서울시립대학교
UNIVERSITY OF SEOUL

Artificial Intelligence for Learning Analytics

학습분석의 발전을 위한 인공지능의 기대와 역할

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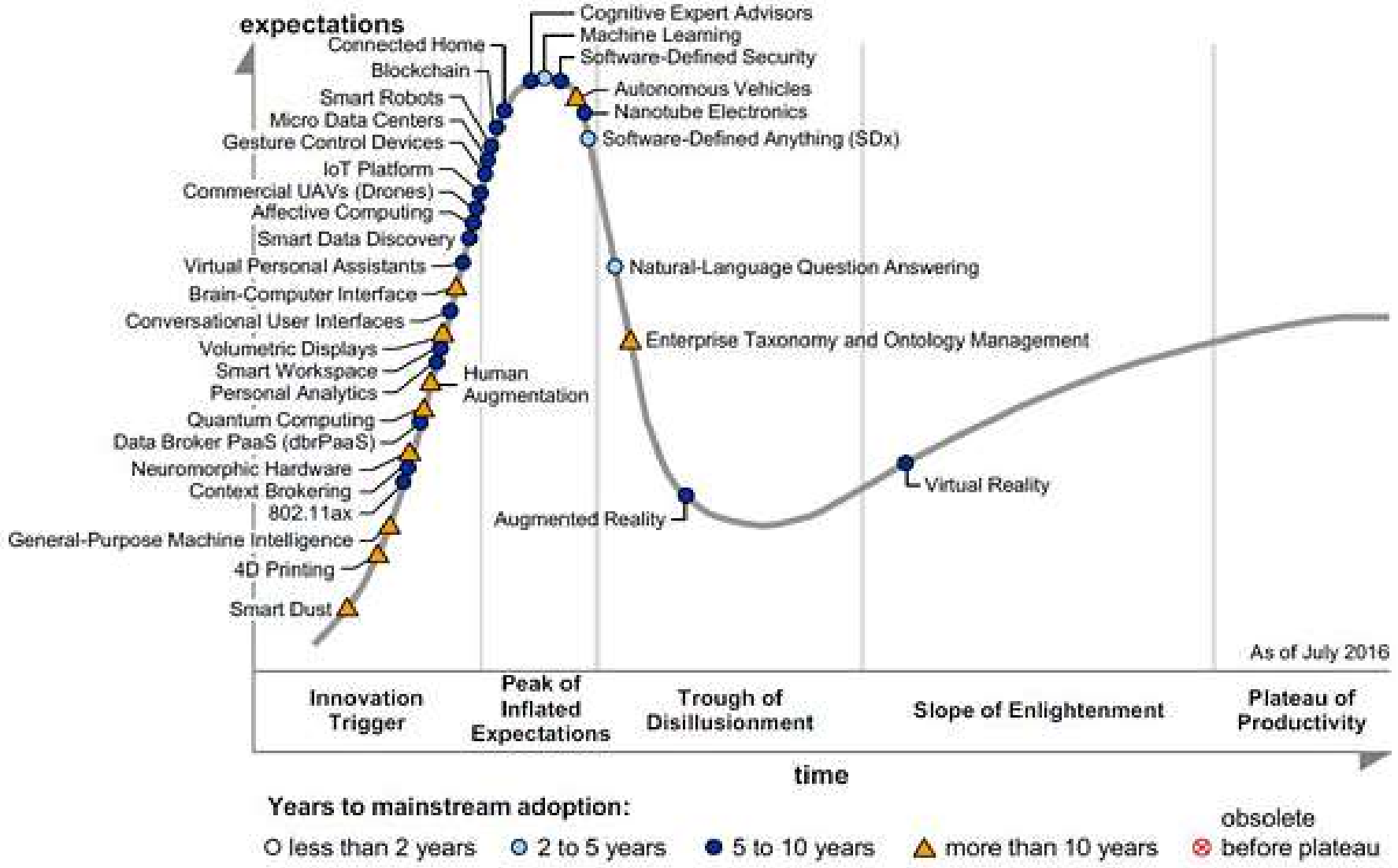
Contents

- Emerging technology
- Emerging E-learning technology
- Introduction to Artificial Intelligence
- AI for Education
- AI and Learning Analytics
- Conclusion

Hype Cycle for Emerging Technologies, 2016



Source: Gartner (July 2016)

Three Trends

Transparently Immersive Experiences

- Human Augmentation
- 4D Printing
- Brain-Computer Interface
- Human Augmentation
- Volumetric Displays
- Affective Computing
- Connected Home
- Nanotube Electronics
- Augmented Reality
- Virtual Reality
- Gesture Control Devices

Perceptual Smart Machine Age

- Smart Dust
- Machine Learning
- Virtual Personal Assistants
- Cognitive Expert Advisors
- Smart Data Discover
- Smart Workspace
- Conversational User Interfaces
- Smart Robots
- Commercial UAVs (Drones)
- Autonomous Vehicles
- Natural-Language Q & A
- Personal Analytics
- Enterprise Taxonomy and Ontology Management
- Data Broker PaaS (dbrPaaS)
- Context Brokering

