Metaari's Learning Technology Research Taxonomy

Research Methodology, Product Definitions, and Licensing Model

Updated: January 2017
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Metaari's Learning Technology Research Taxonomy

Over several decades, Metaari (formerly Ambient Insight) principals have refined a sophisticated and precise learning technology product categorization schema based on pedagogical principles, knowledge engineering systems, data science, and information architecture.

Our research taxonomy is the backbone of our quantitative data repository. It is the foundation of our classification system that enables us to identify, catalog, and index addressable revenue opportunities for suppliers marketing specific products to discrete buying segments in particular countries across the planet.

Figure 1 – Metaari's Learning Technology Research Taxonomy

Our taxonomy is designed to provide clarity to suppliers competing in a complex global market. This document illuminates how we define different learning technology product types and buyer segments and describes our research methodology. These definitions are a foundation for our research and analysis.

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We track six buying segments that buy eight types of learning technology products from five types of suppliers. The five supplier types in our taxonomy map directly to the subcategories of learning technology products and services.

We track buying behavior in over 122 countries across seven international regions. We have the most complete view of the international demand for learning technology in the industry.

Who are We?
Metaari principals are well-known competitive intelligence experts in the global learning technology industry. Metaari (formerly Ambient Insight) was founded in 2017 by the original members of the Advanced Knowledge Engineering team that built the Microsoft Online Learning Institute (MOLI), the world’s first international commercial eLearning business, which launched in 1995.

Metaari publishes quantitative syndicated reports. In our syndicated reports, Metaari provides quantitative market research by customer segment (demand-side) and by product category (supply-side) based on our taxonomy and our proprietary Evidence-based Research Methodology (ERM).

We Are Unique
We are the only research firm in the industry that has developed a precise learning product taxonomy based on pedagogical principles, knowledge engineering systems, data science, and information architecture. We specialize exclusively in learning technology. We continue to modify, refine, and enhance our taxonomy as products and buying behavior changes.

For example, Mobile Learning value added services (VAS), a subset of Mobile Learning, is essentially a new type of learning product that has come on the market in the last two years. Smartphone-based virtual reality educational apps were non-existent prior to 2014.

We Are Precise
We are a quantitative research firm. Quantitative market research is an empirical process in which deductive mathematical models are used to identify and calibrate statistically-valid variables that contain measurable data about target products, market conditions, and/or buyers. We use
predictive analytics software and proprietary algorithms to triangulate measurable Total Addressable Market (TAM) forecasts and tangible revenue opportunities.

Metaari knows suppliers need precise product definitions and forecasts across all buyer segments to compete in the international learning technology industry. We provide our clients with precise actionable data.

**We Are Ethical**

We do not endorse specific suppliers or products. None of our syndicated research is influenced, sponsored, or subsidized by suppliers. We do not evaluate, compare, or rank products.

We understand the competitive value of the intellectual property owned by our clients and we take non-disclosure agreements (NDAs) seriously. All of the proprietary information that our clients have shared with us is kept in strict confidence.

**Our Quantitative Evidence-based Research Methodology**

Metaari provides quantitative market revenue forecasts using our proprietary Evidence-based Research Methodology (ERM). We developed ERM by modifying and refining industry-standard quantitative methods to reflect the unique characteristics of the international learning technology market.

The ERM is an iterative process with five key phases that:

- Isolate the target market
- Triangulate the baseline (the floor) and the topline (the ceiling) revenue boundaries
- Forecast the Total Addressable Market (TAM) for specific products
- Generate "market share maps" by supplier
- Quantify actionable competitive intelligence

Each phase of the ERM functions as an input and output in the process. In the sense that one phase "informs" the next phase, it is an input. Each phase also generates standalone data points, which are discrete outputs.

**Figure 2 – Metaari's Quantitative Evidence-based Research Methodology (ERM)**
The ERM progresses from general patterns (the big picture) to very precise granular patterns. Once the target market is isolated, calculations triangulate the potential revenues boundaries. Actual revenues cannot be below the baseline boundary, known in the research industry as "the floor." Likewise, actual revenues cannot be any higher than the topline boundary. The TAM is located within these boundaries.

**Data Sources: Metaari's Actionable Competitive Intelligence**

Metaari generates actionable competitive intelligence by mapping the competitive landscape, performing supply-side and demand-side analyses, and by compiling data from a wide spectrum of information broadly classified as leading and lagging indicators.

- **Leading indicators** signal future events and include venture capital investment trends, patent applications, technology-related legislation, technology standards development, product research trends, product substitution patterns, technology infrastructure trends, labor demand, and outsourcing demand.

- **Lagging indicators**, referred to as "rear-view mirror" data, are past events captured in data that include supplier activity, M&A activity, divestitures, executive hiring patterns, US Economic Census data, and the governments in Canada, Ireland, Taiwan, and South Korea (among others) actively promote and subsidize the export activities of domestic learning technology suppliers.

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SIC and NAICS tax data, SEC filings and financial reporting, international stock exchanges, local and federal government data, Universal Commercial Code banking reports, public-domain business records, court records, press releases, government export trade data, regional trade association resources, and international industry association information.

Many of the companies tracked by Metaari are publicly traded on various international stock exchanges and their financial disclosures provide baseline data for global sales, regional competitive pressures, and specific country-by-country business activity.

