Cut costs by up to 65% when onboarding new applications and services.
- Reduce vendor lock-in, as platform migration becomes simpler.
- Improve the ability to focus on differentiation and transformational initiatives, as the “keeping-the-lights-on” burden is dramatically reduced.

Drivers

- Cloud hyperscalers provide features such as service discovery, metadata extraction, intelligent document processing and natural language processing.
- Automation or integration vendors provide features such as intelligent data mapping, metadata extraction, next-best-action recommendations, process discovery and automated decision making.
- SaaS vendors provide features such as process automation, packaged integration processes, portfolio discovery and platform composability.
- In the new era, intelligent application portfolio management is placed on top of augmented integration platforms in order to properly address the challenge.
- Generative AI simplifies the build process to create integration processes.

Obstacles

- Embedded integration features within SaaS are good enough to enable organizations to get started quickly, thus stalling investment in improving self-integration capabilities.
- Generally, organizations are not well aware of the availability of augmented integration technologies for enabling self-integrating applications. Many organizations still view integration as a complex issue requiring specialist tools.
- There is not a clear market leader that is looking to push this technology forward as the major application vendors look to protect their customer bases.
- Complex scenarios across multiple datasets and service interfaces are too challenging for the current technology. Organizations place too much trust in the solution to do the right thing. Ownership and visibility of the integrations might become contentions within the organizations.

User Recommendations

Software engineering leaders responsible for integration should:

- Ask your major application vendors about the interoperability of applications within their portfolios. This is the area where self-integrating applications are most likely to emerge first.

- Investigate integration vendors that have augmented artificial intelligence features to automate the process of onboarding applications and services into a portfolio.
- Manage your expectations for ease of integration. Self-integrating applications will provide just enough integration with the rest of the application portfolio to enable a new application to work efficiently.
- Keep track of governance capabilities. Who can authorize access? Has the appropriate observability been established? Is everything fully audited? Does something need to change? An organization's integration landscape is an ever-evolving environment, and each integration has a life cycle that needs to be maintained.

Sample Vendors

Boomi; IBM; Microsoft; Oracle; Salesforce; SAP; SnapLogic; Tray.io; Workato

Learning Experience Platforms

Analysis By: Paul Riley, Grace Farrell

Benefit Rating: Moderate

Market Penetration: Less than 1% of target audience

Maturity: Emerging

Definition:

A learning experience platform (LXP) is the front-end layer that typically sits on top of a learning management system (LMS). LXPs are used to enhance an individual learner's interactions and engagement via greater personalization, content curation, and expanded breadth of content.

Why This Is Important

Students are demanding education institutions provide learning platforms that are easier to use and offer better personalization. LMSs have traditionally focused on delivering course content and tracking learner activities. LXPs look to go a step further by delivering personalized learning paths, channels and collections that allow learners to easily organize, access and share relevant resources, and gain visibility on additional learning assets, including noninstitutional developed content.

Business Impact

LXPs in corporate learning allow organizations to improve learner experience and engagement by providing a more open, interactive, and effective way to learn. Education institutions are now looking to enhance online and blended learning, and seeking solutions to provide enhanced learner engagement and stronger student performance. However, LXPs do not fully duplicate LMS functionality and are not a direct LMS replacement.

Drivers

- Sharing content without personalization risks low adoption and engagement. Especially when learners are spread across geographies and are made up of various cultures, jobs and preferences, a more targeted approach is needed. LXPs have emerged from the corporate learning space as a solution to address this challenge.
- Remote/hybrid teaching environments and digital workplaces have changed expectations for learners. While some are still happy to consume lecture-based teaching experiences, others more familiar with workplace collaboration tools may now expect more frequent and detailed insight on context. Institutions must blend approaches to engage different learner preferences.
- Students are demanding a wider range of resources and upskilling options beyond traditional course design.
- Some students are willing to learn with content purely from the institution. However, others are seeking to supplement their learning through access to a wider range of content sources to support learning and skills development for employability. This opens up opportunities for new styles of content partnerships and credential pathways.
- Education institutions must develop a balance of structured pathways and social/personalized approaches aligned to learning design. As online learning design evolves, so do demands for evolution and expansion of LMS functionality to incorporate LXP-style solutions.

Obstacles

- The landscape for LXPs in education is still maturing and evolving. Recent and potential consolidation in the market adds a layer of uncertainty and risk. At present, very few corporate LXP vendors sell in the education space and there is no commonly defined feature set.
- Education LMS vendors are evolving in response to market need to offer similar benefits to LXPs. Therefore, the boundaries between LXP and LMS in education are not clear.
- Quantifying LXP return on investment is challenging in corporate environments and even more so within education. Enhanced learner engagement can be tracked and measured, but education institutions are currently faced with multiple paths and potential systems to support improved student outcomes.
- Institutions historically have provided students with structured pathways, learning resources and academic e-portfolios. Shifting to a more open, personalized environment requires a high-level investment in course design, content provision and change management.

User Recommendations

- Evaluate the strengths, weaknesses and roadmap of the various LXP providers to determine their advantages relative to existing systems and their fit for institutional strategy, culture and context.
- Assess their compatibility with existing education learning technologies to ensure integration, appropriate functionality and continuity across platforms.
- Acknowledge that corporate LXP products may not fully fit higher education requirements.
- Keep track of the evolution of existing education LMS platform providers toward LXP functionality.
- Pilot any LXP for a small, targeted population of learners to clarify benefits prior to major investment.
- Prioritize any initial pilot on programs, where the LXP can demonstrably enhance programs and the overall institution.
- Ensure that thorough business-case evaluation and change management communications are carried out prior to any LXP initiative.

Sample Vendors

360Learning; Absorb Software; Cornerstone OnDemand; Degreed; Fuse Universal; Learning Technologies Group; Microsoft; Skillsoft

Gartner Recommended Reading

[Market Guide for Corporate Learning Technologies](#)

[Market Guide for Higher Education Learning Management Systems](#)

[Tool: RFI/RFP Questions for Selecting Learning Technology Platforms](#)

Industry Cloud Platforms

Analysis By: Gregor Petri

Benefit Rating: Transformational

Market Penetration: 20% to 50% of target audience

Maturity: Adolescent

Definition:

Industry cloud platforms address industry-relevant business outcomes by combining underlying SaaS, PaaS and IaaS services into a whole product offering with composable capabilities. These typically include an industry data fabric, a library of packaged business capabilities, composition tools and other platform innovations. IT leaders can use the composability of these platforms to gain the adaptability and agility their industries need to respond to accelerating disruption.

Why This Is Important

Cloud, software and service providers are launching industry cloud platforms (ICP) by combining SaaS, PaaS and IaaS offerings with industry-specific functionality and composable capabilities to create more compelling propositions for mainstream customers. Emerging industry cloud platforms are leveraging innovative approaches such as composable packaged business capabilities (PBCs), PBC marketplaces, data grids and fusion teams to accommodate faster change and platform adaptability.

Business Impact

Broader cloud adoption within enterprises requires more whole-product business solutions that enable defined industry scenarios and process models, rather than technology-oriented solutions that enterprises have to largely configure and integrate themselves. ICPs enable enterprises to adopt more holistic cloud strategies that span across established cloud service categories such as SaaS, PaaS and IaaS.

Drivers

- As the complexities of both business and technology continue to increase, enterprises are looking for more outcome-based engagements with their cloud providers. However, such outcomes must be flexible enough to be able to adapt to the changing circumstances.
- To be relevant and be able to resonate with enterprise audiences, such outcomes must be business relevant, specific, measurable and tangible — a goal that is easier achieved when approached in a specific industry context.
- Industry cloud platforms can create value for enterprises by bringing traditionally separately purchased solutions together in a composable and modular way. This simplifies the sourcing, implementation and integration process.
- Currently, industry cloud platforms are being initiated and created by various technology providers. In addition, we see some enterprises considering creating — often in collaboration with a technology provider — a dedicated industry cloud platform as the basis for a more autonomous industry ecosystem.
- Enterprises can gain business value from industry clouds through shared best practices; vertically specialized go-to-market and implementation teams; compliance of the infrastructure platform with industry-specific regulations.
- Value can also be gained through analytical capabilities to integrally mine the data from existing and new applications; industry-specific add-on functionality in front- and back-office enterprise applications; combined with collections of composable building blocks available from industry cloud marketplaces.
- Providers are on a pathway to creating whole-product offerings that cater directly to the established needs of vertical industry enterprises.

Obstacles

- Industry clouds are at risk of following the same path as classic government and community clouds where providers created difficult to support or slightly outdated copies of the original cloud with specific functionality.
- Industry cloud platforms can be overwhelming in terms of the wide breadth of functionality they potentially cover. Customers and providers must therefore be disciplined and not burn precious resources on fixing/replacing things that are not broken.
- Implementing an industry cloud platform must be approached as adding an exoskeleton, bringing new and improved capabilities rather than a vital organ transplant, replacing or repairing functionality that was already present.
- To reach their full potential, industry clouds will need to evolve into something best described as ecosystem clouds. Enterprises can leverage these ecosystems by participating in shared (business) processes, such as procurement, distribution, payment procession, and maybe even R&D and innovation.

User Recommendations

- Target ICPs to complement the existing application portfolio like an exoskeleton by introducing new capabilities that add significant value, rather than as full-scale replacements of largely already existing functionality with more up-to-date technology.
- Start building composability skills by engaging business technologists and fusion teams to create enterprisewide understanding and support for the ICP journey.
- Formulate rules for when to deploy ICP capabilities as a productive platform for optimization and modernization by improving existing processes, and when to actively recompose them for more differentiating transformation and innovation initiatives.

Sample Vendors

Amazon Web Services (AWS); Google; IBM; Infor; Microsoft; Oracle; Salesforce

Gartner Recommended Reading

[Top Strategic Technology Trends for 2023: Industry Cloud Platforms](#)

[Presentation: Industry Cloud Platform Adoption by Vertical Industry](#)

[Analyzing Industry Cloud Offerings From CIPS Providers](#)

[Providers of Cloud Managed Services: Use Composable Industry Platforms to Productize Your Offerings](#)

[Changes and Emerging Needs Product Managers Must Address in the CIPS Market](#)

At the Peak

Smart Campus

Analysis By: Grace Farrell, Kelly Calhoun Williams

Benefit Rating: High

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Definition:

A smart campus is a physical or digital environment in which humans and technology-enabled systems interact, using gathered data and coordinated technologies. Multiple elements, including people, processes, services and things, come together to create a more immersive and automated experience for the students, staff, faculty, and stakeholders of an institution.

Why This Is Important

A smart campus can heavily influence many aspects of student life. Education leaders are under pressure to retain students and staff, strengthen their reputation, and reduce carbon footprint. Smart campus initiatives offer these institutions opportunities to personalize the student experience, save money on energy-draining technologies and fortify security measures on campus. As more students return to a physical campus, smart-campus technologies can reinvigorate the education experience.

Business Impact

A smart campus will boost efficiencies for utilities, traffic, parking, safety, space usage and campus navigation. As the digital campus matures, learning and student retention will improve, as an immersive and content-rich environment emerges. Mature smart campuses are likely to support higher education research in new ways and act as critical sources of research data. In K-12, a smart campus can free up critical funding and people resources, given the current staff and funding shortages.

Drivers

- The development of smart cities has yielded significant positive outcomes for local governments and their constituents. These smart cities are partnering with local universities to improve safety, reduce waste and enhance navigation in the area.

- Like many other organizations, education institutions are being pushed to report on their sustainability efforts. Smart-city-related measurement and data visualization can be important ways of accomplishing these sustainability goals.
- Where applicable globally, funds designated to support a shift toward renewable energy, building modernization, or greening and decarbonization will provide schools with more funding to support smart-campus efforts.
- There is a growing public concern that many institutions must bolster safety and security efforts. The use of automated license plate readers, facial recognition, AI-based gunshot detection and location intelligence has helped to ensure that stakeholders feel safer on campus.
- The ability to measure and automatically adjust heating, cooling and lighting presents potentially significant cost-saving opportunities.
- As the student experience demands more personalization, education organizations are looking to differentiate by incorporating smart-campus technologies in stadiums, laundry services, classrooms and food services.

Obstacles

- Designing a smart campus takes significant time and resources. Institutions will need to begin by upgrading their wireless and wired infrastructure, and improving bandwidth and software-defined networks.
- Many smart campus initiatives begin with a hyperfocus on one particular aspect, rather than a holistic strategy for the ecosystem. Smart-campus goals can range from traffic and parking, to virtual health services. Cross-collaboration among different departments is essential for interoperability, yet many institutions fail at this step and get stuck at the individual project level.
- Education leaders will need to think beyond technologies implemented, and look toward the utilization of data and how it will impact the student experience.
- Decentralizing large systems and securely using gathered data have proven to be challenging for many.
- Stakeholders may resist smart-campus initiatives due to unforeseen risk and privacy concerns.