Platform Revolution

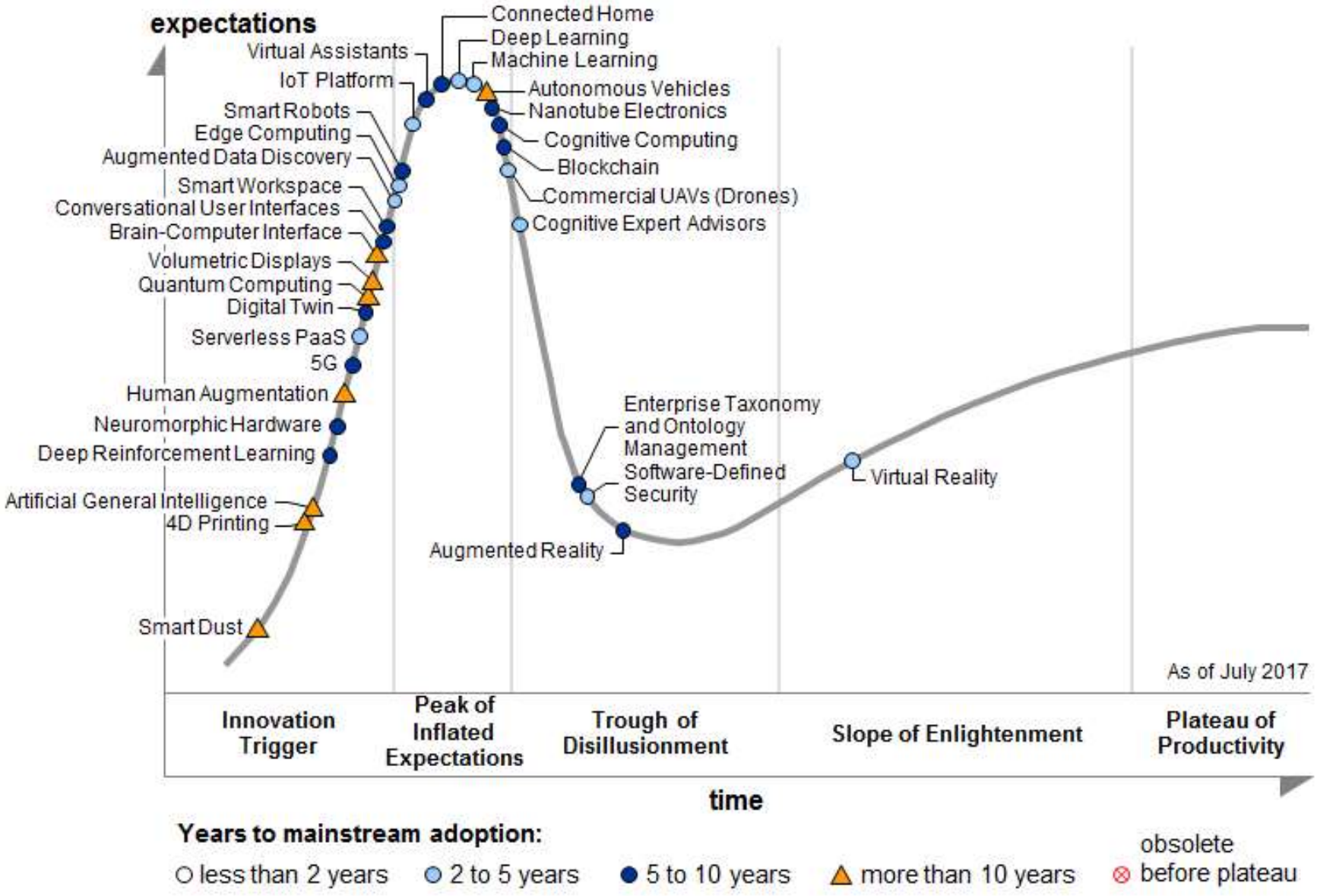
- Neuromorphic Hardware
- Quantum Computing
- Blockchain
- IoT Platform
- Software-Defined Security
- Software-Defined Anything (SDx)

gartner.com/SmarterWithGartner

Source: Gartner

Gartner.

Hype Cycle for Emerging Technologies, 2017



Three Trends

AI Everywhere

Deep Learning
Deep Reinforcement Learning
Artificial General Intelligence
Autonomous Vehicles
Cognitive Computing
Commercial UAVs (Drones)
Conversational User Interfaces
Enterprise Taxonomy
Ontology Management
Machine Learning
Smart Dust
Smart Robots
Smart Workspace

Transparently Immersive Experiences

4D Printing
Augmented Reality
Brain-Computer Interface
Connected Home
Human Augmentation
Nanotube Electronics
Virtual Reality
Volumetric Displays

Digital Platforms

5G
Digital Twin
Edge Computing
Blockchain
IoT Platform
Neuromorphic Hardware
Quantum Computing
Serverless PaaS
Software-Defined Security