**Figure 3 – Metaari's Actionable Competitive Intelligence**

Many private companies, particularly outside the US, report their revenues as a matter of policy. Non-profit education organizations (like ETS, Cambridge University Press, and Oxford University Press) also report their revenues. These financial disclosures provide baseline data for the demand for specific types of products in particular countries and regions.

Federal government and industry trade bodies, particularly in the US, Japan, South Korea, Germany, France, Canada, Ireland, China, Brazil, India, and the UK, provide extensive data on export opportunities in specific international education markets.

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Federal, state, provincial, and local agencies provide detailed reports on technology funding, the adoption of learning technology, and the buying behavior in the academic, vocational, and workforce markets. Educational legislation and policy mandates often include very detailed data on funding allocated to learning technology.

Several countries (particularly China, Japan, and South Korea) track consumer adoption of learning technology products and publish reports that include total annual expenditures. The European Union funds ongoing research on the adoption of electronic learning in the EU and Eastern Europe.

Several international bodies such as the World Bank, the UN, and the Commonwealth of Learning provide funding for projects and detailed data on the adoption of learning technology in developing countries.

There are now distance learning and learning technology trade associations in every region of the world. Publications, event presentations, and press from these associations provide valuable insight into the market conditions inside particular countries and regions.

The various publishing, training, and education associations across the globe provide a wealth of information about the migration to digital formats and the buying behavior in specific countries.

**Countries Tracked by Metaari**

Metaari tracks the learning technology markets in 122 countries. While there can be similarities in buying behavior for a few countries, they are usually confined to a particular buying segment.

For example, consumer preference for certain types of Mobile Learning apps can be very similar. Brain trainers are now popular in over 100 countries. In general, however, the buying behavior is usually quite different in each country, particularly in the academic and government segments.

**Table 1 - The 122 Countries Tracked by Metaari**

<table>
<thead>
<tr>
<th>Number of Countries Analyzed in Each Region</th>
<th>Countries Analyzed in this Report by Region</th>
</tr>
</thead>
</table>

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30 Countries in Africa
Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Chad, Côte d'Ivoire (The Ivory Coast), the Democratic Republic of Congo (DRC), Ethiopia, Ghana, Kenya, Madagascar, Malawi, Mali, Mauritania, Morocco, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, South Africa, Tanzania, Tunisia, Uganda, Zambia, and Zimbabwe

21 Countries in Asia Pacific
Australia, Bangladesh, Cambodia, China (including Hong Kong and Macao), India, Indonesia, Japan, Laos, Malaysia, Mongolia, Myanmar (Burma), Nepal, New Zealand, Pakistan, the Philippines, Singapore, South Korea, Sri Lanka, Taiwan, Thailand, and Vietnam

15 Countries in Eastern Europe
Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Georgia, Kazakhstan, Kyrgyzstan, Moldova, the Russian Federation, Serbia, Tajikistan, Turkmenistan, Ukraine, and Uzbekistan.

18 Countries in Latin America
Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, the Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay, and Venezuela

12 Countries in the Middle East
Bahrain, Egypt, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Turkey, the United Arab Emirates (UAE), and Yemen

2 Countries in North America
Canada and the United States

24 Countries in Western Europe
Austria, Belgium, Bulgaria, Croatia, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Lithuania, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Spain, Sweden, Switzerland, and the United Kingdom

The buying behavior inside particular countries and regions tend to be quite different. That said, there are often pan-regional revenue opportunities and Metaari identifies those for suppliers

What is Learning?
Cognitive Learning and behavior modification are synonymous. The synonymous relationship between behavior modification (Cognitive Learning) and knowledge transfer (learning) is widely understood by instructional design experts in the federal government (particularly the military) and corporate segments. Cognitive Learning is a fundamental tenet in both the Bloom and Gagne taxonomies, two of the most prevalent instructional schemas used in systematic approaches to instructional design used to develop training content.
Webster's Dictionary defines learning as "a modification of a behavioral tendency by experience." Learning is demonstrated by a change in behavior. Technology-based Cognitive Learning products are behavior modification products designed to improve or enhance perception, working memory, comprehension, emotional states, decision making, fluid intelligence (general problem solving), and reasoning.

They are meta-cognition products that enable users to modify cognitive behavior (learn) by understanding and manipulating the learning process itself.

In educational psychology, there are two phases of the learning process; knowledge transfer and learning transfer. Knowledge transfer is the transmission of information and skills to the learner. Learning transfer is the ability of the learner to demonstrate mastery in a real world setting. New learning technology products on the market now essentially merge these two phases.

A Canadian company called DAQRI is selling extraordinary augmented reality products designed to merge real time knowledge transfer and learning transfer simultaneously while a worker performs tasks on the job. They obtained $115 million in funding in 2016. Their premier product is their augmented reality Smart Helmet, which is a hardhat that has a visor that displays procedural data over objects (machinery, construction sites, etc.)

DAQRI is targeting the industrial verticals with the helmet. "Reduce talent and experience gap with repeatable, fully modularized, and contextualized training capturing experts’ knowledge and experience; avoid costly human teaching errors with the use of precise data driven decision-support training."

And Game-based Learning is attracting investor interest due not only to technology innovations but also due to the new and rapid uptake of psychometric-based assessment edugames in the corporate segment used to assess job candidates.