User Recommendations

- Identify the business purpose and specific objectives for developing a smart campus first. Campus and organization stakeholders must be involved.
- Investigate opportunities to leverage sustainability and recovery funding.
- Create a strong data infrastructure by investing in robust data integration, data mining and analytics capabilities. The underlying fundamentals of a smart campus are solid integration, privacy and security.
- Engage with facilities departments in the earliest possible stages of building design. New buildings being planned on campus will need the appropriate infrastructure to support smart-campus applications.
- Prepare the institution for a future smart campus by planning for highly scalable network availability, especially in high-volume areas, such as outdoor spaces, classrooms, and dorms.
- Maintain satisfaction with student- and faculty-facing smart-campus applications through continuous feedback and development.

Sample Vendors

CommScope; Honeywell International; Johnson Controls; Microsoft; NTT DATA Group; Quantela

Gartner Recommended Reading

[Accelerating the Digital Campus in Higher Education](#)

[Smart City Funding Models: It's Time to Get Creative](#)

[Case Study: An Intelligent Urban Ecosystem Approach to a Sustainable Smart City](#)

Responsible AI

Analysis By: Svetlana Sicular

Benefit Rating: Transformational

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Definition:

Responsible artificial intelligence (AI) is an umbrella term for aspects of making appropriate business and ethical choices when adopting AI. These include business and societal value, risk, trust, transparency, fairness, bias mitigation, explainability, sustainability, accountability, safety, privacy, and regulatory compliance. Responsible AI encompasses organizational responsibilities and practices that ensure positive, accountable, and ethical AI development and operation.

Why This Is Important

Responsible AI has emerged as the key AI topic for Gartner clients. When AI replaces human decisions and generates brand-new artifacts, it amplifies both good and bad outcomes. Responsible AI enables the right outcomes by ensuring business value while mitigating risks. This requires a set of tools and approaches, including industry-specific methods, adopted by vendors and enterprises. More jurisdictions introduce new regulations that challenge organizations to respond in meaningful ways.

Business Impact

Responsible AI assumes accountability for AI development and use at the individual, organizational and societal levels. If AI governance is practiced by designated groups, responsible AI applies to everyone involved in the AI process. Responsible AI helps achieve fairness, even though biases are baked into the data; gain trust, although transparency and explainability methods are evolving; and ensure regulatory compliance, despite the AI's probabilistic nature.

Drivers

- Responsible AI means a deliberate approach in many directions at once. Data science's responsibility to deliver unbiased, trusted and ethical AI is just the tip of the iceberg. Responsible AI helps AI participants develop, implement, utilize and address the various drivers they face.
- Organizational driver assumes that AI's business value versus risk in regulatory, business and ethical constraints should be balanced, including employee reskilling and intellectual property protection.
- Societal driver includes resolving AI safety for societal well-being versus limiting human freedoms. Existing and pending legal guidelines and regulations, such as the [EU's Artificial Intelligence Act](#), make responsible AI a necessity.
- Customer/citizen driver is based on fairness and ethics and requires resolving privacy versus convenience. Customers should exhibit readiness to give their data in exchange for benefits. Consumer and citizen protection regulations provide the necessary steps, but do not relieve organizations of deliberation specific to their constituents.
- With further AI adoption, the responsible AI framework is becoming more important and is better understood by vendors, buyers, society and legislators.
- AI affects all ways of life and touches all societal strata; hence, the responsible AI challenges are multifaceted and cannot be easily generalized. New problems constantly arise with rapidly evolving technologies and their uses, such as using OpenAI's ChatGPT or detecting deepfakes. Most organizations combine some of the drivers under the umbrella of responsible AI, namely, accountability, diversity, ethics, explainability, fairness, human centricity, operational responsibility, privacy, regulatory compliance, risk management, safety, transparency and trustworthiness.

Obstacles

- Poorly defined accountability for responsible AI makes it look good on paper but is ineffective in reality.
- Unawareness of AI's unintended consequences persists. Forty percent of organizations had an AI privacy breach or security incident. Many organizations turn to responsible AI only after they experience AI's negative effects, whereas prevention is easier and less stressful.
- Legislative challenges lead to efforts for regulatory compliance, while most AI regulations are still in draft. AI products' adoption of regulations for privacy and intellectual property makes it challenging for organizations to ensure compliance and avoid all possible liability risks.
- Rapidly evolving AI technologies, including tools for explainability, bias detection, privacy protection and some regulatory compliance, lull organizations into a false sense of responsibility, while mere technology is not enough. A disciplined AI ethics and governance approach is necessary, in addition to technology.

User Recommendations

- Publicize consistent approaches across all focus areas. The most typical areas of responsible AI in the enterprise are fairness, bias mitigation, ethics, risk management, privacy, sustainability and regulatory compliance.
- Designate a champion accountable for the responsible development and use of AI for each use case.
- Define model design and exploitation principles. Address responsible AI in all phases of model development and implementation cycles. Go for hard trade-off questions. Provide responsible AI training to personnel.
- Establish operationalize responsible AI principles. Ensure diversity of participants and the ease to voice AI concerns.
- Participate in industry or societal AI groups. Learn best practices and contribute your own, because everybody will benefit from this. Ensure policies account for the needs of any internal or external stakeholders.

Sample Vendors

Amazon; Arthur; Fiddler; Google; H2O.ai; IBM; Microsoft; Responsible AI Institute; TAZI.AI; TruEra

Gartner Recommended Reading

[A Comprehensive Guide to Responsible AI](#)

[Expert Insight Video: What Is Responsible AI and Why Should You Care About It?](#)

[Best Practices for the Responsible Use of Natural Language Technologies](#)

[Activate Responsible AI Principles Using Human-Centered Design Techniques](#)

[How to Ensure Your Vendors Are Accountable for Governance of Responsible AI](#)

Emotion AI

Analysis By: Annette Zimmermann

Benefit Rating: Transformational

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Definition:

Emotion artificial intelligence (AI) technologies (also called affective computing) use AI techniques to analyze the emotional state of a user (via computer vision, audio/voice input, sensors and/or software logic). Emotion AI can initiate responses by performing specific, personalized actions to fit the mood of the customer.

Why This Is Important

Emotion AI is considered transformational as it turns human behavioral attributes into data that will have a large impact on human-machine interface (HMI). Machines will become more “humanized” as they can detect sentiments in many different contexts. Furthermore, applying deep learning to computer vision or audio-based systems to analyze emotions in real time has spawned new use cases for customer experience enhancements, employee wellness and many other areas.

Business Impact

Contact centers use voice analysis and natural language processing (NLP)-based algorithms to detect emotions in voice conversations, in personal chat conversations and chatbots. Computer vision (CV)-based emotion AI has already been used for more than a decade in market research with neuromarketing platforms that test users' reactions toward products. In addition, we see the technology expanding to other verticals and use cases, i.e., healthcare (diagnostic), sales enablement and employee wellness.

Drivers

The increasing number of use cases we have identified indicates an increase in commercialization as emotion AI finds applicability in new domains:

- One of the drivers for detecting emotions/states is the need for a system to act more sympathetically. For instance, it creates anthropomorphic qualities for personal assistant robots (PARs) and virtual beings, making them appear more “human.” This “emotional capability” is an important element in enhancing the communication and interaction between users and a PAR.
- This can be an empathic avatar or an emotion-detection-enabled chatbot. A person's daily behavior, communication and decisions are based on emotions — our nonverbal responses in a one-to-one communication are an inseparable element from our dialogues and need to be considered in the human-machine interface (HMI) concept.
- Combinatorial technology solutions such as computer-vision-based and audio analytics, or language-based and computer vision, enable customer experience enhancements.
- Strongest adoption is currently happening in the context of contact centers where voice-based emotion analysis supports multiple use cases such as real-time analysis on voice conversations, emotion detection in chat conversations, emotional chatbots and more.
- Market research and neuromarketing tools are continuously leveraging emotion detection in various user scenarios including focus groups and product testing. Vendors have been extending their offerings toward remote/online interviews during 2020 — due to the pandemic.
- In the creation of virtual beings in customer service or other consumer-facing scenarios, emotional responses are a critical element.

- As the metaverse unfolds, virtual beings will play an important role as business models evolve and the entire ecosystem of this new digital world emerges.

Obstacles

- Privacy concerns are the main obstacle to rapid adoption in the enterprise. This is especially a concern in real-life situations (vs. lab/research environments) for both consumer-facing (e.g., monitoring emotions in a retail environment via cameras) and employee-facing situations. Research environments like product testing have the advantage that the emotion AI is used for this specific purpose and the user (product tester) is fully aware that their emotions are being captured to improve usability or other features.
- Bias: When using facial expression analysis, models are likely to be retrained in different geographies to get the system to detect the different nuances present due to different cultural backgrounds.
- Variation across modalities. Certain emotions can be better detected with one technology mode than with another. For instance, “irony” can be detected using voice-based analysis while this is close to impossible to detect with facial expression analysis.

User Recommendations

- Review vendors’ capabilities and reference cases carefully. As the market is currently very immature, most vendors are focused on two or three use cases in two or three industries. At the same time, identifying and processing human emotion is currently a gray area, especially in the EU. The EU Commission has started an initiative to review the ethical aspects of AI technologies, and emotion AI will certainly be part of this debate.
- Enhance your customer analytics and behavioral profiling by applying emotion AI technologies bringing your customer experience strategy to the next level.
- Be use-case-driven. The use case will determine the emotion AI technology to be used and vendor selection.
- Appoint responsibility for data privacy in your organization — a chief data privacy officer or equivalent.
- Work with your vendor on change management in order to avoid user backlash due to sensitive data being collected.

Sample Vendors

Behavioral Signals; Cogito; DAVI; Intelligent Voice; kama.ai; MorphCast; Soul Machines; Superceed; Symanto; Uniphore

Gartner Recommended Reading

[Competitive Landscape: Emotion AI Technologies](#)

[Emerging Tech: Computer Vision, Voice Analysis and CGI Evolve Into Emotionally Intelligent Virtual Beings](#)

[Tool: Vendor Identification for Natural Language Technologies](#)

Adaptive Learning

Analysis By: Saher Mahmood

Benefit Rating: Transformational

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Definition:

Adaptive learning dynamically adjusts the way that instructional content is presented to students, based on their responses or preferences. Technology-driven adaptive learning is dependent on a large-scale collection of learning data and algorithmically (and even AI-derived) pedagogical responses.

Why This Is Important

Adaptive learning uses instructional content and integrated digital assessments to determine what students have (or have not) learned with far more precision than has been possible in the past. The application is designed to then take that insight and, often with the enhancement of AI or ML, modify or adapt the curriculum in a way that addresses the unique and specific needs of the learner. When fully realized, adaptive learning has the potential to create personalized learning opportunities.

Business Impact

The aim of adaptive learning in education is to enhance the learning experience and empower students by addressing their unique learning styles, preferences and needs. It also allows targeting specific concepts to be retaught with a new approach if needed, streamlining and filling in learning gaps. These changes can lead to tangible results, such as improved learning outcomes, higher retention rates and better graduation rates, all of which are important accountability measures in education.

Drivers

- Adaptive learning is especially attractive as it enables instructors to quickly identify learning gaps for individual students, groups or the entire class. It also provides potentially multiple modifications to the curriculum that target specific needs, rather than spending time on unnecessary reteaching.
- Adaptive learning has been in place for several years in K-12 education. The ability to leverage intelligence to improve the accuracy and effectiveness of the content has been possible in the past few years, greatly elevating its impact and usefulness.

Obstacles

Adaptive learning remains at the Peak of Inflated Expectations, with broader availability and adoption needed to move it to the trough. AI introduces new challenges:

- There must be enough data to mine to produce valid insights. The data must be available from a very large set of users using the product, larger than is available in most organizations currently.
- To achieve this, publishers must have control over both the content and digital assessments to develop content adaptations that will work.
- This limitation has to date largely restricted use to mainly digital publishers that control both the content and assessments, and have large numbers of student users.
- There are adaptive learning platforms on which K-12 organizations can customize content and assessments, but this has evolved into an overwhelming undertaking.
- Generative AI offers potential for granular insights and real-time, rapid and dynamic adjustment of learning content, which may challenge the adaptive learning experience.

User Recommendations

CIOs should approach adaptive learning projects as large-scale curricular redesign undertakings, rather than technology projects. To this end, CIOs should:

- Identify curriculum and instruction champions early in the process.
- Identify vendors experimenting with adaptive learning content. Establish pilots to learn how these work and what is their roadmap for AI-driven technologies that support teaching and learning.
- Engage teachers and staff to participate in product evaluation, as they will have a vested interest in ensuring that learning outcomes are improved with the product.
- Obtain a clear understanding of adaptive learning and how each product functions as it supports and supplements student learning.
- Follow a four-stage process: (1) become educated about the products and educate key stakeholders about them; (2) use your pioneer educators to identify and pilot products that meet required learning standards; (3) review lessons learned; and (4) move to larger-scale implementations.