gartner.com/SmarterWithGartner

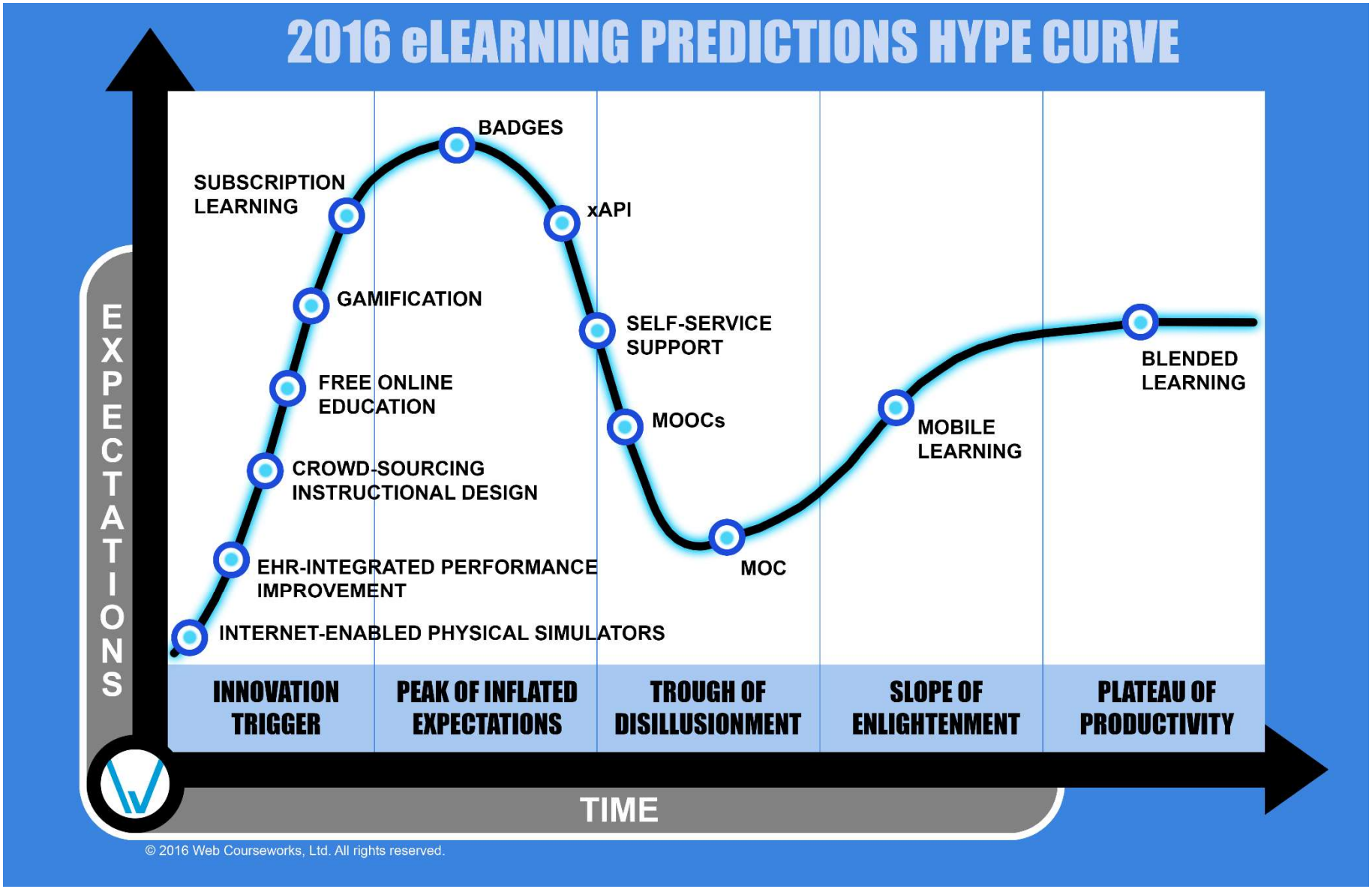
Source: Gartner

Gartner

Hype Cycle for Artificial Intelligence, 2017

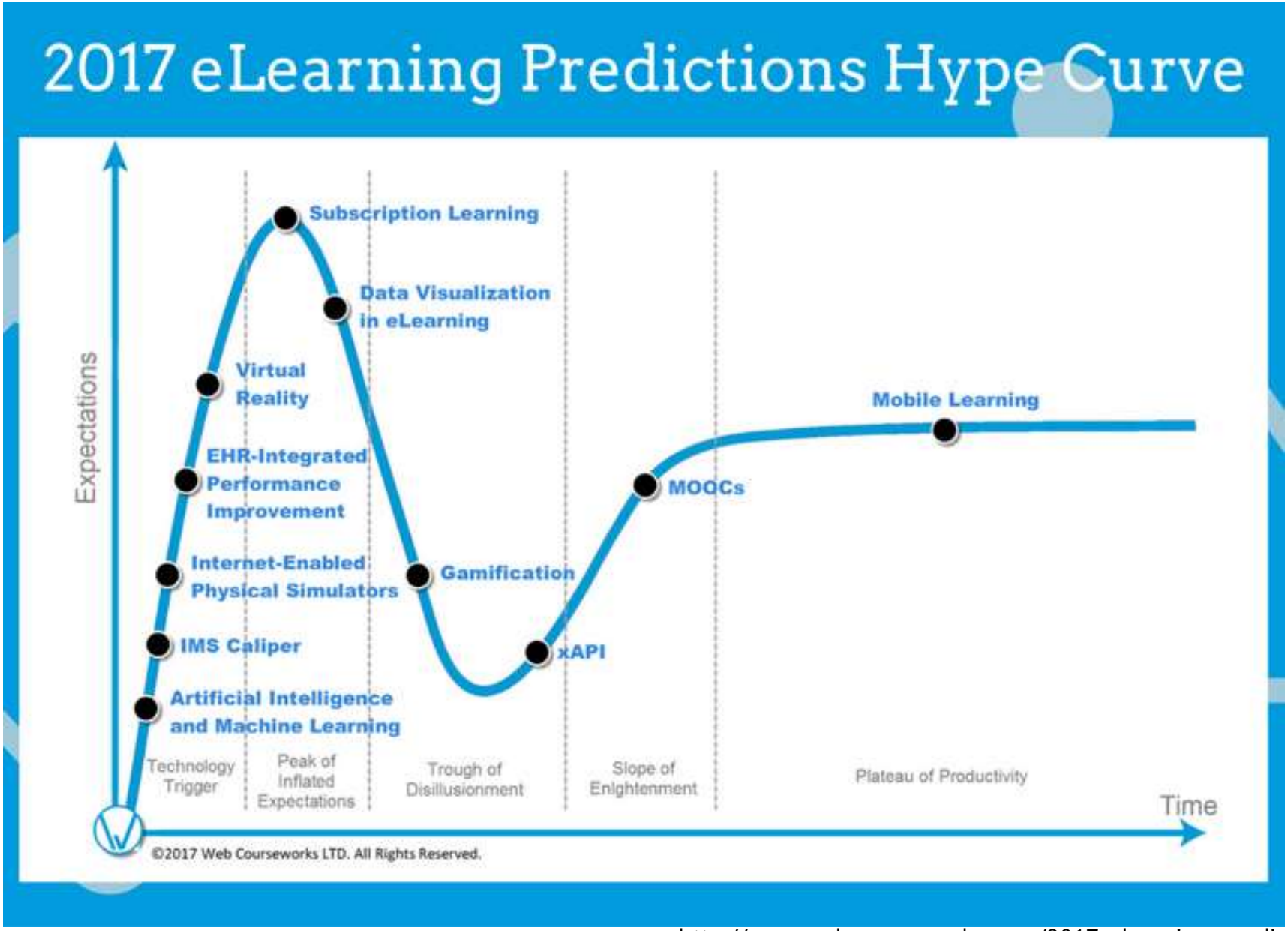
- On the Rise
  - Human-in-the-Loop Crowdsourcing
  - AI-Related C&SI Services
  - Artificial General Intelligence
  - Algorithm Marketplaces
  - Artificial Intelligence for IT Operations (AIOps) Platforms
  - Deep Reinforcement Learning
  - Neuromorphic Hardware
  - Natural-Language Generation
  - Bots
  - Conversational User Interfaces
  - Digital Ethics
- At the Peak
  - Deep Neural Network ASICs
  - Level 3 Vehicle Autonomy
  - Smart Robots
  - Graph Analytics
  - Prescriptive Analytics
  - Virtual Assistants
  - Deep Learning
  - Machine Learning
  - NLP
  - Autonomous Vehicles
  - Intelligent Apps
  - Cognitive Computing
  - Computer Vision
  - Level 4 Vehicle Autonomy
  - Commercial UAVs (Drones)
  - Predictive Analytics

Web Courseworks -- Jon Aleckson



http://www.webcourseworks.com/2016-elearning-hype-curve-predictions/

Web Courseworks -- Jon Aleckson



http://www.webcourseworks.com/2017-elearning-predictions/

William and Flora Hewlett Foundation in 2010

Deeper learning

- Educational outcomes
  - Mastery of rigorous academic content
  - Development of critical thinking and problem-solving skills
  - The ability to work collaboratively
  - Effective oral and written communication
  - Learning how to learn
  - Developing and maintaining an academic mindset

Partnership for 21st Century Skills (P21)

Four Cs

- Critical thinking and problem solving,
- Communication,
- Collaboration
- Creativity and innovation