One of the big game changers for Cognitive Learning is the number of new products that are built on top of IBM's Watson cognitive computing platform. Products built on AI-based platforms like Watson have the ability to deliver highly personalized learning (targeted knowledge transfer) and measure learning transfer in real time. These products effectively learn to adapt to the individual.
IBM claims that IBM Watson Education "is bringing education into the cognitive era. We are transforming the learning experience through personalization. Cognitive solutions that understand, reason and learn help educators gain insights into learning styles, preferences, and aptitude of every student. The results are holistic learning paths, for every learner, through their lifelong learning journey."

All legacy products like eLearning and live online synchronous instruction bifurcate these two phases into totally separate processes. Legacy products introduce a significant degree of "noise" that inhibits the learning process and are significantly less effective than the new advanced learning products.

**Empirical Evidence on the Effectiveness of Next-generation Learning Products**

Over the last twenty-five years, one-to-one tutoring has been empirically proven to be the most effective knowledge transfer method. There are now Cognitive and intelligent tutors on the market that can perform better than human tutors.

"One-on-one tutoring is the Holy Grail of teaching and all educational approaches should be aimed at replicating this model. Advanced technologies can help us to understand individual interaction patterns and enable us to tailor educational content accordingly.” (October 26, 2016, Harriet Green, IBM Watson Education)

In a seminal study known as the “Two Sigma Problem,” Bloom found that, on average, tutored students scored better than 98% of classroom students. This means that the achievement of individually-tutored students may exceed that of classroom students by as much as two standard deviations (a two sigma shift).

This knowledge-transfer improvement is roughly equivalent to raising the performance of 50th percentile students to that of 98th percentile students. New intelligent Cognitive Tutor products are capable of exceeding the two-sigma deviation.

**Figure 4 - Scientifically Proven to Work: The Most Effective Knowledge Transfer Method is One-to-one Tutoring**
There is also a growing body of evidence on the effectiveness of Social and Emotional Learning (SEL) on cognition and behavior. The Collaborative for Academic, Social, and Emotional Learning (CASEL) has compiled a large catalog of empirical meta-analysis data across large numbers of schools. In a study of 668 schools using SEL programs, CASEL found that "up to 50 percent of children showed improved achievement scores and up to 38 percent improved their grade-point averages. SEL programs also made schools safer: incidents of misbehavior dropped by an average of 28 percent; suspensions by 44 percent; and other disciplinary actions by 27 percent. At the same time, attendance rates rose, while 63 percent of students demonstrated significantly more positive behavior."

In early 2011, CASEL released the results of a study on SEL programs used by 270,000 PreK-12 students. "Compared to controls, SEL participants demonstrated significantly improved social and emotional skills, attitudes, behavior, and academic performance that reflected an 11-percentile-point gain in achievement. School teaching staff successfully conducted SEL programs. The use of four recommended practices for developing skills and the presence of implementation problems moderated program outcomes. The findings add to the growing empirical evidence regarding the positive impact of SEL programs."
According to Roger P. Weissberg, the editor of *Handbook of Social and Emotional Learning: Research and Practice*, "SEL not only improves achievement by an average of 11 percentile points, but it also increases prosocial behaviors and reduces depression and stress among students."

**Cognitive Learning Excels at Behavior Modification**

Researchers and suppliers have a growing body of empirical evidence to show that people who use Cognitive Learning products can condition and train the brain to improve memory, attention, visual and spatial awareness, auditory processing, linguistic skills, planning skills, and problem solving. Despite criticism of the effectiveness of brain trainers, there is empirical evidence proving otherwise.

Perhaps the most persuasive evidence is the research done by Jaeggi on the use of so-called dual n-back tasks in brain training. The dual n-back tasks require users to process information simultaneously from two different sensory domains. She found that performing dual n-back tasks "accrues transferable benefits in Gf (fluid intelligence), over and above any gains in working memory capacity. This finding merits particular attention because Gf has traditionally been viewed as highly heritable and stable and is positively correlated with a large number of desirable outcomes including academic success, and neurological, psychological and physical health."

Jaeggi's research has been replicated by other researchers. "These findings constitute preliminary evidence that intensive cognitively demanding brain-training can improve not only our abstract problem-solving capacity, but also ameliorate cognitive control processes (e.g. decision-making) in our daily emotive environments." (National Center for Biotechnology)

As of June 2016, there are dozens of brain trainers on the market that use the n-back method. The majority of these edugames are mobile apps. Many are free and offer fee-based premium content. BrainScale.net provides a free brain trainer based on the n-back method and sells subscription-based premium upgrades for $2.99 a month or $14.99 a year.

In July 2016, the results of the ten-year ACTIVE (Advanced Cognitive Training for Independent and Vital Elderly) study on 2,785 people (65 and older) funded by the National Institutes of Health provided empirical evidence for the effectiveness of cognitive training. The study found that "older adults’ risk for dementia was reduced by 48 percent over 10 years when they completed 11 or more sessions of brain-training. The scientists
say this is the first time a cognitive training intervention has been shown to protect against dementia in a large, randomized, controlled trial."

**Edugames Empirically Proven Prove to be Effective Knowledge-Transfer Products**

One major inhibitor for the Game-based Learning market was the lingering debate over the effectiveness of the product. That tide has turned as well. A string of empirical meta-analysis research results have found that Game-based Learning is a more effective knowledge transfer method than conventional methods. Meta-analysis is defined as "a method for systematically combining pertinent qualitative and quantitative study data from several selected studies to develop a single conclusion that has greater statistical power."