Sample Vendors

ALEKS; CENTURY; CogBooks; DreamBox Learning; MobyMax; Pearson Education; Realizeit; Sumdog; John Wiley & Sons (Knewton)

Everyday AI

Analysis By: Adam Preset

Benefit Rating: Transformational

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Definition:

Everyday AI refers to snippets of AI services that help workers improve productivity, deliver higher-quality work and save time. Workers interact with everyday AI mostly as features of widely used personal and team productivity applications that are typically deployed across an organization horizontally. These AI services are used by employees throughout the day, and will become increasingly varied and integrated into our working lives.

Why This Is Important

Everyday AI technology aims to help employees deliver work with speed, comprehensiveness and confidence. Recent advances in generative AI promise to streamline content creation, analysis and collaboration. Machine learning and natural language processing capabilities are becoming more common and embedded in application features to enable automation and efficiency. Everyday AI supports a new way of working where intelligent software is acting as more of a collaborator than a tool.

Business Impact

Everyday AI can amplify the productivity of any worker. As digital work becomes more complex, workers are expected to master more capable yet complex applications. Everyday AI can simplify some of that complexity. Employees who wield everyday AI can focus on meaningful, high-value, creative output rather than the routine tasks that can be delegated away. Deployment of technology to meet this need is more scalable and efficient than hiring and training additional talent.

Drivers

Vendors in different technology markets seek to improve worker productivity in novel ways beyond simple application and feature enhancements. The development of everyday AI capabilities delivers these productivity benefits while also providing vendors with a marketable and monetizable set of new capabilities. Gartner expects to see continuing innovation from vendors as they expand their everyday AI features, with collaboration megavendors making the most aggressive investments and prominent announcements.

Several enterprise application markets have AI assist capability that aids workers in various ways. Following are examples of categories and functions that employ everyday AI:

- Business productivity: correcting errors, improving message clarity, coordinating meetings.
- Content creation: composing entire documents or designing presentations based on modest prompts.
- Workstream collaboration: notifications, canned responses, task execution.
- Meeting solutions: transcription, translation, highlighting and identifying action items, meeting scheduling.

- Search: aggregating, summarizing and citing information following natural language prompts.
- HR applications: streamlining access to organizational and employee information.
- Performance management: aggregating metrics data, providing coaching guidance.

Workers generally embrace everyday AI as it helps them save time while reducing drudgery and stress. Organizations will invest further in everyday AI as they see the technology is able to multiply their workers' output and effort. Everyday AI will become increasingly sophisticated, moving from a service that, for example, can sort and summarize chats and email messages, to services that can write a report with minimal guidance. In many ways, everyday AI is the future of workforce productivity.

Obstacles

- Employees are unaware of everyday AI features. They distrust everyday AI, are concerned about privacy and may resist use due to poor early experiences with it.
- Some routine work processes may not be suitable for everyday AI. Enterprises may need to create foundational governance policies and practice guidance to enable the use of everyday AI. New everyday AI tools backed by generative AI demand more cloud computing resources, so sustainability and environmental impact may limit comfort with the technology.
- The benefits of successful use may be hard to capture or attribute to everyday AI capabilities. Everyday AI may require an explicit request for service, rather than being integrated into how people work where contextual disclosure can be applied.
- Vendors may overrepresent the capabilities of everyday AI. They may create and charge for product models where varying levels of everyday AI features are available at different tiers, which can make broad adoption confusing or expensive.

User Recommendations

- Ensure that employees are aware of everyday AI capabilities in the tools they use. Find out why employees may be hesitant to use everyday AI features and methodically address objections, particularly around privacy.
- Maintain a running inventory of everyday AI features and create an everyday AI digital side hustle. Retain healthy skepticism when vendors claim to have advanced everyday AI capabilities.
- Track new everyday AI usage patterns to inform enablement strategies. Make everyday AI a top software evaluation criterion.
- Be increasingly bold in the approach to everyday AI; look for applications where the use of everyday AI can have an increasingly larger impact, such as in common activities such as creating written and visual content, data analysis and improving meetings.

Sample Vendors

AmplifAI; Beautiful.ai; Calendly; Google; Grammarly; Microsoft

Gartner Recommended Reading

[Predicts 2022: Digital Workplace Is Foundational for Employee Experience](#)

[Quick Answer: How Can Everyday AI Improve Worker Digital Dexterity?](#)

[Quick Answer: How Will AI in Microsoft 365 Copilot Impact the Workplace?](#)

Generative AI in K-12 Education

Analysis By: Kelly Calhoun Williams

Benefit Rating: Transformational

Market Penetration: 1% to 5% of target audience

Maturity: Adolescent

Definition:

Generative AI technologies can generate new derived versions of content, strategies, designs and methods by learning from large repositories of original source content. Generative AI has profound business impacts, including on content discovery, creation, authenticity and regulations; automation of human work; and customer and employee experiences. Generative AI refers to AI techniques that learn a representation of artifacts from data, and use it to generate brand-new, unique artifacts that resemble but don't repeat the original data. These artifacts can serve benign or nefarious purposes. Generative AI can produce totally novel content (including text, images, video, audio, structures), computer code, synthetic data, workflows and models of physical objects. Generative AI also can be used in art, drug discovery or material design.

Why This Is Important

Generative AI's popularity has exploded since the public launch of ChatGPT and other large language models in the fall of 2022, moving forward at a breakneck pace. K-12/primary-secondary ("K-12") education organizations currently have more questions than answers, seeing its potential for transforming teaching and learning, while simultaneously recognizing its incredibly nascent development and potentially very high early risks that need attention on many fronts.

Business Impact

Most educational technology products and services will seek to incorporate generative AI capabilities in the next 12 months, including for instructional, administrative and business use cases. Examples of use of generative AI tools already exist in products such as Khan Academy's Khanmigo and Duolingo for learning a new language. These tools will naturally form the basis of personal learning assistants of the future, reaching well beyond current abilities to customize and advance instruction at scale.

Drivers

- The hype around generative AI is accelerating. Currently, ChatGPT is the most hyped technology in education, but others are rapidly rising on the horizon.
- A current priority for many organizations is to define governance policies for this technology. For K-12, this may involve working with broader government policymakers.
- Educating all stakeholders on how generative AI works, as well as on the ethical and appropriate use of these tools, will be an early imperative. Today's students will be living in a world in which these tools are in use everywhere, and they must be appropriately prepared.
- New foundation models and their new versions, sizes and capabilities are rapidly coming to market. They can combine concepts, attributes and styles, creating original images, video and art from a text description or translating audio to different voices and languages. The potential applications in an educational environment are nearly endless.
- Industry applications of generative AI are growing. In education, ChatGPT has quickly been adopted by teachers to rapidly identify resources for lesson plan development (including suggestions for improvements in instructional design). Generative AI abilities include creative work, design, music, architecture and content, as well as content creation and improvement in text, images, video and sound, potentially offering increased access to many learning opportunities and resources for students.
- Generative AI will disrupt software coding. Combined with development automation techniques, it can automate up to 30% of the programmers' work.

Obstacles

- Worry about the potential misuse of these tools has caused some organizations to block access to them. This response is rapidly being overturned as (a) the tools are so ubiquitous that it is nearly impossible to block access to them; and (b) blocking prevents students from gaining critical insights on these powerful tools with appropriate guardrails.
- Democratization of generative AI uncovers new ethical and societal concerns. Government regulations may hinder generative AI research.
- Significant research remains to be done to develop appropriate governance, policies and guidelines that maintain safe use of these tools in an educational environment.
- Hallucinations (confident responses by the tool unjustified by available data) currently preclude the use of generative AI for critical use cases without putting proper safeguards in place.
- Low awareness of generative AI among security professionals may cause incidents that could undermine generative AI adoption.
- Generative AI can be used for many nefarious purposes. Full and accurate detection of content such as deepfakes will remain challenging or impossible.

User Recommendations

- Mitigate generative AI risks by developing governance policies, working with legal, governmental, security, fraud and subject matter experts. Technical, institutional and political interventions will be necessary to implement the policies. Include data security and personally identifiable information usage guidelines.
- Identify initial use cases where education-tailored products exist or may evolve. Focus on those with demonstrable improvement in learning, administrative or other business outcomes, or those that vastly streamline or optimize current operations.
- Evaluate use cases' advantages and limitations with generative AI. Provide generative AI education and guidelines regarding each use case, as it requires skills, awareness and caution. Weigh technical capabilities with ethical factors. Beware of subpar offerings that exploit the current hype.
- As a category undergoing a historically massive period of hype, don't be blinded by generative AI. Examine and challenge assumptions about the benefit it may or may not bring via each use case and application.

Sample Vendors

Adobe; Amazon; Anthropic; Duolingo; Google; Grammarly; Hugging Face; Khan Academy; Microsoft; OpenAI

Gartner Recommended Reading

[Quick Answer: How Should Education Institutions Respond to Use of Generative AI Such as ChatGPT?](#)

[Innovation Insight for Generative AI](#)

[Emerging Tech Roundup: ChatGPT Hype Fuels Urgency for Advancing Conversational AI and Generative AI](#)

[Emerging Tech: Generative AI Needs Focus on Accuracy and Veracity to Ensure Widespread B2B Adoption](#)

[ChatGPT Research Highlights](#)

Immutable Data Vault

Analysis By: Michael Hoeck, Jerry Rozeman

Benefit Rating: High

Market Penetration: 1% to 5% of target audience

Maturity: Adolescent

Definition:

Immutable data vault (IDV) solutions provide an immutable, air-gapped and independent copy of the backup in a secure environment for safeguarding backups against ransomware and insider attacks. Deployed on-premises or in the cloud, they are often delivered as packaged or hosted solutions by a variety of vendors, including backup and recovery software manufacturers, systems integrators and managed service providers. IDVs may or may not be part of an isolated recovery environment (IRE).

Why This Is Important

Against the backdrop of cyberattacks increasing in numbers and sophistication, organizations are expanding their efforts to prepare for the need to recover from an attack. With the latest round of attacks targeting backup systems, backup solutions are improving their ability to prevent backup data from being compromised. IDVs provide additional levels of protection and security of backup data to ensure backup data is available after an attack.

Business Impact

IDVs safeguard backup copies by:

- Creating a copy of backup data, independent from production and disaster recovery copies, which is isolated in a physically separate and secure environment.
- Restricting administration to physical console access to remove remote access.
- Using immutable storage to protect copies from being altered.
- Implementing physical or virtual air gap to separate vault copy from production environment.

Drivers

- Threats and sophistication of ransomware attacks, and the potential risk associated with rogue administrators, are increasing.
- Ransomware-as-service offerings are being sold, increasing the threat of new attackers and variants of malware.
- Work-from-home demands have significantly increased the risk of attacks via unsecured or poorly secured endpoints.
- Some attackers take over backup console operations to expire and delete backup data.
- There is an increased focus on new backup strategies to protect, detect and recover from the evolving threats of ransomware.
- Industry-led initiatives, such as Sheltered Harbor (financial services), have created awareness and demand for adding IDVs and IREs to improve cyber resilience.
- Industries such as the government, education and healthcare have had a higher rate of reported ransomware incidents.
- The number of regulatory and executive orders advising implementation of additional, highly protected copies of backup data is growing. Cyber insurers are adding requirements for air-gapped copies of backup data.

Obstacles

- Implementing another solution to store backup data amounts to additional cost that may not be budgeted.
- IDVs not only require additional backup storage, but also are recommended to be physically separated within or outside a data center. This requires additional infrastructure, such as a new cage, an area with limited physical access or at an off-site-managed storage location and air-gapped from the production network.
- The backup environment has become more complex due to the addition of a new isolated copy of data, additional technologies like advanced networking and data scanning, requirement of new procedures and runbooks, and potentially limited staff to operate it.
- Vendors have created confusion over the definition and implementation of “immutable” and “air gap,” due to a lack of standards. Therefore, it’s important to understand what each vendor means by “immutable” and “air gap” and how its functionality is implemented to assess the risk of hackers to override it.

User Recommendations

- Plan for when, not if, an attack will occur in the cost-benefit analysis to gain management buy-in to phase in costs. All new backup implementations should require immutability of the backup store.
- Conduct a thorough cost-benefit and risk assessment to align expectations and acceptable risks to the current backup and recovery solution capabilities. Leverage IDVs for your most critical applications to minimize investments.
- Align recovery time objectives (RTOs) and cost considerations in the selection and deployment of cloud or on-premises IDV solutions.
- Be mindful that the data stored within an IDV may also contain the agent or infectious code, as well as infected or encrypted data. Therefore, incorporate other requirements to scan, cleanse and repair backup data into the environment to prevent the reinfection of other systems during the recovery and restoration process.