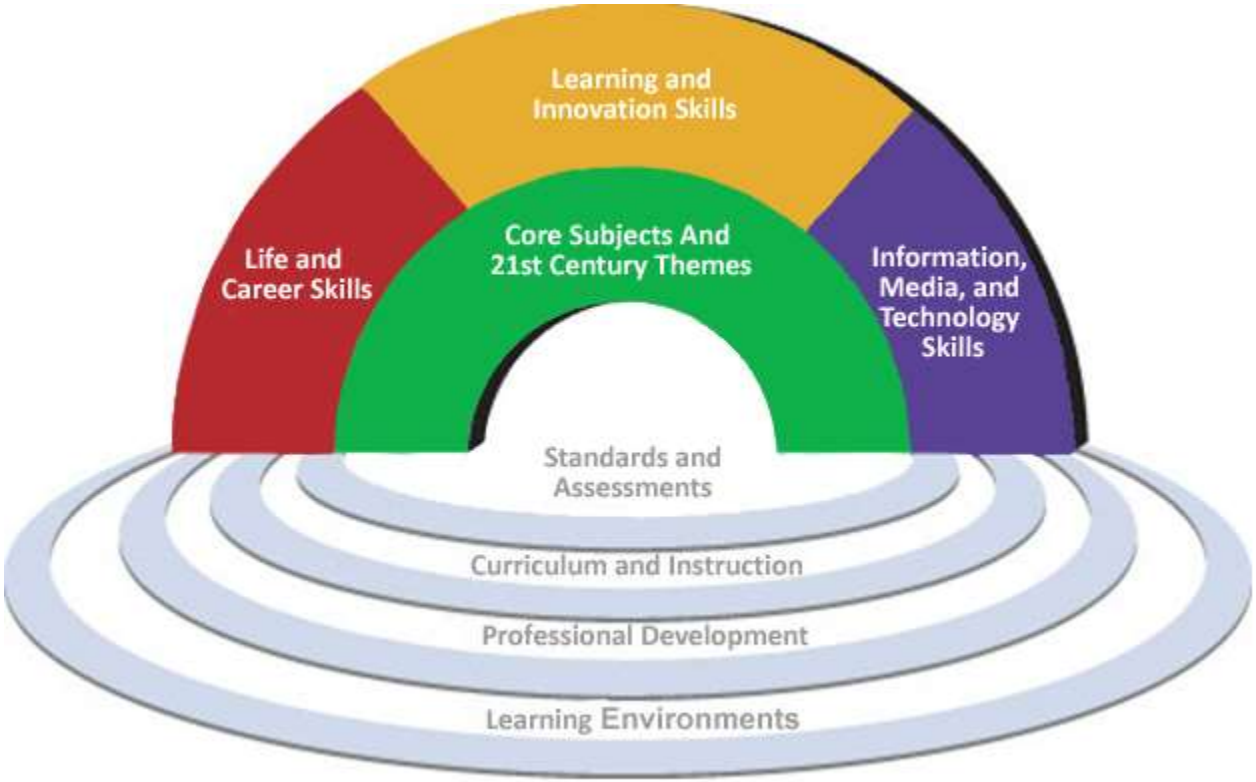
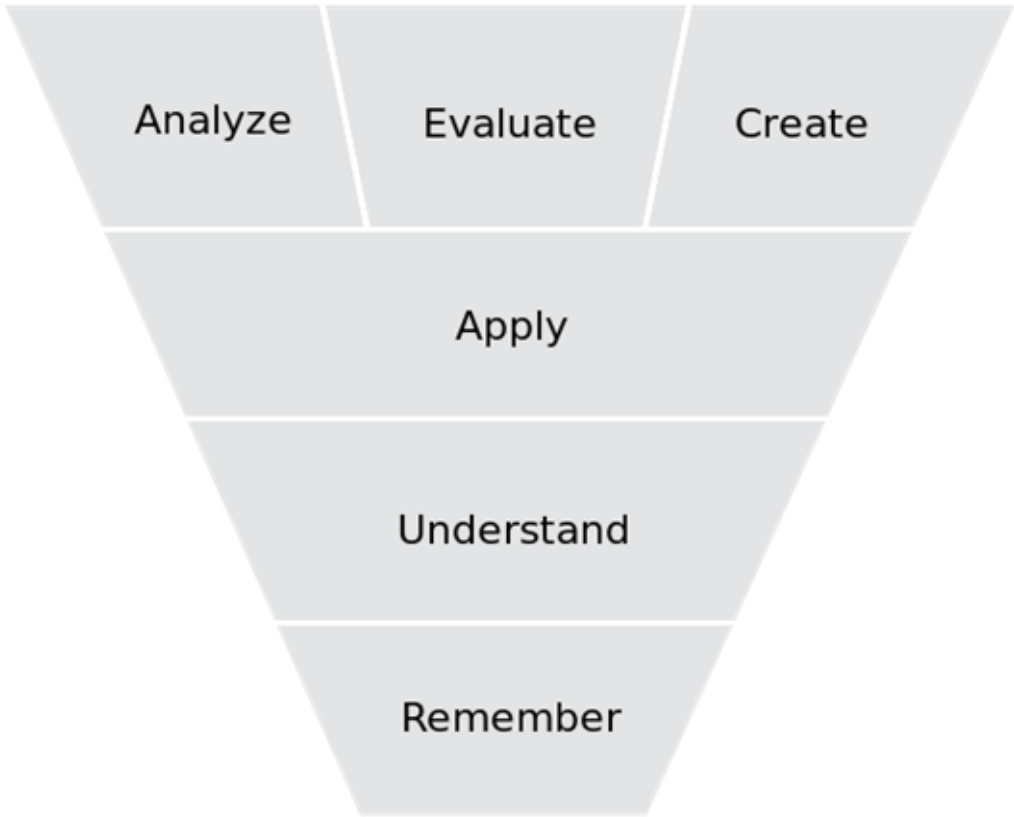


Figure 1 - P21 Framework for 21st Century Learning

Higher-Order Thinking Skills (HOTS)

- Skills involving analysis, evaluation and synthesis (creation of new knowledge) are thought to be of a higher order, requiring different learning and teaching methods than the learning of facts and concepts.



Categories in the cognitive domain of Bloom's taxonomy (Anderson & Krathwohl, 2001)

AI100 timeline

1950 In his famous paper Computing Machinery and Intelligence, Alan Turing posits that computer programs could think like humans and proposes a test to ascertain whether a computer's behavior is "intelligent."

1956 Stanford computer scientist John McCarthy, above, convenes the Dartmouth conference on "artificial intelligence," a term he defined. At this conference Herbert Simon and Allen Newell demonstrate a program that uses artificial intelligence to prove theorems in Principia Mathematica, by Bertram Russell and Alfred North Whitehead about logical foundations of mathematics. Simon and Newell also start work on computerized chess.

1962 Arthur Samuel, an IBM computer scientist who later became a Stanford professor, creates a self-learning program that proves capable of defeating one of America's top-ranked checkers champions.

1965-1970 Stanford researchers Ed Feigenbaum, seated above, Joshua Lederberg, Bruce Buchanan and Carl Djerassi create DENDRAL, the first "expert system." It creates scientific hypotheses about molecular structure using measured data.

1970-1980 Researchers develop more expert systems with applications to biology, medicine, engineering and the military.