In 2011, the results of study by Traci Sitzmann were released in a paper called "A Meta-Analytic Examination of the Instructional Effectiveness of Computer-based Simulation Games". She found that "Interactive cognitive complexity theory suggests that simulation games are more effective than other instructional methods because they simultaneously engage trainees’ affective and cognitive processes. Meta-analytic techniques were used to examine the instructional effectiveness of computer-based simulation games relative to a comparison group. Consistent with theory, post training self-efficacy was 20% higher, declarative knowledge was 11% higher, procedural knowledge was 14% higher, and retention was 9% higher for trainees taught with simulation games, relative to a comparison group."

In 2012, Thomas M. Connolly and his team published a paper called "A systematic literature review of empirical evidence on computer games and serious games". "This paper examines the literature on computer games and serious games in regard to the potential positive impacts of gaming on users aged 14 years or above, especially with respect to learning, skill enhancement, and engagement. Search terms identified 129 papers reporting empirical evidence about the impacts and outcomes of computer games and serious games with respect to learning and engagement and a multidimensional approach to categorizing games was developed. The findings revealed that playing computer games is linked to a range of perceptual, cognitive, behavioral, affective, and motivational impacts and outcomes. The most frequently occurring outcomes and impacts were knowledge acquisition/content understanding and affective and motivational outcomes."
In a seminal study called "A Meta-Analysis of the Cognitive and Motivational Effects of Serious Games" released in 2013 in the Journal of Educational Psychology, Pieter Wouters and his Utrecht research team reported that, "It is assumed that serious games influences learning in two ways, by changing cognitive processes and by affecting motivation. However, until now research has shown little evidence for these assumptions. We used meta-analytic techniques to investigate whether serious games are more effective in terms of learning and more motivating than conventional instruction methods. Consistent with our hypotheses, serious games were found to be more effective in terms of learning and retention."

In March 2014, SRI International, an international R&D company, released the results of their meta-analysis of research papers on the effectiveness of simulation and games on learning. Both Simulation-based Learning and Game-based Learning were found to be significantly more effective knowledge transfer methods than learning products that did not include simulation or game play. "When digital games were compared to other instruction conditions without digital games, there was a moderate to strong effect in favor of digital games in terms of broad cognitive competencies."

In a 2015 Stanford study on the effectiveness of edugames for third grade math it was found that third graders that played the Wuzzit Trouble math edugame for ten minutes a day on 3 days a week over a four week period (a mere two hours of total game play) had a 20.5% improvement rate over the control group that were given the same material in traditional formats.

The industry is on the verge of extraordinary innovations in knowledge transfer using games. In April 2016, Sesame Street announced a three-year partnership with IBM to develop educational products using IBM's artificial intelligence platform Watson. In the press, IBM stated "As part of a three-year agreement, Sesame Workshop and IBM will collaborate to develop educational platforms and products that will be designed to adapt to the learning preferences and aptitude levels of individual preschoolers. Research shows that a significant extent of brain development occurs in the first five years of a child’s life, making this window critical for learning and development. Working together with Sesame Workshop, we aim to transform the way in which children learn and teachers teach, and envision having an impact on the lives and education of millions of children."

"Over the next three years, the pair will create mobile apps, games, smart toys, and a range of products offering adaptive, individualized education. Using Watson's cognitive capabilities, the app will analyze a child's
response in real-time and then intervene with content just for that child because each of us learns in a very, very different way."

Perhaps the most effective knowledge transfer products in the current market are the new assessment and evaluation edugames based on psychometrics. Psychometrics is the science that focusses on statistical measurement of psychological states. Psychometric instruments measure knowledge, abilities, skills, attitudes, and personality traits.

Several new companies that specialize in this type of edugame have come on the market in just the last 2-3 years including Pymetrics, Revelian, Knack, Scoutible, SHFuse, RoundPegg, Arctic Shores, and High Voltage Software. All of them are seeing rapid uptake in the corporate segments across the planet.

Psychometrics can be complex and very few people outside of the psychometrician profession understand the science, but psychometrics are the foundation of all the major certification exams. It is not a hard sell to convince corporations to buy products based on psychometrics. They may not understand the science, but they recognize the clear benefits of using it.

"Pymetrics is reinventing the recruiting process by using big data, neuroscience, and machine learning to identify optimal career paths for job seekers and ideal employees for organizations. Pymetrics assesses cognitive and personality traits using a series of fun and quick neuroscience games, making it easier than ever to understand where inherent characteristics can lead to success."

Artic Shores was founded in 2013 and has developed a job recruitment edugame based on psychometrics called Cosmic Cadet that places a job candidate on a virtual spaceship where they must complete six levels of "interstellar challenges" in 30 minutes. "Measuring cognitive processes such as resilience and problem-solving, the game collects data on how job candidates instinctively respond to given situations, thereby helping employers gain a better understanding of how they would perform in the role and whether they are a good fit for the company."