Sample Vendors

Cohesity; Commvault; Dell Technologies; IBM; Kyndryl; Microsoft; Rubrik; Unisys; Veritas; Zerto

Gartner Recommended Reading

[Magic Quadrant for Enterprise Backup and Recovery Software Solutions](#)

[2022 Strategic Roadmap for Storage](#)

[Quick Answer: Can My Disaster Recovery Plan Also Address Ransomware Recovery?](#)

[Innovation Insight for Leveraging Isolated Recovery Environments and Immutable Data Vaults to Protect and Recover From Ransomware](#)

[Detect, Protect, Recover: How Modern Backup Applications Can Protect You From Ransomware](#)

Online Tutoring (K-12)

Analysis By: Saher Mahmood

Benefit Rating: Moderate

Market Penetration: 1% to 5% of target audience

Maturity: Early mainstream

Definition:

Online tutoring services are online marketplaces where learners can seek one-on-one or group tutoring from private tutors around the globe. These can be live or recorded virtual sessions, and they help students meet and supplement their learning requirements.

Why This Is Important

COVID-19-induced disruption increased uptake by students (and their parents) as direct consumers, as virtual schooling became a challenge for many. Federal funding for recovery has also allowed organization-level use of online tutoring services, particularly in North America, to address the challenge of learning loss as well as other issues like faculty shortages. Unlike state-funded in-person remedial education programs, online tutoring is mostly offered by private, for-profit companies.

Business Impact

Online tutoring can potentially address learning gaps among students, which were exacerbated during the pandemic. As AI technologies mature, many vendors are branching into AI-aided tutoring, especially for skills like literacy, reading and numeracy. Collaborating with online tutoring companies at an organizational level will require administrative and academic leaders to do a needs assessment, understand its benefits and implications, and have a consensus on the estimated ROI.

Drivers

- With students already provisioned with laptops for remote learning and school districts armed with stimulus funding allocated for learning loss, two major criteria for facilitating online tutoring are already met.
- The virtual-only model makes it an equalizer in access to learning, with internet connection being the only criteria. This ease of access to learning support will continue to be relevant beyond the pandemic-induced disruption.
- The additional insights and data that can be gleaned from learner activity and responses to these services could be a potential advantage that educators can seek.
- 24/7 services and a vast pool of vendor-vetted tutors (including university students and faculty) offer the potential to lower tutoring costs.
- With AI algorithms to connect students' needs and tutors' skill sets, the growing need for more accurate and personalized matches has a greater chance of being realized.
- Many platforms have expanded their offerings to include career and university counseling services and exam prep to align themselves better with the K-12 requirements.
- To facilitate ease of adoption, most tutoring solutions offer single sign-on (SSO) integration with learning management systems (LMSs). This allows easy sign-up and access, encouraging uptake.
- Service providers are leveraging AI to expand automated tutoring offerings, particularly for objective skills like reading and math. For example, there are early signs of the incorporation of generative AI chatbots into the suite of services offered. How this will impact the demand for human-centric online tutoring is to be observed in the coming months.

Obstacles

- Online tutoring as a tool to supplement classroom learning is relatively new. With no precedence, it lacks the structure or benchmarks to prioritize students and measure before and after outcomes.
- The market is driven by private vendors and hence there aren't enough standardized benchmarks and processes to vet and regulate the quality of the service provided.
- Online tutoring can lack the personal touch of an in-person teaching and learning experience. While academic learning can take place via screen, overall human interaction, including fine motor skills, which are an integral part of the K-12 learning ecosystem, cannot be easily addressed by online tutoring.
- Usage data suggests in some places that partnerships between school districts and service providers for 24/7 voluntary tutoring do not have the desired uptake, particularly among the students who need it the most.

User Recommendations

- Work with academic leaders to do a needs assessment and run focused pilots to get a clear understanding of benefits and implications. Use these pilots to establish frameworks for assessing outcomes and estimating ROI.
- Prepare for future adoption of online tutoring services in your district by exploring the market and identifying the major vendors partnering with institutions, their licensing models and their technology requirements.
- Establish a clear understanding of the quality and volume of learning data that can be accessed through sign-ups by discussing frequency, formats and requisite integrations.

Sample Vendors

Amira Learning; BYJU'S; GoStudent; Littera Education; Ostaz; Paper; Skooli; Tutor.com; TutorMe; Vedantu

Edge Computing

Analysis By: Bob Gill, Philip Dawson

Benefit Rating: Transformational

Market Penetration: More than 50% of target audience

Maturity: Early mainstream

Definition:

Edge computing describes a distributed computing topology in which data storage and processing are placed in optimal locations relative to the location of data creation and use. Edge computing locates data and workloads to optimize for latency, bandwidth, autonomy and regulatory/security considerations. Edge-computing locations extend along a continuum between the absolute edge, where physical sensors and digital systems converge, to the “core,” usually the cloud or a centralized data center.

Why This Is Important

Edge computing has quickly become the decentralized complement to the largely centralized implementation of hyperscale public cloud. Edge computing solves many pressing issues, such as sovereignty, unacceptable latency and bandwidth requirements, given the massive increase in data produced at the edge. The edge-computing topology enables the specifics of Internet of Things (IoT), digital business and managed distributed IT solutions.

Business Impact

Edge computing improves efficiency, cost control, and security and resilience through processing closer to where the data is generated or acted upon, fostering business opportunities and growth (e.g., customer experience and new real-time business interactions). Earliest implementations succeeded in enterprises that rely on operational technology (OT) systems and data outside core IT, such as the retail and industrial sectors.

Drivers

- Growth of hyperscale cloud adoption has exposed the limits of extreme centralization. Latency, bandwidth requirements, the need for autonomy and data sovereignty or location requirements may be optimized by placing workloads and data closer to the edge, rather than centralizing in a hyperscale data center.
- Data growth from interactive applications and systems at the edge often cannot be economically funneled into the cloud.
- Applications supporting customer engagement and analysis favor local processing for speed and autonomy.
- IoT is evolving from simply reporting device status to using edge-located intelligence to act upon such status, bringing the benefits of automation and the creation of immediately responsive closed loop systems.
- Edge computing's inherent decoupling of application front ends and back ends provides a perfect means of fostering innovation and enhanced ways to do business. For example, using technologies such as machine learning and industrial sensors to perform new tasks at locations where business and operational events take place, or at the point of interaction with a retail customer, can drive significant business value.

Obstacles

- The diversity of devices, software controls and application types all amplify complexity issues.
- Widespread edge topology and explicit application and networking architectures for edge computing are not yet common outside vertical applications, such as retail and manufacturing.
- Edge success in industrial IoT applications and enhancing customer experience in retail are well-understood, but many enterprises still have difficulty understanding the benefits, use cases and ROI of edge computing.
- A lack of broadly accepted standards slows development and deployment time, creating lock-in concern for many enterprise users.
- Edge physical infrastructure is mature, but distributed application management and orchestration challenges are still beyond most vendor-supplied component management offerings. The tasks of securing, maintaining and updating the physical infrastructure, software and data require improvement before management and orchestration can mature.

User Recommendations

IT leaders responsible for cloud and edge infrastructure should:

- Create and follow an enterprise edge strategy by focusing first on business benefit and holistic systems, not simply focusing on technical solutions or products.
- Position edge computing as an ongoing, enterprisewide journey toward distributed computing, not simply individual isolated projects.
- Establish a modular, extensible edge architecture through the use of emerging edge frameworks and design sets.
- Accelerate time to benefit and derisk technical decisions through the use of vertically aligned systems integrators and independent software vendors that can implement and manage the full orchestration stack from top to bottom.
- Evaluate “edge-as-a-service” deployment options, which deliver business-outcome-based solutions that adhere to specific SLAs while shifting deployment, complexity and obsolescence risk to the provider.

Gartner Recommended Reading

[Market Guide for Edge Computing](#)

[5 Top Practices of Successful Edge Computing Implementers](#)

Sliding into the Trough

Conversational User Interfaces

Analysis By: Gabriele Rigon, Stephen Emmott, Van Baker, Bern Elliot, Frank O'Connor

Benefit Rating: Transformational

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Definition:

Conversational user interfaces (CUIs) are human-computer interfaces that enable natural language interactions for the purpose of fulfilling a request, such as answering a question or completing a task. The sophistication of a CUI can vary from understanding basic queries to handling complex multiturn dialogs, so CUIs range from Q&A bots to more advanced virtual assistants (VAs). CUIs fundamentally shift the interaction medium from traditional point-and-click to natural-language-driven.

Why This Is Important

UIs provide direct control between the user and the applications they are operating. In a CUI, this responsibility shifts from application-specific controls to conversational controls, and the CUI is determining the intent and acting upon it. This makes CUIs more widespread as agent (acting) UIs for software, devices and the Internet of Things. AI-enabled CUIs can provide a single, intuitive, common interface to multiple application functions across the entire organization.

Business Impact

Training, onboarding, escalations, productivity, empowerment and responsibility all change with CUIs and need to be embraced as part of CUI projects. AI-enabled CUIs can dramatically standardize and improve the usability of a variety of applications across all business functions, such as CRM, the digital workplace and ERP, hence improving efficiency. They can also benefit customer experience when used to automate support in the form of self-service chatbots or VAs.

Drivers

- **Users' expectations and generative AI:** Users increasingly expect to be able to hold conversations with and ask natural language questions of the applications they use. CUIs are beginning to complement or even replace traditional interfaces in a variety of applications, such as search and insight engines, business intelligence platforms and productivity software, such as document and spreadsheet applications. The trend toward the enablement of interactions in natural language between users (customers and employees) and software has been significantly accelerated by the hype around generative AI and ChatGPT.
- **Conversational AI platforms:** The underlying technology supporting custom-developed CUIs (like chatbots and VAs) built on top of conversational AI platforms (CAIPs) has matured significantly in the last few years. Vendors are investing in core AI technologies, such as large language models (LLMs), to improve components such as natural language understanding. They are also expanding their capabilities to support broader use cases beyond self-service chatbots and toward broader B2C and B2E automation.
- **Search:** CUIs will be increasingly used for knowledge search and retrieval based on document ingestion. Some technologies driving this include LLM-enabled enterprise applications, such as Microsoft 365 Copilot, as well as ChatGPT-like Q&A chatbots and LLM-powered VAs. This is also causing the market to be flooded with dedicated add-ons and even new vendors.
- **Multimodal interactions:** Generative AI methods are increasing the availability of multimodal interactions, such as those based on images, videos, audio and other sensory data. As a matter of fact, beyond text, voice is emerging as a primary modality of interaction between users and CUIs. This can add a powerful enhancement to the communications. Multimodality can solve some of the problems of the current generation of LLMs. Multimodal language models will also unlock new applications that were impossible with text-only models.

Obstacles

- Developing CUIs is intrinsically complex and requires more effort than graphical UIs. More sophistication has to be built into VAs' conversational capabilities to deal with a range of users and edge cases. CUIs' predictions about users' intents can be wrong, so the CUI designer has to keep ambiguity in mind.
- Lack of CUI personality, poor accuracy and conversational design, as well as unreliability of answers generated by LLMs, can affect user sentiments negatively and, as a consequence, adoption and ROI.

- CUIs are available from many sources, whether offered by applications, CAIPs or through separate augmentation. For example, transactional conversational AI use cases require capabilities that only platforms can provide. Q&A scenarios may also be supported by architectures primarily leveraging search and LLMs. Understanding the sophistication and the limitations of these and other approaches is not trivial. This may lead buyers to choose the wrong tooling and many CUIs to fail.

User Recommendations

- Treat CUIs as transformative, and plan on them becoming the dominant interaction model between users and applications.
- Prioritize the requirements of your custom CUIs in terms of sophistication, integration and control. Do not underestimate the risks of building CUIs that do not meet enterprise-grade performance, accuracy and security standards.
- Develop your strategy for consolidation upon one or few conversational AI platforms or approaches, avoiding challenges that derive from the proliferation of CUIs deployed by different business units in different regions.
- Educate stakeholders around benefits and limitations of generative-AI-enabled CUIs, and encourage well-informed employees to experiment with such CUIs.
- Prepare for new roles and skills in the enterprise. Dialogue designers and AI trainers, for example, are needed to enable custom CUI initiatives. Citizen developers will acquire prompt engineering and model management skills to leverage generative-AI-enabled CUIs effectively.

Sample Vendors

Amelia; Avaamo; Cognigy; Google; IBM; Kore.ai; Omilia; OneReach.ai; OpenAI

Gartner Recommended Reading

[Magic Quadrant for Enterprise Conversational AI Platforms](#)

[Critical Capabilities for Enterprise Conversational AI Platforms](#)

[Competitive Landscape: Conversational AI Platform Providers](#)

[Emerging Tech Roundup: ChatGPT Hype Fuels Urgency for Advancing Conversational AI and Generative AI](#)

Innovation Insight for Generative AI

Zero-Knowledge Proofs

Analysis By: Mark Horvath, Bart Willemsen

Benefit Rating: Moderate

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Definition:

Zero-knowledge proofs (ZKPs) are privacy-preserving messaging protocols that enable entities to prove that information available to either or both of them is correct, without the requirement to transmit or share the underlying (identifiable or otherwise sensitive) data. ZKPs enable entities to prove information validity without the requirement to transmit personal or confidential data.