1973 SRI's Artificial Intelligence Group creates Shakey the Robot, which crosses an obstacle-filled room autonomously using vision and locomotion systems. Shakey is the Computer History Museum's iconic exhibit for AI and Robotics.

1997 IBM's Deep Blue beats world chess champion Garry Kasparov in a six-game match, capping what Simon and Newell started four decades earlier.

2000 Statistical machine learning research that began in the 1980s achieves widespread practical use in major software services and mobile devices.

2005 Computer scientist Sebastian Thrun, above, and a team from the Stanford Artificial Intelligence Laboratory build a driverless car named Stanley. It becomes the first autonomous vehicle to complete a 132-mile course in the Mojave Desert, winning the DARPA Grand Challenge. Stanley is now on exhibit in the Smithsonian.

2009 Computer scientist Eric Horvitz assembles an AAAI study group on long-term AI futures, which holds its final meeting at Asilomar in California.

2011 IBM's Watson supercomputing system beats the two best human players of the TV game show Jeopardy, demonstrating an ability to understand and answer the types of nuanced questions that had previously bedeviled computer programs.

2014 Stanford accepts proposal to host One-Hundred-Year Study on Artificial Intelligence.

(See AITopics.org for a complete and authoritative timeline.)

Definition of Artificial Intelligence

- *Nils J. Nilsson:* Artificial intelligence is that activity devoted to making machines intelligent, and intelligence is that quality that enables an entity to function appropriately and with foresight in its environment

- *Wikipedia*: Artificial intelligence (AI) is intelligence exhibited by machines. In computer science, the field of AI research defines itself as the study of "intelligent agents": any device that perceives its environment and takes actions that maximize its chance of success at some goal. Colloquially, the term "artificial intelligence" is applied when a machine mimics "cognitive" functions that humans associate with other human minds, such as "learning" and "problem solving".

- *Gartner*: Artificial intelligence is technology that appears to emulate human performance typically by learning, coming to its own conclusions, appearing to understand complex content, engaging in natural dialogs with people, enhancing human cognitive performance (also known as cognitive computing) or replacing people on execution of non-routine tasks.

AI effect / Odd Paradox

- *AI brings a new technology into the common fold, people become accustomed to this technology, it stops being considered AI, and newer technology emerges* -- Pamela McCorduck, 2004

- *AI is whatever hasn't been done yet* -- Tesler's Theorem
- *If It Works, It's Not AI: A Commercial Look at Artificial Intelligence startups* -- Eve M. Phillips, 1999

- *AI does not “deliver” a life-changing product as a bolt from the blue. Rather, AI technologies continue to get better in a continual, incremental way*

Wikipedia

Artificial general intelligence (AGI)

- the intelligence of a (hypothetical) machine that could successfully perform any intellectual task that a human being can.
- Artificial general intelligence is also referred to as "strong AI", "full AI" or as the ability to perform "general intelligent action".
  - "applied AI" (also called "narrow AI"or "weak AI"): the use of software to study or accomplish specific problem solving or reasoning tasks.
  - Weak AI, in contrast to strong AI, does not attempt to simulate the full range of human cognitive abilities.

Wikipedia

AGI: Requirements

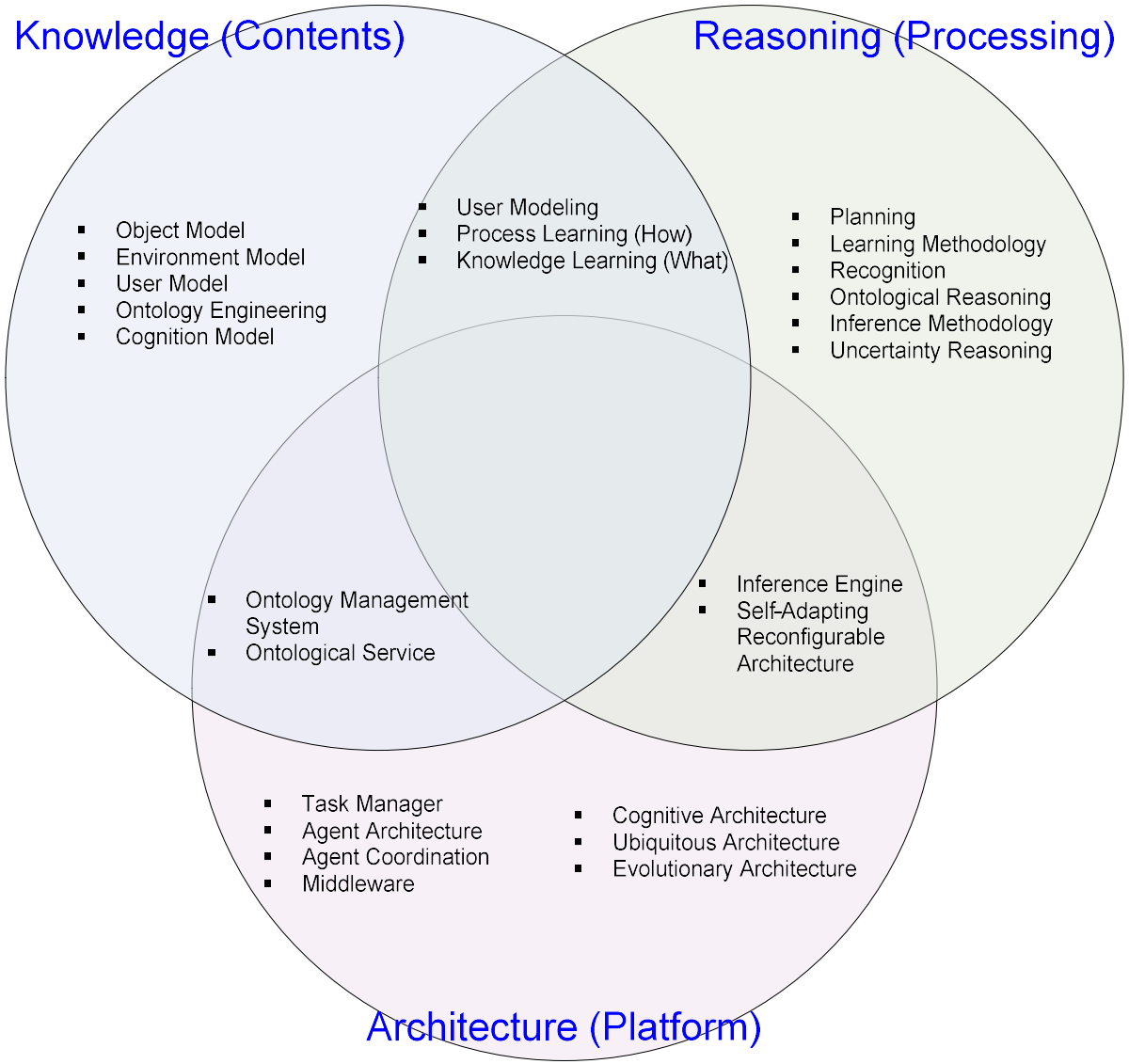
- reason, use strategy, solve puzzles, and make judgments under uncertainty;
- represent knowledge, including commonsense knowledge;
- plan;
- learn;
- communicate in natural language;
- and integrate all these skills towards common goals.
- the ability to sense and act in the world where intelligent behavior is to be observed.