In July 2016, Arctic Shores announced a distribution agreement with the talent measurement and assessment company Cut-e. Cut-e is now a global distributor of Arctic Shores' edugames and is collaborating with Arctic Shores on new learning games. "Cut-e provides ability, personality, motivation, values, creativity and integrity assessments in 70 countries."
A company called Simcoach has worked with dozens of businesses in healthcare, retail, manufacturing, government. They have developed games for numerous companies such as Alcoa, Honeywell, Lowe’s, and Wegmans and organizations like the 3 Rivers Workforce Investment Board, OSHA, and other agencies. "Measurable and sustainable behavior change is at the core of what we do. Our team of experienced game developers is committed to making every learning experience fun. Our Simcoach Method combines superior game design with proven learning science to develop industry leading workforce training that is both engaging and effective."
International Buyer Segmentation Descriptions

Metaari provides market research across all the buyer segments in each of the 122 countries including:

- Consumers
- PreK-12 academic institutions
- Higher education institutions
- Local, state/provincial governments
- Federal governments
- Corporations and businesses

The buying behavior in each segment is unique. Each segment tends to favor certain product types. For example, Mobile Learning is essentially a consumer phenomenon across the planet.

Consumers

Metaari defines consumers as individual buyers that purchase products directly. It should be noted that consumers do not buy tools or platforms.

The consumer segment is the only buying segment in which the buyer and the user are identical. In all other segments the buyers and the users are not the same.

Consequently, buying behavior in the global consumer markets tend to provide the best data on customer satisfaction from a product standpoint. In all other segments customer demand is based on the needs of organizational buyers, not the actual users. The consumer demand for technology-based learning products is different in each country across the planet.

PreK-12 (Preschool, Primary, and Secondary) Institutions

PreK-12 school systems are different in each country. Consequently, academic buying behavior is quite different in each country. In some countries, schools are autonomous and can make their own buying decisions.

In other countries, like China, central government agencies not only decide what products are used, but also purchase the products directly. Many of these central government education agencies use primary contractors to
A country's educational policies are often more important than a country's technical readiness when it comes to the adoption of learning technology. A significant global catalyst driving the adoption of learning technology in the schools is the migration to digital content in the PreK-12 buying segments throughout the world.

There are now major digitization efforts going on in the school systems in South Korea, Thailand, China, Taiwan, Vietnam, Turkey, Brazil, France, Poland, Italy, Spain, Ukraine, Azerbaijan, Kazakhstan, Georgia, Brazil, Mexico, Japan, Singapore, Qatar, Kuwait, the United Arab Emirates (UAE), and in various school systems in the UK and the US.

While all domestic school systems are unique, the US stands out because it has the largest population of online PreK-12 students, so far. The large (and growing) number of children attending online primary and secondary schools *fulltime* in the US is a trend found nowhere else in the world.
Higher Education and Tertiary Institutions
The adoption of learning technology in higher education institutions varies dramatically from country to country. Government-mandated educational policies act as either catalysts or inhibitors.

One interesting trend across the globe is the emergence of national virtual universities funded by the government. Finland, Sweden, Norway, Bulgaria, Estonia, Malaysia, Tunisia, the Philippines, Mexico, Uganda, Australia, Kenya, Pakistan, and Switzerland have national virtual universities.

There are variations on these centralized virtual universities. The Bavarian Virtual University in Germany is an example of a state-funded virtual campus. ASEAN Cyber University, UNISA, and the African Virtual University are examples of pan-regional virtual universities.

Considering their large international student enrollments, the UK's Open University and India's Indira Gandhi Open University (IGNOU) can be considered international virtual universities.

Local and State/Provincial Governments
Relative to buying behavior, the local and state/provincial governments vary widely across the planet. The one common thread is the impact of training budget cuts induced by slowing economies in many countries in the world. Education and training budgets have been dramatically reduced except for training for public safety personnel.

One common adoption of learning technology in local and state governments around the world is electronic tests related to obtaining a driving license. Government agencies pay custom content service providers to create test prep products and usually offer the test prep to citizens for free. The agencies are also converting their paper-based portions of the driving test to electronic formats, which dramatically reduces the costs compared to paper-based tests.

Interestingly, the last recession and the current struggling economy has contributed to a spike in expenditures on learning technology in city and county libraries. Libraries across the globe have been purchasing learning content, particularly around workforce development, to help their patrons...
retrain for new jobs. Language learning content is also popular with library patrons.

As of early 2015, US-based OverDrive (acquired by the Japanese company Rakuten in March 2015), one of the leading digital content suppliers for libraries, had over 15,000 library customers across 21 countries. A significant portion of their online content catalog is educational.

**Federal Governments**

A consistent international pattern is the growing demand for learning technology in government agencies. Federal buy learning products for their civilian employees and military personnel, but they also fund a great deal of technology-based learning initiatives as part of citizen outreach and export programs. For example:

- The South Korean government subsidizes a great deal of online learning. For example, the government's Cyber Home Learning System is essentially a national virtual school. The government also actively promotes domestic learning technology suppliers in foreign markets.

- Colombia's National Learning Service (SENA) awarded Rosetta Stone a million dollar contract to provide English language learning to over 100,000 Colombian citizens.

Brazil won the competition to host two major games: The 2014 World Cup and the 2016 Summer Olympics. Brazil's Ministry of Tourism awarded EF's Englishtown a multimillion dollar multi-year contract to provide online language learning to the country's tourism professionals.

EF delivered English language training to "110,000 Rio 2016 staff as well as to over 900,000 candidates for the Olympic volunteer program, contractors, and school children in Brazil. In total, more than 1,000,000 people were trained, making this the world's largest language training program."