Why This Is Important

Following increasingly imminent digital threats and legislative data protection requirements, security and risk management (SRM) leaders must support use cases that enable digital business while ensuring in-use protection. These protocols limit the requirement for mass decryption/encryption of data elements, which benefits the efficiency of work — including potential adoption of blockchain-based systems.

Business Impact

ZKPs are being applied for many use cases, especially in the context of authentication and transaction verification. Other use cases include payments, decentralized identity, custody management, anti-money-laundering (AML), know your customer (KYC), consumer identity and access management (IAM), age verification, etc. With the addition of ZKPs to blockchain platforms, SRM leaders can cover information security use cases that require confidentiality, integrity and availability (CIA). Some blockchain platforms have evolved to include this.

Drivers

- Traditional data protection techniques typically focus on data in motion (i.e., transport layer security) and data-at-rest encryption. Data-at-rest encryption, as commonly implemented, does not provide strong protection from data theft and privacy disclosures. It is unable to secure data in use and data sharing scenarios.
- New use cases and maturing privacy legislation worldwide present new privacy and cybersecurity concerns that require data-in-use protection. There are also scenarios where the data itself does not need to be shared. ZKPs enable such data-in-use protection.
- Concerns about data security in several scenarios, including collecting and retaining sensitive personal information, processing personal information in external environments such as the cloud and information sharing.
- Privacy violations (due to the exposure of sensitive information).
- Need for mitigation of sensitive data leakage and cyberattacks.

Obstacles

- Even with a variety of web applications (e.g., ZKProof), ZKPs remain in an emerging state. They still require a common framework for applications to leverage.
- Only a limited number of practical implementations have emerged to date.
- The variety of methodologies and the multiplicity of approaches to data management inhibit adoption. ZKPs will need to scale at the rate of blockchain transactional volumes to be effective.
- ZKPs require integration into applications. Downstream applications, such as CRMs and databases, will need some modification.
- Some ZKPs, like ZK-SNARK, have a dependency on existing encryption/hashes (ECDSA in this case) as part of their implementation. This adds a potential complexity in upgrading them to quantum-safe protocols and limits available staff/experts.

User Recommendations

- Work with SRM leaders to gain a deeper understanding of the nature of these controls, understanding that ZKP techniques are a paradigm shift.
- Be realistic with the current immaturity of ZKP solutions and approaches when evaluating ZKP benefits for privacy protection.
- Evaluate how ZKP controls may impact transaction authentication and, ultimately, consumers.
- Assess the impact on the broader information management strategy.
- Assess the architectural implications for using ZKP with different blockchains and distributed ledgers.

Sample Vendors

DropSecure; Evernym; IBM; Ligero; Microsoft; Ping Identity; QEDIT; Sedicii; StarkWare

Gartner Recommended Reading

[Three Critical Use Cases for Privacy-Enhancing Computation Techniques](#)

[Emerging Tech: Assess Zero-Knowledge Proof Technologies to Strengthen Competitive Advantage in Decentralized Ecosystems](#)

[Predicts 2022: Privacy Risk Expands](#)

[Top Strategic Technology Trends for 2022: Privacy-Enhancing Computation](#)

Data Breach Response

Analysis By: Nader Henein, Bernard Woo

Benefit Rating: High

Market Penetration: More than 50% of target audience

Maturity: Early mainstream

Definition:

Data breach response, augmentation and the associated disclosure are the activities required to assess and notify regulatory authorities and, depending on the impact, the affected individuals when personal data is compromised. Disclosure is mandated by omnibus laws, such as the European Union's General Data Protection Regulation (GDPR), Australia's Notifiable Data Breaches (NDB) scheme, or subject- and region-specific laws, like the individual U.S. state breach notification legislation.

Why This Is Important

Appropriate management of a breach impacting personal data can substantially reduce fines and potentially strengthen ties with affected consumers. It demonstrates that the organization is proactively taking ownership of the situation. However, delayed response, limited transparency and overly legal communications often elicit regulatory investigations, resulting in reputational damage and customer loss.

Business Impact

Data breach response can have a critical impact on an organization's resilience. Breaches often create significant chaos as key executive team members pivot from preexisting priorities to address the reputational, regulatory and likely financial impacts of the breach. Further, newer legislation imposes statutory sentences on company directors for inadequate or negligent handling of personal data.

Drivers

- Modern privacy regulations have raised the bar for data breach notification. When personal data is impacted, disclosure to a supervisory authority within days of discovery is often required.
- In the U.S., all 50 states have breach notification laws in place and many states, such as New York and California, have amended their laws in the past two years. Amendments typically expand the data in the scope of the legislation and the responsibilities surrounding disclosure.
- Regulatory evolution illustrates the need for organizational commitment and resource allocation.
- Organizations must constantly align the technical and operational elements of incident response (IR) with new legal and regulatory requirements.
- Elevating the capacity to disclose a data breach to regulators and potentially affected individuals in an accelerated time frame is something many organizations still need to prepare for.
- Though many organizations are driven by fine avoidance, incidents are bound to happen, and a well-developed response program can pay back in dividends with fine reductions of over 50%.
- An emerging trend is rapid consumer mobilization following an incident. The impact of mass customer exodus, often led by social media, is expected to suppress regulatory fines. Also, it does not offer the organization the option of an appeal through the courts.

Obstacles

- Establishing and testing a data breach program is an expense without an immediate return. It will pay off only if something goes wrong. This often causes the program to be deprioritized in place of more pressing or revenue-generating tasks.
- Data breach service retainers are not commonly available because of the variability and uncertainty of the type of breach, the data involved and the number of records that makes each breach scenario unique.
- Even with a strong program, the time to discover an incident can range from months to years — although it is improving over time.
- Tensions between the general counsel and chief information security officers (CISOs) over limiting information may become available through discovery following an incident. This could negatively impact the organization's capacity to effectively handle a breach.
- Data breach response requires a combination of technical acumens, such as forensics analysis of how the breach occurred, the number and type of records involved, and appropriate remediation. Data breach response must be paired with coordinated organizational processes.

User Recommendations

- Assess whether an incident will trigger regulatory actions. Meet the threshold for a privacy violation.
- Record and maintain the details about incidents (not just violations), as some jurisdictions have stringent record-keeping requirements.
- View data breach response as a multidisciplinary process involving documented procedures and simulated drills, such as tabletop exercises. Doing so will ensure tasks are well-defined and responsibilities are clear. The process should also involve coordination and transparency between various teams and integration into the larger IR training to provide breach disclosure and rapid response requirements.
- Augment your organization's ability to address data breaches in an efficient and timely manner to fulfill regulatory and data-subject disclosure requirements.

Sample Vendors

BigID; BreachRx; Canopy; OneTrust; RadarFirst; Securiti

Gartner Recommended Reading

[Toolkit: Cybersecurity Incident Response Plan](#)

[Toolkit: Security Incident Response Roundtable Scenario for Privacy](#)

Immersive Technology

Analysis By: Grace Farrell

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Definition:

Immersive technology now describes the category that includes virtual, augmented and mixed reality. These are different, yet related technologies. Virtual reality (VR) technologies create computer-generated environments to immerse users in a virtual environment. Augmented reality (AR) technologies overlay digital information on the physical world to enhance it and guide action. Mixed reality (MR) blends the physical and digital worlds in new ways.

Why This Is Important

Immersive technology represents an important, potentially transformational technology in education. Its unique ability to create interactive learning spaces not possible in the classroom is itself a compelling argument for its use, but requires a well-designed curriculum. Prices of various platforms and hardware have continued to fall, but are still too high for large-scale deployment, slowing its progress in education environments.

Business Impact

The new generation of immersive applications promises to support learning activities that improve student engagement, such as:

- Virtual field trips — Trips to remote (even historical) locations
- Vocational or practical training — Simulated experiences with a digital overlay
- Athletic experiences — For example, football accuracy training

Immersive technologies can be extremely engaging, though expert curricular design is required to lead to improved learning outcomes as a result.

Drivers

- Good examples of quality content being adopted can be found in fields such as manufacturing and healthcare, where simulations are particularly effective for student understanding.
- Increased sector adoption of online and blended learning has led to an interest in environments that can enhance engagement and impact.
- Some poor online learning experiences from those institutions pivoting to online during the pandemic have stimulated a search for more interactive learning experiences.
- The progress of this content development continues the profile's march through the Peak of Inflated Expectations.
- Popular use cases involve simulation and skills development (for example, learning how to operate heavy machinery prior to real-life physical use.).
- The overall costs of developing immersive technologies are falling over time. However, the hardware and space constraints, particularly in schools, still need to be solved. Most institutions implementing immersive technology now are doing so in smaller, more concentrated class sizes.

Obstacles

- There is a relatively small amount of high-quality, education-specific content to meet the broad range of curricular needs that align with academic standards.
- Individual comfort in immersive environments remains variable and undermines widespread adoption. Studies have warned about VR sickness, particularly in head-mounted displays, causing individuals dizziness, nausea, and blurred vision.
- Immersive technologies' novelty can stop them from being leveraged effectively to achieve results that matter. Hence, educational institutions should ensure that quality content comes first.
- The issue of cost and scale continues to be particularly problematic in K-12, where models for using a few expensive immersive headsets in limited physical classroom space are not very practical.
- The technical challenges and the policy and pedagogical obstacles to be overcome mean that it will be five to 10 years before these technologies reach the Plateau of Productivity in education.

User Recommendations

Education institutions have been anticipating the large-scale adoption and practical use of immersive technology tools for some time:

- Ensure that users gain experience implementing and supporting smaller applications of immersive technologies before moving on to large, classroom-scale applications, given price concerns.
- Strengthen network coverage to support large-scale use of these tools.
- Find ways to manage the currently consumer-oriented nature of many of these tools that are in an enterprise environment.
- Continue to track effective applications and pilot and adopt those that really do impact learning outcomes for the better. Immersive technologies represent potentially powerful learning tools — do not neglect the pedagogical future that is possible here.

Sample Vendors

Alchemy Immersive; Bodyswaps; Google; INDYLAB VR; InstaVR; Microsoft; Nearpod; VictoryXR; zSpace

5G

Analysis By: Sylvain Fabre

Benefit Rating: High

Market Penetration: 20% to 50% of target audience

Maturity: Early mainstream

Definition:

5G is the fifth generation cellular technology standard by the 3rd Generation Partnership Project (3GPP). The standard targets maximum downlink and uplink throughputs of 20 Gbps and 10 Gbps, respectively. Latency is as low as 4 milliseconds in a mobile scenario and can be as low as 1 millisecond in ultra reliable low-latency communication scenarios, down to centimeter-level location accuracy indoors, and massive IoT scalability. New system architecture includes core slicing and wireless edge.

Why This Is Important

5G supports the 4th industrial revolution and IoT. Its fast and reliable real-time data transfer will benefit many industries. 5G supports eMBB, URLLC and MIoT – vital for enterprise transformation. 3GPP 5G standards releases deliver incremental functionality in: R15, extreme mobile broadband; R16, industrial IoT (massive IoT, slicing and security) – latest commercially available release; R17, MIMO enhancements, sidelink, DSS, IIoT/URLLC, bands up to 71GHz, nonterrestrial networks; and RedCap R18 is under definition with a planned freeze date in 1Q24.

Business Impact

- 5G enables three main technology deployments; each supports distinct new services for multiple industries and use cases of digital transformation, and possibly new business models (such as latency as a service). These are enhanced mobile broadband (eMBB) for HD video, mMTC for large IoT deployments, and URLLC for high-availability and very low-latency use cases, such as remote vehicle operations.
- Promising applications for 5G use include fixed wireless access, IoT support and private mobile networks.

Drivers

- Over 249 operators have rolled out 5G (see [GSA](#)), 30% of public mobile networks, and some form of 5G capability is penetrating lower cost smartphones in vendors' portfolios (with over nine versions of the technology depending on the band and the 3GPP release).
- Gartner estimates that 5G-capable handset penetration in 2025 will reach 54% worldwide, and 78% in Western Europe, with 5G-capable handset share of sales reaching 80% in 2023 in Western Europe from 51% in 2021. North America share will rise to close to 87%.
- 5G capability is starting to deliver value in emerging always-on wearables use cases.
- Increased data usage per user and device requires a more efficient infrastructure.
- Requirements from industrial users value 5G lower latency from ultra reliable and low-latency communications (URLLC) and expect 5G to outperform rivals in this area.
- Demand continues for massive machine-type communications (mMTC) to support scenarios of very dense deployments up to the 5G target of one million connected sensors per square kilometer. While diverse networks can offer adequate and cost-effective alternatives to 5G for many use cases (e.g., LPWA, NB-IoT, LoRa, Wi-SUN), overall total cost of ownership (TCO) and future proofness may not be as good.
- Availability has increased for industry-specific spectrum options (e.g., CBRS).
- Competitive pressures continue, for example, if one CSP launches 5G in the market others usually have to follow or risk losing market share — this includes both public as well as private 5G offerings.