Wikipedia

AGI: Operational definitions

- The Turing Test (Turing)
- The Coffee Test (Goertzel)
  - A machine is given the task of going into an average American home and figuring out how to make coffee. It has to find the coffee machine, find the coffee, add water, find a mug, and brew the coffee by pushing the proper buttons.
- The Robot College Student Test (Goertzel)
  - A machine is given the task of enrolling in a university, taking and passing the same classes that humans would, and obtaining a degree.
- The Employment Test (Nilsson)
  - A machine is given the task of working an economically important job, and must perform as well or better than the level that humans perform at in the same job.

Components of AI



AI for Education

- Teaching Robots
  - Ozobot: teaches children to code and reason deductively while configuring it to dance or play based on color-coded patterns
  - Cubelets: teach children logical thinking through assembling robot blocks to think, act, or sense, depending upon the function of the different blocks
  - Pleo rb: a robot pet that helps children learn biology by teaching the robot to react to different aspects of the environment

AI for Education

- Intelligent Tutoring Systems (ITS) and online learning
  - Why-2 Atlas: supports human-machine dialogue to solve physics problems early in the era
  - Duolingo: provide foreign language training using Automatic Speech Recognition (ASR) and NLP techniques to recognize language errors and help users correct them
  - SHERLOCK: teach Air Force technicians to diagnose electrical systems problems in aircraft
  - Educational Testing Service and Pearson: automatic NLP assessment tools to co-grade essays in standardized testing
  - Personalized tutoring

AI for Education

- Learning analytics
  - Current projects seek to model common student misconceptions, predict which students are at risk of failure, and provide real-time student feedback that is tightly integrated with learning outcomes
  - Recent work has also been devoted to understanding the cognitive processes involved in comprehension, writing, knowledge acquisition, and memory, and to applying that understanding to educational practice by developing and testing educational technologies.

AI for Education

- Assessments
  - Just-in-time assessments
    - Today: LA can predict if a student will fail or drop-out
    - Tomorrow: how motivation and engagement varies
  - Tracking learning progress
    - Today: is the answer right/wrong?
    - Tomorrow: why? What type of mistakes? What emotional state?
  - Stealth assessments:
    - Today: short quizzes, final exam
    - Tomorrow: assessing while learning is happening (e.g. through a collaborative project)

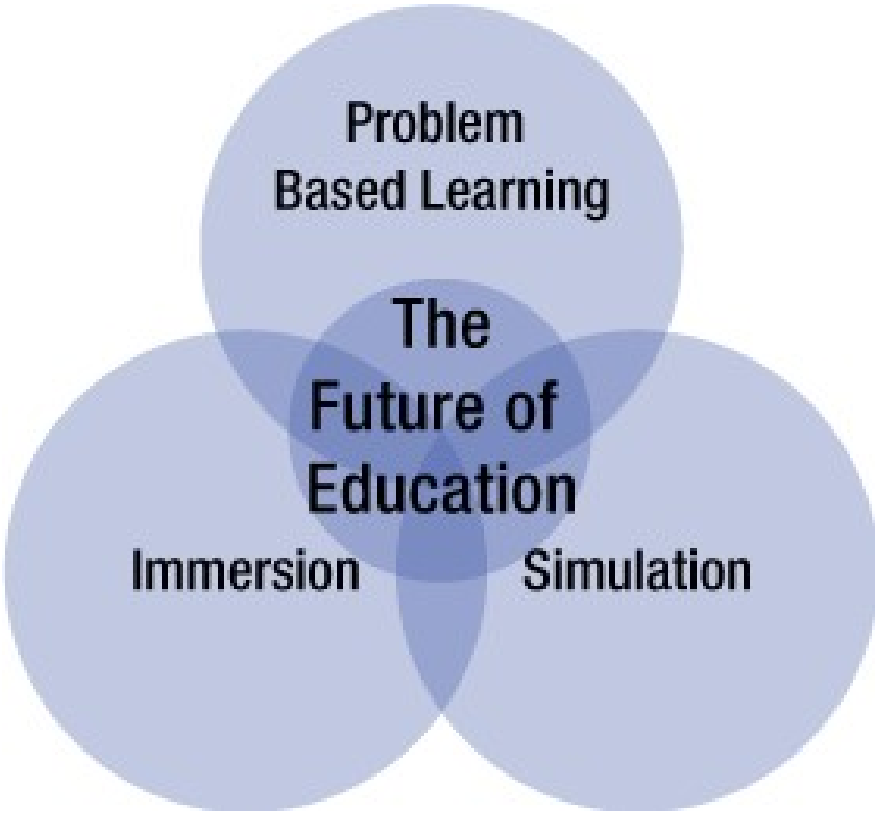
Benefits

- Students
  - Learning outcomes
- Educators
  - Productivity & Insights
- Organizations
  - Scalable High Quality Education