South Korea is ramping up English training in preparation for the 2017 FIFA World Cup and the 2018 Winter Olympics. The 2017 FIFA World Cup (Soccer) will be held in six cities across South Korea.
PyeongChang has been selected to hold the 2018 Winter Olympics. The cities are spending a significant amount of money on training tourism and public safety personnel in foreign languages, particularly English.

Japan will host the 2020 Summer Olympics and Paralympic Games. It is likely that Japan will replicate the buying behaviors of Brazil and the Russian Federation and spend a great deal of money on online English training for hospitality, public safety, emergency medical, and tourism personnel starting in the 2018 timeframe. Both South Korea and Japan intend to have operational 5G networks in time for the events.

Corporations and Businesses
Large companies (particularly in the US) were early adopters of learning technology and during the current gradual economic recovery they are reducing their expenditures on all types of training and education products. On the other hand, small and medium-sized businesses (SMB) are migrating away from classroom products to a range of learning technologies.

The current economic conditions are influencing the growth rates of expenditures on specific types of content. Companies tend to calibrate budgets for certain types of content during economic recoveries, increasing expenditures in some areas and decreasing them in others.

One major change in the global corporate learning technology markets that emerged in 2015 and 2016 is the presence of next-generation augmented and virtual reality educational products for industrial workers. Corporations once resisted Game-based Learning but that is fading fast.

Until recently, Game-based Learning was perceived to be incompatible with the corporate culture and very time consuming and expensive to develop. This has changed dramatically in just the last two years. Game-based recruiting and job application assessments are rapidly gaining traction in the corporate segment and creating the breakthrough moment for the uptake of Game-based Learning by corporations and businesses.

Several of these new learning products utilize sophisticated psychometrics that yield statistically-sound quantitative learning results. The science of psychometrics is the core measurement method used in all the major professional certifications and this is the game type that has overcome the corporate resistance.

For more information about this research, email: contact@metaari.com
Proof of the growing corporate demand for Game-based Learning can be found in the success of corporate-facing companies. A company called Gamelearn was founded in 2008 in Spain. In July 2016, the CEO reported that "Our results were spectacular. We increased our website traffic tenfold, developed a new product launch plan, collaborated with HR directors of multinational companies, and positioned Gamelearn as an industry leader. Now Gamelearn boasts thousands of clients from Burger King to Hyundai, and hundreds of thousands of satisfied users." One factor the company cites for their success is a 90% completion rate among their clients. This is extraordinary considering the notoriously high dropout rates (50-70%) for legacy learning technology products like Self-paced eLearning.

A corporate-facing Game-based Learning company called mLevel obtained $5 million in funding in July 2015. GamEffective also serves the corporate segment and garnered $7 million in private investment in June 2016. Between them, they have dozens of high-profile clients including Microsoft and Yahoo! that use their product for product rollouts, sales training, employee alignment, and customer service.

This is more evidence pointing to the uptake of edugames in the corporate segment. Investment interest in corporate-facing edugame developers is very new in the industry. And an indication that they expect returns on their investments.

**Learning Technology Product Definitions**

Metaari provides market forecast research for eight pedagogically-defined learning products. Metaari defines three of these products as legacy products and five as next-generation products.

Legacy products include:
- Self-paced eLearning (courseware)
- Digital Reference-ware (digital eTextbooks, instructional audio, lecture video, diagrams, maps)
- Collaboration-based Learning (live online classes and live tutoring)

Next-generation products include:
- Simulation-based Learning (including AR and VR products)
- Game-based Learning
- Cognitive Learning (behavior modification)
- Mobile Learning
- Robotic Tutors

For more information about this research, email: contact@metaari.com
The growth rates and revenues for the three legacy learning technology products (Self-paced eLearning, Digital Reference-ware, and Collaboration-based Learning) are in steep decline. This is why Metaari does not forecast revenues for legacy learning products.

These are the most mature learning products on the market and despite vendor claims to the contrary, there have been no major innovations to these legacy products in decades. All three combined generated $55.5 billion in global revenues in 2016.

By 2021, the combined revenue of the three legacy product types will drop to $40.7 billion, with $33.4 billion of that being generated by the sales of Self-paced eLearning products (down precipitously from the $46.6 billion in 2016).

Due to the steep decline in the global eLearning market, the 2021 global learning technology market (across all eight products) will only reach $84.3
billion by 2021. The global five-year growth rate for all eight products combined is essentially flat at 2.0%.

Table 2 - Worldwide 2016-2021 Five-year Revenue Forecasts for Eight Learning Technology Product Types (in US$ Millions)