Obstacles

- Issues with availability and cost of spectrum, in particular for industrial private networks, occur in some countries.
- Security concerns arise when using 5G in critical industrial scenarios.
- Availability and pricing of networks and modules for R16 and beyond solutions.
- Upgrade to 5G SA (stand-alone) core is needed for more advanced R16 releases (such as slicing), and commit to the continuous evolution of 5G releases over R17, R18 and beyond.
- Cost of radio network upgrades for 5G coverage and availability may require additional sites.
- Use of higher frequencies and massive capacity requires denser deployments with higher frequency reuse, which could raise network costs.
- Uncertainty exists about use cases and business models that may drive 5G for many CSPs, enterprises, and technology and service providers (TSPs).
- Feedback from some industrial clients mentioned that the majority of their use cases could be serviced by a 4G private network, Wi-Fi and/or NB-IoT, and other LPWA such as LoRa.

User Recommendations

- Enable R16 and above 5G for enterprise connectivity for mobile, nomadic and FWA secondary/tertiary use cases for branch location redundancy, as long as 5G is not the primary link for high-volume or mission-critical sites and unless there are no other options.
- Provide clear SLAs for network performance by testing installation quality for sufficient and consistent signal strength, signal-to-noise ratio, video experience, throughput and coverage for branch locations.
- Ensure backward compatibility to 4G devices and networks, so 5G devices can fall back to 4G infrastructure.
- Focus on architecture readiness — such as SDN, NFV, CSP edge computing and distributed cloud architectures, and end-to-end security — in preparation for 5G.
- Build an ecosystem of partners to target industry verticals more effectively with 5G before your competition.

Sample Vendors

Ericsson; Huawei; Mavenir; Nokia; Qualcomm; Rakuten Symphony; Samsung Electronics; ZTE

Gartner Recommended Reading

[Emerging Tech: 5G mmWave at a Crossroads](#)

[Infographic: 5 Steps for Vendors to Scope and Run Successful POCs for Enterprise 5G PMNs](#)

[Invest Implications: Magic Quadrant for 5G Network Infrastructure for Communications Service Providers](#)

[Market Guide for 4G and 5G Private Mobile Networks](#)

[Quick Answer: What Vendor Product Leaders Need to Know About MWC Barcelona 2023](#)

RPA in K-12 Education

Analysis By: Kelly Calhoun Williams

Benefit Rating: Moderate

Market Penetration: 1% to 5% of target audience

Maturity: Early mainstream

Definition:

Robotic process automation (RPA) is software that automates tasks within business and IT processes via software scripts that emulate human interaction with the application user interface. An RPA tool enables human processes to be recorded into a script via low-code or no-code graphical user interfaces. The deployed scripts are referred to as a “bot.”

Why This Is Important

In their initial form (over five years ago), RPA tools predominantly focused on task-centric use cases, automating manual, repetitive processes. End-user adoption has been growing, and tools are expanding to automate more extensive process workflows across industries but it still has yet to gain substantial momentum in K-12 education.

Business Impact

Though not new, the concept of RPA is largely unfamiliar in K-12, where the struggle to automate repetitive and inefficient tasks continues, across business, administrative and instructional tasks. Products are beginning to reference their capabilities more effectively, and K-12 CIOs increasingly want to understand what RPA can do. If effectively combined with existing systems, RPA has the potential to drive down costs and streamline tasks with potential organizationwide benefits.

Drivers

- K-12 organizations are still typically rife with heavily manual, paper-driven and highly repetitive tasks — the kind that could benefit most from RPA. From administrative (for example, attendance, enrollment, scheduling and service improvement) to business (for example, data collection, reporting and analysis) and instruction (eventually streamlining learning data collection and analysis), use cases abound for RPA.
- Though perhaps the earliest and most obvious targets, the potential exists to focus on cost-saving opportunities and streamlining efficiencies, freeing up staff for other tasks that cannot be automated. This could represent a major driver for organizations typically struggling to make the most of limited revenue. This is doubly true in light of the current serious shortages of faculty and staff being experienced in K-12 around the globe.
- Across industries, vendors have grown and made extensive R&D investments. Vendors are starting to take note of the K-12 market, and are leveraging RPA to improve products.
- There are also new entrants, such as SAP and Microsoft. Gartner estimated the global RPA software market reached \$2.9 billion in 2022 and estimates \$3.3 billion in 2023, showing the category is one with massive global uptake and growth. However, K-12 education has yet to fully embrace this capability.

Obstacles

- For other industries, RPA has rapidly matured, and is on the verge of becoming mainstream in the Plateau of Productivity. By contrast, K-12 education is frequently so overwhelmed by inefficient processes that it can fail to invest time and money in options that could reduce that burden.
- In K-12, the use of RPA by organizations is present, but not on a large scale. K-12 vendor PowerSchool has adopted the use of an airSlate RPA bot to automate workflows within its systems, illustrating an example of it being embedded in existing products.
- The lack of adoption in K-12 moves this into the Trough of Disillusionment. Given the fast-moving nature of the technology as a whole, we anticipate that, as new use cases are created and new vendors appear to leverage it in their products for K-12, RPA use may accelerate in this sector. However, K-12's relative lack of doing its own application development may mean this has to advance by way of vendors, not by K-12 organizational adoption.

User Recommendations

To maximize the benefits of RPA offerings:

- Identify areas that will benefit most from RPA as a place to start, so benefits are realized quickly.
- Form the foundation that will underpin workflow, efficiency, efficacy and agility, with the overall approach and architecture designed for the automation of business and IT processes.
- Ensure the use of multidisciplinary governance and coordination across stakeholder groups, IT, security and sourcing functions.

Sample Vendors

AntWorks; Automation Anywhere; Kofax; Microsoft; NICE; Pegasystems; PowerSchool; ProcessMaker; SAP; SS&C Blue Prism

Data Science Education

Analysis By: Peter Krensky, Aura Popa

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Definition:

Higher education institutions and solutions vendors offer learning experiences for credit-bearing courses and independent study of data science capabilities. These include massive open online courses (MOOCs), certifications, diplomas, and undergraduate and postgraduate degrees.

Why This Is Important

As demand for data science talent stays high and data science careers remain attractive, many organizations and forward-thinking professionals are exploring avenues for upskilling in data science and machine learning (DSML). There are a variety of tools designed for users with minimal DSML experience and newly acquired skills. Education is the best answer to further narrow the data science talent gap, and prepare organizations for optimal adoption of next-generation AI and ML technologies.

Business Impact

Data science education helps leaders take individuals with business or technical experience and domain expertise and equip them to become citizen data scientists. Education is becoming vital to preparing the large populations of augmented consumers to better engage with and understand embedded machine learning. Continuing education is also a vital practice to develop and retain expert data scientists.

Drivers

- Data science class sizes, faculties and degree programs have been expanding in traditional universities for the past decade.
- General upskilling and online education in data science are thriving, and online education activity has only intensified over the last year.

Other key drivers of data science education at all levels include:

- Sudden and widespread interest in generative AI
- Abundant and lucrative job opportunities for those with data science skills and ML literacy

- New and expanded university degree programs and curriculums in analytics and data science
- Large populations of knowledge workers interested in upskilling in data science
- Training and certification programs of all kinds from software vendors, some tied to specific technologies
- Low technical barrier to entry in DSML with the advent of low-code/no-code platforms and augmented DSML, making the area well within the reach of interested individuals
- DSML talent development as a retention strategy
- Rapid progress of research and new technologies coming out of academia and corporate research labs
- The low cost of a foundational data science education (under \$1,000 for strong independent learners)

Obstacles

- An overwhelming number of online course options designed for different personas and experience levels
- Broad interpretations of the terms “data science” and “data scientists” in terms of training approach, curriculum and desired skills
- Plenty of content failing to justify cost despite there being many popular and excellent options
- Students and organizations recognizing that data science is a moving target, and certain areas of study can quickly fall out of favor or become obsolete
- A sporadic and inconsistent approach to training and certification
- Training people out the door (that is, sponsoring the development of skills that attract recruiters and lead to the departure of valued employees)
- No expert mentorship available for citizen data scientists after completing foundational education
- Experts lacking education and experience in business considerations around data science use cases and applications

- Underestimating DSML complexity and oversimplifying it to foundational elements

User Recommendations

- Build and expand relationships with local universities to establish internship programs and a data science talent pipeline into your organization.
- Sponsor all MOOCs under \$1,000 per employee in total cost with the expectation that the majority of classroom work will be done outside of working hours.
- Expect leadership from expert data scientists on key new topics, leading tools and technologies, and how to manage common pitfalls that less experienced practitioners will encounter.
- Embrace the fact that the majority of learning and skill development is done after classroom learning in the course of experimentation and project delivery. Quick wins build momentum, but lasting and meaningful change takes time because it requires people to learn new skills and behave in new ways.

Sample Vendors

The Center of Applied Data Science (CADS); Coursera; DataCamp; DeepLearning.AI; edX; Kaggle; Pluralsight; Skillsoft; Udacity; Udemy

Gartner Recommended Reading

[Lessons From Data Scientists on Their Education and Career Development](#)

[Tool: Data Literacy Playbook](#)

Digital Assessment (K-12)

Analysis By: Saher Mahmood

Benefit Rating: High

Market Penetration: 20% to 50% of target audience

Maturity: Early mainstream

Definition:

Digital assessment refers to the application of digital technologies to create, grade, administer, report and manage tests and other assessment types, to evaluate learning outcomes. Technology enables intricate workflows, increased faculty collaboration in creating and assessing, anonymized grading, and enhanced question analytics, among other things. The use of technology has helped expand the application beyond traditional formats to using immersive and other AI-enhanced capabilities as well.

Why This Is Important

Authentic assessments that reliably evaluate learning are a top priority for education. Pandemic-induced learning gaps have made this insight mission-critical in K-12 schools. Analog methods are time-consuming, increasing the reliance on a standardized approach and the traditional, multibillion-dollar industry of high-stakes, summative assessments which grade the students at the end of the learning. Digital assessments allow continuous assessments that help achieve quality insight at scale.

Business Impact

Digital assessment holds the promise of furthering education's aim of moving from assessment of learning to assessment *for* learning and possibly even assessment *as* learning. New assessment platforms are a key component for the growing maturity of online learning and the scalability of education. Digital assessment is foundational in the growth of adaptive learning technologies and other pedagogical approaches that first require an accurate insight into what was learned or missed.

Drivers

- Assessment is a key part of learning trends such as adaptive learning (leveraging artificial intelligence capabilities) and competency-based education. Formative assessment using technology is surging in popularity in support of this holistic data capture, allowing educators and students to receive immediate and continuous feedback throughout the learning process. This, in turn, helps educators meet the students where they are instead of imposing a standard benchmark for all.
- Learning gaps that have emerged in the wake of the pandemic can be addressed more effectively and rapidly by leveraging digital assessments. Technology has allowed users to go beyond simply making traditional assessments digital to using interactive and adaptive technologies and observational, immersive or AI-enhanced capabilities that collect this insight.
- Digital assessments provide the ease and flexibility of being seamlessly deployed in remote, hybrid and fully physical classroom settings.
- Adopting digital assessments has shown abundant potential time savings; for example, as much as 50% of the time to grade. Adding AI to the mix promises to save even more for instructors with large numbers of students and/or subjects.
- The emergence of generative AI will impact teaching and assessment practices in general and it is to be seen how this will influence the use of digital platforms.

Obstacles

- With the growth of online learning and ongoing concerns about integrity, especially in assessments taken by students remotely, proving the validity of the results and learning outcomes is key.
- Even if the adoption of new assessment technologies continues apace, we still anticipate that it will take as much as five to 10 years for the full array of technologies to reach the Plateau of Productivity. Education is fairly renowned for its slowness to change, and this category's time to plateau reflects this.
- Questions around how to develop a strategy both for new means of formative assessment and managing traditional summative assessments need to evolve over the next couple of years. The post-COVID-19 investment in digital devices will play a significant role in this shift.

User Recommendations

- Focus on assessment data literacy and interoperability as critical enablers. Having assessment data without insight into its meaning, value and actionability makes this a hollow pursuit.
- Work with partners in the instructional team to clearly establish use cases for their assessment needs so they can identify the solution or mix of products needed. Some districts are requiring that all purchased digital assessments must be fully integrated with content.
- Pay close attention to security, privacy and location since most vendors are now cloud-based. Seek clarity on how to store and manage data from these tools, as well as about peak usage scenarios with bandwidth limitations, if any.
- Explore the early use of generative AI to experiment with new ways of teaching student creativity, such as how to collect, evaluate, validate or question content. Leverage it to then assess students' skills and progress in new ways.

Sample Vendors

Cambium Assessment; Curriculum Associates; Edmentum; Measurement Incorporated; Renaissance Learning

Privacy by Design

Analysis By: Bart Willemsen, Bernard Woo

Benefit Rating: Moderate

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Definition:

Privacy by design (PbD) is a set of principles about proactively creating a culture of privacy, by embedding it often and early in technology (e.g., application or customer interaction design), as well as into procedures and processes (e.g., through privacy impact assessments, data minimization and subsidiarity). There is no finite list of principles, yet PbD as a best practice is globally applicable to the basis of any privacy program.