AI and the future of education systems

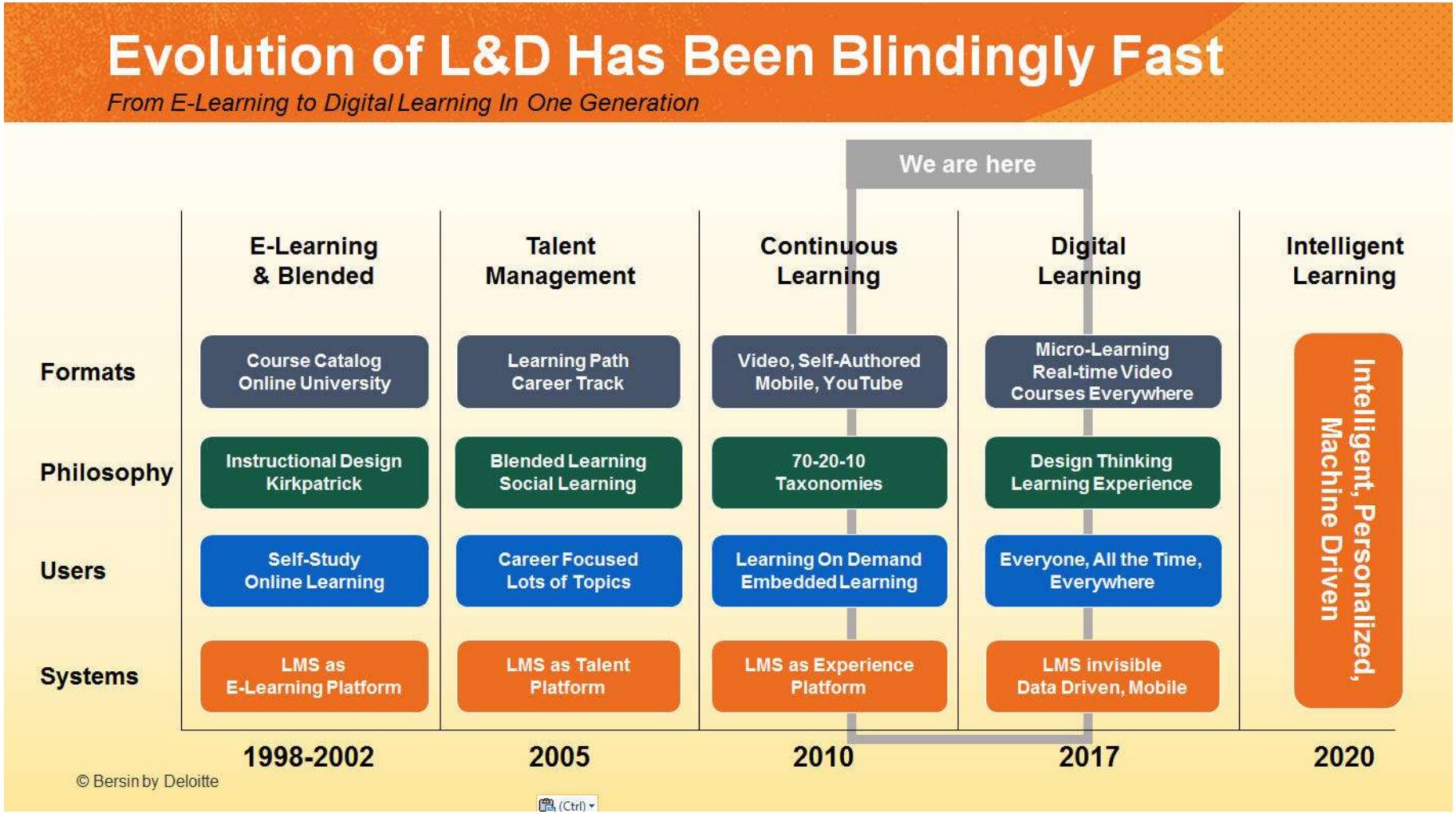
Bernhard Schindlholzer

- Problem-Based Learning
  - Finding drastic new solutions to existing and new problems
- Immersion
  - Real-time decision making over longer periods of time
- Simulation
  - A safe environment to experiment, fail and try again