<table>
<thead>
<tr>
<th>Learning Technology Product Type</th>
<th>2016 Global Revenues (in US$ Millions)</th>
<th>2021 Global Revenues (in US$ Millions)</th>
<th>5-year Compound Annual Growth Rate (CAGR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-paced eLearning (courseware)</td>
<td>$46,674.67</td>
<td>$33,498.21</td>
<td>-6.4%</td>
</tr>
<tr>
<td>Digital Reference-ware</td>
<td>$4,702.32</td>
<td>$4,037.39</td>
<td>-3.0%</td>
</tr>
<tr>
<td>Collaboration-based Learning (live online classes)</td>
<td>$4,210.17</td>
<td>$3,200.71</td>
<td>-5.3%</td>
</tr>
<tr>
<td>Simulation-based Learning</td>
<td>$5,167.87</td>
<td>$11,310.43</td>
<td>17.0%</td>
</tr>
<tr>
<td>Game-based Learning (edugames)</td>
<td>$2,661.96</td>
<td>$7,324.84</td>
<td>22.4%</td>
</tr>
<tr>
<td>Cognitive Learning</td>
<td>$992.98</td>
<td>$3,123.37</td>
<td>25.8%</td>
</tr>
<tr>
<td>Mobile Learning</td>
<td>$11,314.16</td>
<td>$19,968.91</td>
<td>12.0%</td>
</tr>
<tr>
<td>Robotic Tutors</td>
<td>$507.14</td>
<td>$1,841.36</td>
<td>29.4%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$76,231.27</strong></td>
<td><strong>$84,305.21</strong></td>
<td><strong>2.0%</strong></td>
</tr>
</tbody>
</table>

In sharp contrast, the growth rates for Simulation-based Learning, Game-based Learning, Cognitive Learning, Mobile Learning, and Robotic Tutors are very healthy.

**Legacy Learning Products**

Legacy learning products are characterized by commoditization, the lack of innovation, rapidly declining revenues, and product substitution. They are still the dominant learning products in use across the globe but revenues are dropping fast for legacy products.
The growth rates for the three legacy learning technology products (Self-paced eLearning, Digital Reference-ware, and Collaboration-based Learning) are in steep decline.

Cost-effective Game-based Learning, Simulation-based Learning, Mobile Learning, and Cognitive Learning products are coming on the market at a rapid pace and gaining traction in all the buying segments. AI-based Robotic Tutors are also coming to market quickly.

They are far more effective knowledge transfer methods than eLearning and the learning transfer can be quantified with embedded real-time psychometric measurement tools.

These new products are one of the factors contributing to the rampant product substitution in the eLearning industry. Several of these new products mitigate the need for courseware altogether.

**Self-paced eLearning Courseware**

Metaari defines eLearning as self-paced courseware products. This includes off-the-shelf content, installed learning management platforms and services (content and technology). The defining characteristic of Self-paced eLearning is the pedagogical structure imposed by formal instructional design and systematic development of the products.

There is a significant degree of "resistance" to traditional packaged Self-paced eLearning content in various regions, particularly in Asia, the Middle East, and Africa. This resistance is often due to the fact that content is translated, but not localized. Additionally, the systematic instructional design process pioneered in the US results in a very distinct product design and a user experience that does not resonate in many countries.

Also, in Mobile-only countries, there is virtually no market for legacy courseware. Additionally, new next-generation products are much more effective in the knowledge transfer and learning transfer process.

There has been no significant innovation in eLearning for decades and now the product revenues are in steep decline. The global market is characterized by commoditization and severe pricing pressures. Investors are shying away from these companies and buyers are migrating to next-generation products.

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The one major bright spot for eLearning is the demand for Managed Learning Services. Managed services (School-as-a-Service) are provided by commercial third-party suppliers. These managed services are usually turnkey bundles that include content design, content development, cloud-based hosting and delivery, and most importantly, 24/7 technical support; all at a fraction of the cost that the institutions would spend if they did it themselves.

The global managed education and training services suppliers are generating significant revenues and the leading suppliers are reporting annual growth rates between 18-37%.

Managed education services (also called online program management and edtech program management) in the PreK-12 and higher education segments and managed training services in the corporate segments across the globe are bright spots for the eLearning industry in terms of revenues for a handful of companies but also one the factors driving overall revenues down.

When organizations and institutions outsource their online programs, they no longer have to buy their own content, tools, or platforms. They also do not have to pay to maintain and support systems. The business decision by institutions to use managed services is relatively risk free as the managed services suppliers takes a percentage of the tuition paid by students. There are very few, if any, upfront costs for institutions.

**Digital Reference-ware**

Metaari defines Digital Reference-ware as digital video, text, or audio reference content. This product type includes academic content, "how to" content, technical reference, scientific abstracts, medical research, and market research content. Digital audiobooks, eBooks, eTextbooks, dictionaries, video courses, maps, diagrams, schematics, and online technical manuals are common formats.

The vast majority of digital learning content in the world still resides in text-based formats. However, there is a surge in the demand for other types of digital reference media. There is an explosion of peer and user-generated content ranging from Wikipedia-like products, user-populated search engines, podcasts, and "how-to" videos. Likewise, the rapid digitization of academic content around the world is now a major catalyst for the global Digital Reference-ware market.
Digital Reference-ware is seldom interactive, at least in the sense that it is designed for active knowledge and learning transfer. The product is usually a "one-way" information transfer. A mastery test can be given to a user after they consume reference-ware, built it is very difficult to quantify learning transfer without using psychometric-based tests.

This legacy product type is now under siege by the explosion in the amount of free content. It is very difficult to sell Digital Reference-ware when free products are readily available. Suppliers that do generate revenues usually adopt an advertising business model. This is common in consumer health and wellness portals.

**Collaboration-based Learning**

Collaboration-based Learning is human-to-human collaboration and mentoring. As a knowledge-transfer method, by definition, collaboration requires the interaction between two or more people. Consequently the use of *synchronous* collaboration platforms is the defining pedagogical characteristic of Collaboration-based Learning.