Why This Is Important

Privacy is one of the core tenants for organizations that are seeking to earn trust with their customers and drive increased revenue opportunities. In addition, the number of new or significantly revamped regulations continues to increase worldwide. Organizations can expect to operate more efficiently by adopting PbD and embedding privacy considerations throughout their processing activities.

Business Impact

Privacy must be built-in. A proactive risk-based approach helps enhance consumer trust, prevent violations (such as costly data breaches) before they occur, and reduce the damage from them if they do (such as fines or brand damage). All technology design must account for the protection of any personal data at the core to mitigate privacy risk, which is at unprecedented heights with the current data volumes processed.

Drivers

- Systems must be designed so that the collection of privacy-sensitive data is transparent to the data subject. Some technology-focused ideas for implementing PbD are reducing retention length and amount of personal data (data minimization), working on the original data (rather than on copies) and applying anonymization or pseudonymization where possible, alongside purpose-based access controls (PBAC).
- The need persists to continuously evaluate the risks of reidentification and traceability, and include data location in the considerations for clarity on regulatory impact. Moreover, implementing PbD can lead to other positive changes such as designating a privacy officer with reach or procurement activities for new IT services, and frequently conducting privacy impact assessments.
- PbD and one of its subcomponents, privacy engineering, enable an approach to a business process and technology architecture that combines various methodologies in design, deployment and governance. Properly implemented, it yields an end result with an easily accessible functionality to fulfill the Organisation for Economic Co-operation and Development's (OECD's) privacy principles. It also helps mitigate the impact of a personal data breach by reimagining defense in depth from a privacy-centric vantage point.
- The process involves ongoing recalculation and rebalancing of the risk to the individual data owner while preserving optimum utility for personal data processing use cases. As a result, organizations can rely on the right data being available at the right time with maximized information retention and trust in a compliant operation.
- Stakeholders will also benefit from reducing the data footprint and accompanying breach exposure risk reduction. Further, PbD allows consistent delivery to subjects upon a privacy promise as well as collateral enhanced customer trust and engagement levels.

Obstacles

- Adoption and widespread recognition of PbD has been hampered by a lack of industry-recognized principles and consistent regulatory framework support. The Information and Privacy Commissioner (IPC) of Ontario described seven key elements: proactivity, privacy by default, privacy embedded into design, full functionality, end-to-end security, visibility and transparency, and user centricity. In the U.S., a report by the Federal Trade Commission (FTC) of 2012 is the most visible early support for the PbD principle, yet worldwide standards are not yet being created
- Only over the past few years, legislative requirements start to include “data protection by design and/or by default,” implying a PbD approach to all activities. Precedent-shaping rulings are slowly increasing in number and depth. Vendors have added statements like “product X was designed with PbD in mind,” sometimes with little reference material to support the claim. Only when privacy is truly a more organic part of the development process, the need for and benefit rating of PbD increase.

User Recommendations

- Tackle privacy by design in manageable steps; a wholesale shift will be too much to handle. Privacy by design is a cultural change about the processing of personal data. This pertains both to existing operations and to innovations.
- Adjust the existing operations through business process reengineering. Especially in innovative developments and new processes, the change begins by asking questions such as: Can we achieve the purpose set out by using less personal data? Can we end the personal data life cycle sooner? Can we provide the same functionality or customer experience without using the identifiable data? Can we adequately protect what we process? Do customers understand what we are processing about them and why?
- Identify use cases where privacy-enhancing computation (PEC) techniques can be adopted to support the embedding of privacy into current and future operational activities.

Gartner Recommended Reading

[Use a Privacy Impact Assessment to Ensure Baseline Privacy Criteria](#)

[16 Frequently Asked Questions on Organizations' Data Protection Programs](#)

5 Privacy Imperatives for Executive Leaders

Quick Answer: How Can Executive Leaders Manage AI Trust, Risk and Security?

Education Analytics

Analysis By: Marlena Brown

Benefit Rating: High

Market Penetration: More than 50% of target audience

Maturity: Early mainstream

Definition:

Education analytics refers to the collection and analysis of data designed to provide institutions with data-driven insights. These insights enable informed strategic decisions that impact student outcomes, institutional performance and operational efficiency. Information analyzed from various sources, such as student records, learning data, financial data and enrollment data, provides a comprehensive view of institutional performance.

Why This Is Important

K-12 (primary and secondary) education is under pressure to improve outcomes and efficiencies in all aspects of operations. The increased and effective use of data will be a key differentiator going forward, separating schools that are resilient in the face of challenges from those that are unable to respond effectively. Education analytics provides institutions with data-driven insights, enabling decisions around:

- Student outcomes
- Operational efficiency
- Compliance
- Overall competitiveness.

Business Impact

K-12 education analytics provides data-driven insights that support:

- Improved student outcomes by predicting risks and identifying successful behaviors.
- Increased operational efficiency by analyzing process data to optimize resources.
- Expedited compliance reporting by continuously collecting data about student outcomes, teacher qualifications and financials.
- Increased enrollment and talent attraction by identifying areas of strength, promoting reputation and highlighting competitive advantages.

Drivers

- **Fiscal and revenue challenges:** K-12 education institutions face financial pressures that underscore the need to use data to improve efficiency, reduce costs and increase revenue streams.
- **Competition for talent:** The desire to compete for and attract premium talent drives the use of data and analytics to anticipate teacher and staff shortages and remain competitive in the market.
- **Learning loss:** Institutions, still recovering from pandemic-related learning loss, are using data and analytics (D&A) to inform targeted interventions to help students close the learning gaps.
- **Imperatives to improve operations and enhance student experiences:** K-12 institutions can use data to drive innovation, remain relevant and meet the needs of students in a rapidly evolving landscape.
- **Pressure from legislative bodies, employers and students:** Institutions face increasing pressure from external stakeholders to provide data showing how they improve outcomes and efficiencies, demonstrate effectiveness, respond to the needs of the workforce, and meet student expectations.

Obstacles

- Poor quality or incomplete data can impede the creation of a compelling D&A storyline and hinder identification of value opportunities.
- Taking action based on D&A insights is crucial, but difficult, requiring institutions to overcome inertia and implement changes.
- The wide range of technology solutions available for educational analytics can be overwhelming and confusing, making it challenging to establish a clear strategy.
- Lack of clarity regarding objectives can lead to overinvestment in big data and tools with little return, impeding D&A refinement and progress.

User Recommendations

- Create a compelling D&A storyline with outcome examples to engage stakeholders, build buy-in and establish a shared understanding of data value.
- Identify and prioritize near-term value opportunities through D&A strategy to create value and demonstrate early wins.
- Define roles, responsibilities and processes to enable collaboration and provide D&A services across the organization.
- Establish practices for D&A governance that align with organizational goals. Ensure data quality, manage risk, and protect privacy through a governance plan that can adapt to changing needs and technologies.

Sample Vendors

BrightBytes; Edsby; Microsoft; PowerSchool; SAS; Salesforce

Gartner Recommended Reading

[The Chief Data Officer's First 100 Days — Action Plan](#)

[Address K-12 Education's Four Critical Crises Now](#)

[Top Trends in Data and Analytics, 2023](#)

Climbing the Slope

Desktop as a Service

Analysis By: Stuart Downes, Mark Margevicius, Tony Harvey, Craig Fisler, Sunil Kumar, Eri Hariu

Benefit Rating: High

Market Penetration: More than 50% of target audience

Maturity: Early mainstream

Definition:

Desktop as a service (DaaS) is the provision of virtual desktops by a public cloud or service provider. DaaS is bought by IT leaders seeking to provide desktop or application experiences from virtual machines accessed using a remote display protocol. DaaS vendors incorporate a fully managed control plane service into their offerings, which facilitates user connections and provides a management interface. DaaS can be delivered preconfigured as a service or can be delivered as a DaaS platform.

Why This Is Important

With DaaS, no data resides on the endpoint, offering a solution that can increase security, resilience and application responsiveness for remote workers. DaaS offers scalable services without adding infrastructure, allowing clients to appropriately size and consume their environments hour by hour, day by day, and month by month; however, not all DaaS solutions offer such granular billing options.

Business Impact

With DaaS, IT leaders can increase security for desktops and applications. Other benefits of DaaS, compared to traditional VDI, include:

- Flexible procurement options that allow scalable deployments.
- Simplified rollout of services to new geographic regions.
- Applicability to a broader range of industries and use cases.
- Lesser skills required for IT operations teams to deploy and operate virtual desktops and applications.
- More rapid expansion or contraction of workloads.

Drivers

DaaS will continue to mature and witness increased adoption through 2026. The technology has moved through the Trough of Disillusionment onto the Slope of Enlightenment due to the following factors:

- DaaS enables business continuity and remote work, with no data residing on the endpoint.
- The technology securely extends services to external contractors and third parties.
- Endpoint computing models allow device-independence and bring your own PC (BYOPC) endpoints.
- On-demand desktops enable a financial model that allows scaling of cloud resources and an operating expenditure (opex) model.
- DaaS can be purchased for short periods, enabling use cases such as seasonal workers or short-term contracts.
- DaaS enables rapid access to systems during mergers, acquisitions and divestitures.
- Rich graphics use cases like engineering, games development, video editing and geographic information systems (GIS) benefit from GPU-enabled workstation-class virtual desktops and applications.
- DaaS can be delivered to users in hours. The supply of a physical device, on the other hand, can take weeks, incur shipping costs and retrieval is not always guaranteed.
- The technology eliminates the need for complex and static VDI implementations.

Obstacles

- Usually, the business case turns positive only when security and user cost impacts are included.
- Organizations struggle when there is a change in financial models from capex to opex.
- GPU use cases can be extremely expensive and often need advanced protocols, which increases complexity.

- Multimedia streaming, web meetings and video call performance in DaaS are not equivalent to that of a physical endpoint.
- Performance issues may occur in DaaS because application architectures introduce network-related issues (i.e., latency and hairpinning).
- Some DaaS solutions require self-assembly, which, although simpler than VDI, can still be too complex for some clients.
- The full range of desktop management requirements may not be completely fulfilled by DaaS providers.
- Microsoft product terms that prevent the installation of Microsoft 365 applications on “Listed Providers” (see [3 Compliance Questions to Ask When Licensing Microsoft Windows and Office for VDI and DaaS](#)).

User Recommendations

- Get familiar with the three DaaS market segments — self-assembled DaaS, vendor-assembled DaaS and vendor-managed DaaS — and select a vendor from the appropriate segment (see [Market Guide for Desktop as a Service](#)).
- Ensure your operational teams have the necessary skills if you select self-assembled DaaS solutions.
- Select a vendor-defined DaaS or vendor-managed DaaS solution if you do not have the operational skills.
- Choose a DaaS vendor whose services best align with your requirements; even within each segment, there are differences between the services vendors offer.
- Optimize multimedia streaming, web meetings and video calls.
- Select a DaaS vendor that offers the billing granularity you require.

Sample Vendors

Alibaba; Amazon; Anunta; ATSG; Citrix Systems; Microsoft; Nutanix; oneclick; VMware; Workspot

Gartner Recommended Reading

[Market Guide for Desktop as a Service](#)

[How to Choose a Desktop Delivery Model for the Digital Workplace](#)

[Video: PCs, Virtual Desktops or DaaS: What's the Best Fit for Midsize Enterprises](#)

[3 Compliance Questions to Ask When Licensing Microsoft Windows and Office for VDI and DaaS](#)

PC as a Service

Analysis By: Stephen Kleynhans, Autumn Stanish, Erin Pierre

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Early mainstream

Definition:

PC as a service (PCaaS) refers to a PC procurement model in which customers pay for a configured PC that is fully supported throughout its life cycle. It builds on a combination of leasing, management support and added services, but offers more flexibility than traditional leasing or opex models. Changes in the dynamics of PCaaS offerings have necessitated a change in naming. In future Gartner reports, the name will be managed device life cycle services (MDLS) for better alignment.

Why This Is Important

Enterprises are pressured to transform IT delivery services to support and add value to new business initiatives and improve the employee experience. This is driving them to examine alternatives to traditional PC acquisition and management practices. PCaaS is available from several providers (including manufacturers, value added resellers and outsourcers) and can relieve IT teams of tedious device management processes, provide a predictable financial model, and scale to support a remote workforce.

Business Impact

PCaaS can help IT teams with:

- Enabling customers to outfit users with a PC at a predictable monthly fee.
- Reducing the number of touchpoints and contracts needed for service delivery, potentially improving accountability.

- Aligning with modern tools, such as Windows Autopilot, to automatically enroll new devices to distributed employees, potentially providing improved user experience.