From e-learning to digital learning in one generation

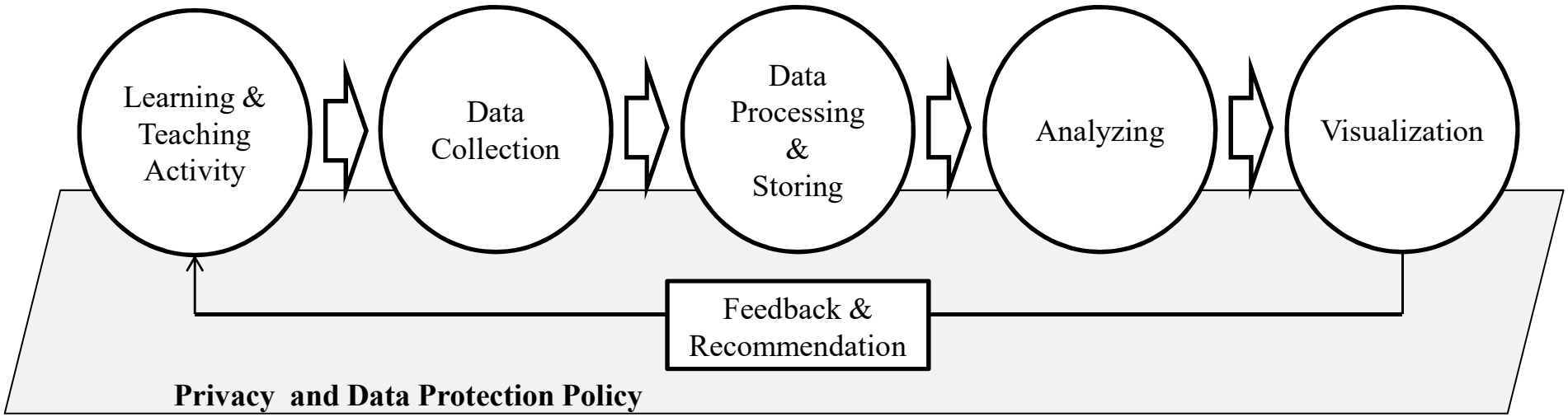
Josh Bersin, Deloitte



Learning analytics

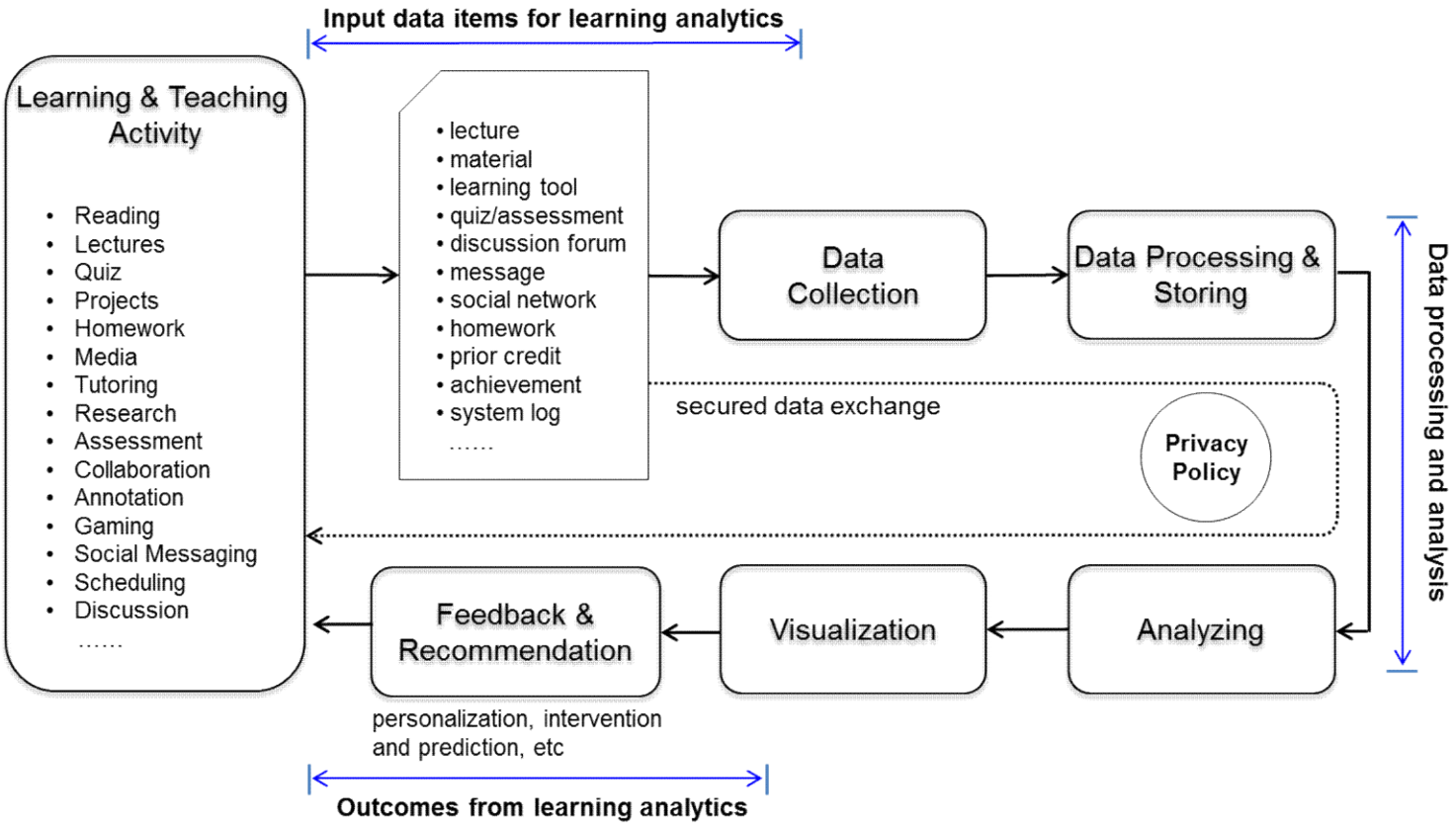
- the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of **understanding** and **optimizing** learning and the environments in which it occurs

- Workflow of Learning Analytics Systems

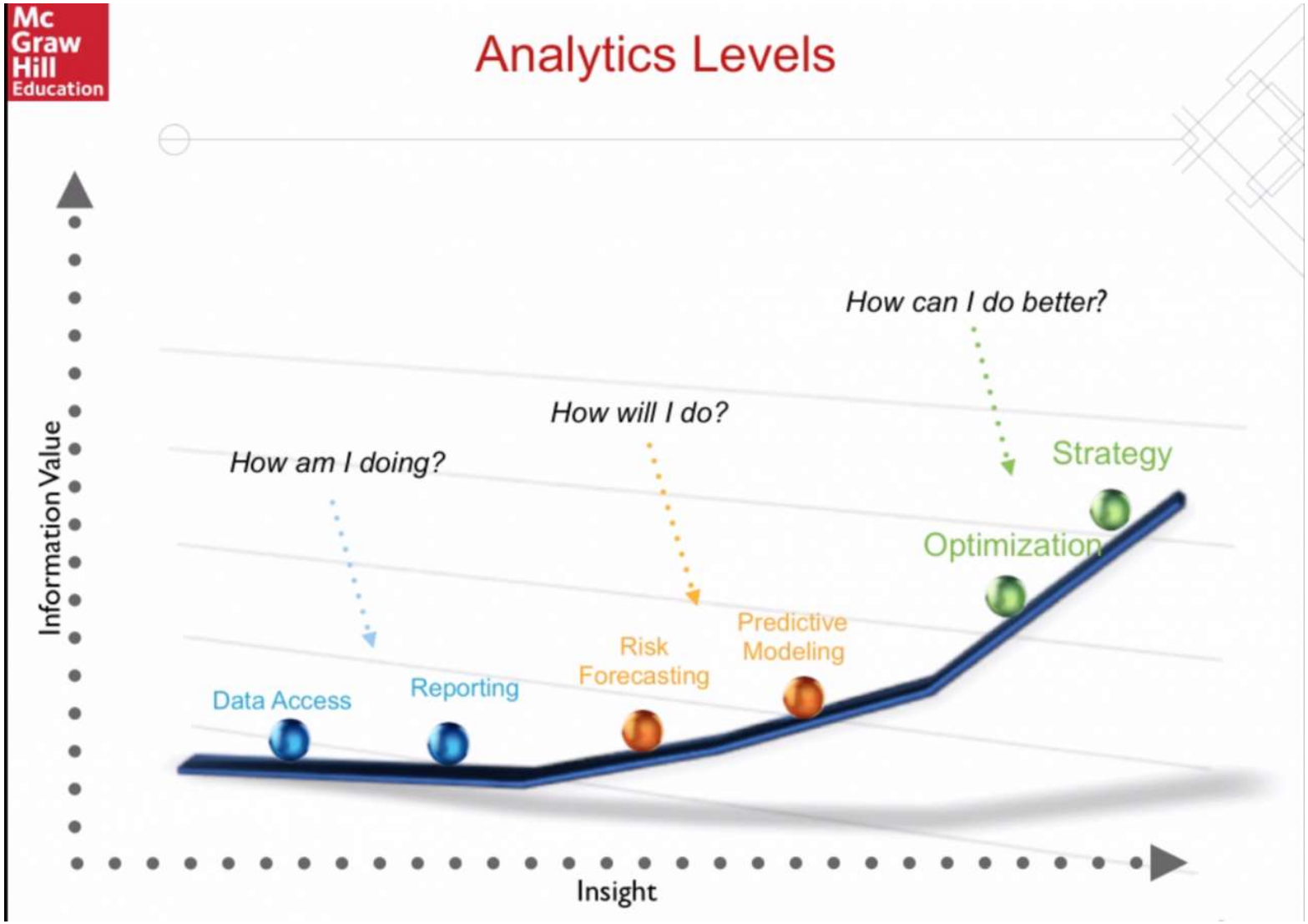


Reference model

- an abstract framework or domain-specific ontology consisting of an interlinked set of clearly defined concepts
- a standard model used to specify system requirements in an implementation- independent manner



3-Levels of Learning Analytics in Adaptive Learning



***Al Essa**- Vice President , Research and Analytics, McGraw-Hill*

Conclusion

- AI does not “deliver” a life-changing product as a bolt from the blue.
- Rather, AI technologies continue to get better in a continual, incremental way
- AI + LA will be more and more important in years to come
- Potential need & benefits to more focus on collaboration of human and machine. (mixed human-computer collaboration and mixed-initiative systems)