Drivers

- Economic challenges have driven organizations to seek solutions that will help them cut costs through process efficiencies. Outsourcing internally inefficient device support operations can offset the added costs of PCaaS in some organizations. However, this is not generally true for most.
- New forms of PCaaS offerings are emerging to appeal to organizations that prioritize sustainability, such as the option to refurbish and remarket/redeploy to keep devices in use longer.
- Widespread remote work and now the shift to hybrid work, has made device management more challenging for many organizations, making PCaaS an increasingly attractive alternative to traditional PC procurement options.
- Offerings have matured and expanded with varied terms and conditions and service options. While there are still a number of custom deals, overall there is less confusion for customers about what PCaaS offers.
- Vendors continue to grapple with building attractive, profitable and affordable solutions by expanding their services while ensuring their internal capabilities are mature enough to deliver these offerings effectively. Initially, it will appeal to many of the same organizations that are looking at PC leasing today, or those looking to offload basic logistical activities associated with PC hardware deployment and maintenance.

Obstacles

- Understanding what services and financial models are available can be confusing, as “PC as a service” is a blanket term for many variations of PC leasing and/or services. In some cases, the services are offered on an “as-a-service” model independent of the actual device purchase.
- Providers occasionally overpromise on their services to make deals more attractive. This leaves customers with unmet delivery expectations as providers attempt to balance growing their service offerings with maturing their own internal capabilities.
- Elevated costs for basic services can be hidden within bundled overall pricing if it is not clearly broken out in proposals.
- Vendor lock-in causes customers to lose their autonomy over the endpoint management tools and processes.

User Recommendations

- Investigate PCaaS offerings as an alternative to standard leasing by weighing the benefits of reduced IT burden and a potential opex model with the additional cost of services.
- Ensure that the bundled services and/or tools are not duplicative of existing contracts or internal capabilities by selecting the offerings most valuable to unique IT team needs.
- Challenge suppliers to prove their ability to provide the services offered by establishing appropriate SLAs and a monitoring process.
- Prioritize vendors that have a broader range of modern software-enabled services, rather than those that still rely on manual processes.
- Prepare for potential volatility in the price of the services as vendors evaluate the true cost of providing these capabilities, by ensuring pricing or price caps are established for the entirety of the agreement.

Sample Vendors

CDW; CompuCom; Computacenter; Dell Technologies; HP Inc.; Insight; Lenovo; SHI

Gartner Recommended Reading

[Customization and Automation Redefine the PCaaS Landscape](#)

Critical Capabilities for Outsourced Digital Workplace Services

When to Purchase, Lease or Use PC as a Service

Digital Credentials

Analysis By: Robert Yanckello, Kelly Calhoun Williams

Benefit Rating: Transformational

Market Penetration: More than 50% of target audience

Maturity: Mature mainstream

Definition:

Digital credentials are the digitalization of traditional diplomas, alternative microcredentials, professional licensure, certifications, badges and informal credentials. They indicate an individual's knowledge, specialized skills or qualifications via a secure framework to digitally capture and visually present achievements that are verifiable and portable.

Why This Is Important

Credentials issued by education institutions, organizations or employers are the only tangible evidence of education or skills achievement, and can be seen as "education currency." New forms of credentials are increasing the speed and granularity of credential exchange. Digital credentials will:

- Enable decoupling of some K-12 and higher education business models.
- Transform some education outcomes.
- Speed up time to market for job seekers and establish a new ecosystem of learning.

Business Impact

Digital credentials enable a secure, validated and expedient exchange of skills and education, and can impact student outcomes for employment, lifelong learning and career advancement. The learner will be empowered to own the credential and share when they choose. The impact of digital credentials on K-12, corporate workforce development and higher education will transform business models for learning, talent identification and fluidity, while enabling new entrants into the education ecosystem.

Drivers

- The growing demand to address workforce needs and employability globally is driving the credential landscape to be more dynamic and responsive and is challenging the essence of traditional higher education.
- As the acceleration of digital business continues at an unprecedented pace, the delivery of all credentials in digital format is a natural progression.
- Changing business models, the increasing number of learners entering the workforce, and the length of time from graduation to employment, are influencing students and employers to reconsider traditional paper-based job and talent search models.
- Digital credentials enable employers to view student information quickly and easily, offering students and learners a swift and agile approach to sharing validated knowledge and skills with potential employers.
- The increased focus in K-12/primary-secondary education on offering more work-based programs fits well with this ability to capture and track specific skills to share with employers. It also holds the potential to capture other nontraditional course and program completions (including for faculty) as K-12 organizations struggle with shortages of staff for traditional instructional delivery models.
- Employer-funded education is growing rapidly as organizations (such as Guild Education and workforce agencies) connect employees with many programs across a variety of institutions. This employer learning market helps corporations educate and train employees with high-demand skills. Additionally, it enables individuals to enter the workforce sooner while they still have a trajectory for new career opportunities.

Obstacles

- Currently, there is no widely used digital credentialing infrastructure or common standards to easily store, share and display credentials that offer a comprehensive picture of learning experiences with employers and training institutions.
- Although digital/alternative credentials are gaining public acceptance, more education is still needed, as progress is hampered by a relative lack of understanding of what they are and how they are defined.
- Until all institutions establish habits to deliver any credential (formal/informal, traditional/new, badge/diploma) in digital format, they will struggle to understand the true essence of digital society, and needs and expectations of their students, partners and community.
- Questions linger about the degree to which digital/alternative credentials can displace traditional diplomas, and the extent to which they will gain employer acceptance.

User Recommendations

- Gain familiarity with current digital credentialing technology and standards organizations — such as Credential Engine, IMS Global Learning Consortium and The Groningen Declaration Network — by participating in these organizations regarding growing digital credential ecosystem and global standards.
- Form a community of interest by establishing a team of academic leaders, faculty, corporate partners and administrators to initiate organizational conversations and build a foundation for digital credentials objectives.
- Search for an appropriate use case of current digital credentialing technology at your institution or organization, by initiating a pilot to help institution leaders consider the policy implications, growing ecosystem and corporate readiness for this new digital currency.

Sample Vendors

Accredible; Accreditrust Technologies; BadgeCert; Digitary; Edalex; Hyland Software; Instructure; Parchment; Pearson (Credly); Smart Certificate

Gartner Recommended Reading

[Changing Economic Conditions Impact How Education Delivers New Credentials](#)

[Higher Education Ecosystem 2030: Jobs U](#)

[Higher Education Ecosystem 2030: Your Own U](#)

Appendixes

See the previous Hype Cycle: [Hype Cycle for K-12 Education, 2022](#)

Hype Cycle Phases, Benefit Ratings and Maturity Levels

Table 2: Hype Cycle Phases

(Enlarged table in Appendix)

Phase ↓	Definition ↓
<i>Innovation Trigger</i>	A breakthrough, public demonstration, product launch or other event generates significant media and industry interest.
<i>Peak of Inflated Expectations</i>	During this phase of overenthusiasm and unrealistic projections, a flurry of well-publicized activity by technology leaders results in some successes, but more failures, as the innovation is pushed to its limits. The only enterprises making money are conference organizers and content publishers.
<i>Trough of Disillusionment</i>	Because the innovation does not live up to its overinflated expectations, it rapidly becomes unfashionable. Media interest wanes, except for a few cautionary tales.
<i>Slope of Enlightenment</i>	Focused experimentation and solid hard work by an increasingly diverse range of organizations lead to a true understanding of the innovation's applicability, risks and benefits. Commercial off-the-shelf methodologies and tools ease the development process.
<i>Plateau of Productivity</i>	The real-world benefits of the innovation are demonstrated and accepted. Tools and methodologies are increasingly stable as they enter their second and third generations. Growing numbers of organizations feel comfortable with the reduced level of risk; the rapid growth phase of adoption begins. Approximately 20% of the technology's target audience has adopted or is adopting the technology as it enters this phase.
<i>Years to Mainstream Adoption</i>	The time required for the innovation to reach the Plateau of Productivity.

Source: Gartner (July 2023)

Table 3: Benefit Ratings

Benefit Rating ↓	Definition ↓
Transformational	Enables new ways of doing business across industries that will result in major shifts in industry dynamics
High	Enables new ways of performing horizontal or vertical processes that will result in significantly increased revenue or cost savings for an enterprise
Moderate	Provides incremental improvements to established processes that will result in increased revenue or cost savings for an enterprise
Low	Slightly improves processes (for example, improved user experience) that will be difficult to translate into increased revenue or cost savings

Source: Gartner (July 2023)

Table 4: Maturity Levels

(Enlarged table in Appendix)

<i>Maturity Levels</i> ↓	<i>Status</i> ↓	<i>Products/Vendors</i> ↓
<i>Embryonic</i>	In labs	None
<i>Emerging</i>	Commercialization by vendors Pilots and deployments by industry leaders	First generation High price Much customization
<i>Adolescent</i>	Maturing technology capabilities and process understanding Uptake beyond early adopters	Second generation Less customization
<i>Early mainstream</i>	Proven technology Vendors, technology and adoption rapidly evolving	Third generation More out-of-box methodologies
<i>Mature mainstream</i>	Robust technology Not much evolution in vendors or technology	Several dominant vendors
<i>Legacy</i>	Not appropriate for new developments Cost of migration constraints replacement	Maintenance revenue focus
<i>Obsolete</i>	Rarely used	Used/resale market only

Source: Gartner (July 2023)

Document Revision History[Hype Cycle for K-12 Education, 2022 - 19 July 2022](#)[Hype Cycle for K-12 Education, 2021 - 14 July 2021](#)**Recommended by the Author**

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[Understanding Gartner's Hype Cycles](#)[Tool: Create Your Own Hype Cycle With Gartner's Hype Cycle Builder](#)[The Future of K-12 Education: Vision 2028](#)[Top Trends in K-12 Education for 2023](#)[Predicts 2023: Education Will See Consolidation, Competition and Creativity](#)

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Table 1: Priority Matrix for K-12 Education, 2023

Benefit ↓	Years to Mainstream Adoption			
	Less Than 2 Years ↓	2 - 5 Years ↓	5 - 10 Years ↓	More Than 10 Years ↓
Transformational	Digital Credentials	Conversational User Interfaces Edge Computing Everyday AI Generative AI in K-12 Education	Adaptive Learning Emotion AI Generative Cybersecurity AI Industry Cloud Platforms Responsible AI Self-Integrating Applications	Metaverse
High	Data Breach Response Desktop as a Service	5G Education Analytics Immutable Data Vault PC as a Service	Bidirectional Brain-Machine Interface Data Science Education Digital Assessment (K-12) Immersive Technology Smart Campus	
Moderate		Online Tutoring (K-12) Privacy by Design RPA in K-12 Education	Learning Experience Platforms Zero-Knowledge Proofs	
Low				

Source: Gartner

Table 2: Hype Cycle Phases

Phase ↓	Definition ↓
<i>Innovation Trigger</i>	A breakthrough, public demonstration, product launch or other event generates significant media and industry interest.
<i>Peak of Inflated Expectations</i>	During this phase of overenthusiasm and unrealistic projections, a flurry of well-publicized activity by technology leaders results in some successes, but more failures, as the innovation is pushed to its limits. The only enterprises making money are conference organizers and content publishers.
<i>Trough of Disillusionment</i>	Because the innovation does not live up to its overinflated expectations, it rapidly becomes unfashionable. Media interest wanes, except for a few cautionary tales.
<i>Slope of Enlightenment</i>	Focused experimentation and solid hard work by an increasingly diverse range of organizations lead to a true understanding of the innovation's applicability, risks and benefits. Commercial off-the-shelf methodologies and tools ease the development process.
<i>Plateau of Productivity</i>	The real-world benefits of the innovation are demonstrated and accepted. Tools and methodologies are increasingly stable as they enter their second and third generations. Growing numbers of organizations feel comfortable with the reduced level of risk; the rapid growth phase of adoption begins. Approximately 20% of the technology's target audience has adopted or is adopting the technology as it enters this phase.
<i>Years to Mainstream Adoption</i>	The time required for the innovation to reach the Plateau of Productivity.

Phase ↓

Definition ↓

Source: Gartner (July 2023)

Table 3: Benefit Ratings

Benefit Rating ↓

Definition ↓

Transformational

Enables new ways of doing business across industries that will result in major shifts in industry dynamics

High

Enables new ways of performing horizontal or vertical processes that will result in significantly increased revenue or cost savings for an enterprise

Moderate

Provides incremental improvements to established processes that will result in increased revenue or cost savings for an enterprise

Low

Slightly improves processes (for example, improved user experience) that will be difficult to translate into increased revenue or cost savings

Source: Gartner (July 2023)

Table 4: Maturity Levels

Maturity Levels ↓	Status ↓	Products/Vendors ↓
Embryonic	In labs	None
Emerging	Commercialization by vendors Pilots and deployments by industry leaders	First generation High price Much customization
Adolescent	Maturing technology capabilities and process understanding Uptake beyond early adopters	Second generation Less customization
Early mainstream	Proven technology Vendors, technology and adoption rapidly evolving	Third generation More out-of-box methodologies
Mature mainstream	Robust technology Not much evolution in vendors or technology	Several dominant vendors
Legacy	Not appropriate for new developments Cost of migration constraints replacement	Maintenance revenue focus
Obsolete	Rarely used	Used/resale market only

Source: Gartner (July 2023)