Metaari defines Collaboration-based Learning products sold via the hosted SaaS model as Technology Services in our market research. Access to the products is sold as a service and customers do not actually own the products.

There are five specific types of Collaboration-based Learning platforms:

- Remote assistance and screen-sharing tools
- Virtual labs
- Virtual classrooms and virtual learning environments (VLE)
- General-purpose collaboration platforms used for learning
- Classroom collaboration management systems

With the exception of classroom collaboration management systems, which to date, are usually sold as installed solutions; Collaboration-based Learning can all be sold either as hosted cloud-based solutions or as installed platforms.

Collaboration-based Learning shares one disadvantage in common with physical classroom training: the so-called prevalence of the Pygmalion Effect. The theory maintains that high expectation can lead to higher
performance. But the opposite is also true. If a teacher holds lower expectations for particular students, the performance is poor.

This legacy product is now highly commoditized with many free collaboration tools available on the market. Microsoft's Skype is the most common tool used for Collaboration-based Learning on the planet.

In most cases, it is difficult to quantify learning transfer without delivering a psychometric-based test. The one major exception is live language learning sessions. Learning transfer is demonstrated by fluency in conversations between the student and the tutor.

**Next-generation Learning Products**

Metaari defines five distinct types of next-generation learning products. Each of them have high growth rates and their combined revenues will outpace the combined revenues for legacy products by 2012.

**Simulation-based Learning**

There are distinct pedagogical differences between Simulation-based Learning and Game-based Learning. There is confusion in the marketplace with practitioners and suppliers using the terms interchangeably.

The definitions of Simulation-based Learning and Game-based Learning in our taxonomy are based on the research done by Alessi and Trollip. In their seminal work entitled, "Computer Based Instruction: Methods and Development," they identified five types of computer-aided instruction (CAI): drills, tutorials, simulations, instructional games, and tests. Alessi and Trollip define four types of Simulation-based Learning:

- Physical Object and Environmental
- Process
- Procedural
- Situational

The researchers compressed these four into two instructional strategies: **learning about something** (physical and process), and **learning to do something** (procedural and situational). These can be restated in instructional terms as knowledge-based and performance-based simulations.

For more information about this research, email: contact@metaari.com
Metaari's Learning Technology Research Taxonomy, Research Methodology, Product Definitions, and Licensing Model

Metaari does not include high-end military, aviation, and heavy equipment simulator revenues in our forecasts. The barriers to entry are quite high to develop and market these machines and only a handful of suppliers can compete in the simulator market.

**Virtual Reality (VR) Educational Products Hit the Market**

The second wave of virtual reality educational products starting hitting the market in 2015. By October 2015, Google announced that Cardboard had been downloaded over fifteen million times. Cardboard viewer kits in just one year. In October 2015, the New York Times distributed an additional one million Cardboard viewers to their subscriber base.

Google started offering schools a free bundle called Expeditions based on the low-cost Cardboard VR technology in May 2015. As of November 2015, over 100,000 PreK-12 students in the US were using the platform. The bundle comes with smartphones for the students, the cardboard (literally) viewer, and a tablet for the teacher preloaded with a variety of field trips. The teacher selects the expedition on the tablet and all the students experience it simultaneously in the VR viewers. Google announced that it was working with the Planetary Society, the American Museum of Expeditions, and the Palace of Versailles on content for Expeditions.

A company called WEARVR operates a VR App marketplace. They have several categories related to learning including educational, architecture, travel, exploration, space, and virtual worlds. They support all the major VR headsets. They publish a weekly top-ten list and educational apps consistently rank in the top ten. WEARVR obtained $1.5 million in private equity in March 2015. One of the most popular VR apps according to WEARVR is DinoTrek designed for Google Cardboard and developed by Geomedia and HIVE VR.

Suppliers are already meeting the growing demand for VR-based learning for young children and students in the early grades. Google and Mattel announced a partnership in February 2015 to launch a smartphone enabled product for the iconic View-Master that displays animated virtual learning experiences when the viewer is pointed at a physical "experience reel" (a physical disk-shaped trigger). The device shipped in October 2015.

The reel triggers a virtual reality experience on Cardboard's smartphone display. "Mattel's new View-Master offers an easy-to-use and affordable platform that will enable users to take engaging field trips where they can explore famous places, landmarks, nature, planets, and more in 360 degree
'photospheres'. By pairing the View-Master's 'experience reel' and app with an Android smartphone, kids will immediately experience an imaginative and interactive learning environment."

**Augmented Reality (AR) Learning Products are Game Changers**

Augmented reality (AR) technology is evolving at a fast pace; new commercial innovations are coming on the market at a rapid rate. The products are too new and it is too early to make forecasts until a baseline emerges. Mobile AR is an ideal technology for Mobile Learning and there are dozens of new products on the market.

Augmented reality and virtual reality are not the same. In AR, digital information is overlaid on the real world. In virtual reality, the user is totally immersed in a simulated environment. Almost all AR educational products on the market are mobile and Metaari categorizes AR-based learning products as a native type of Mobile Learning. VR-based learning products are by definition a type of Simulation-based Learning.

Mobile augmented reality (AR) overlays images, schematics, multimedia, 3D objects, animation, location data, and other forms of digital content on real-world objects and locations using the device’s camera and sensors; most AR content is interactive.

The augmented elements are "triggered" by object recognition, print-based markers, barcodes, and geotags (collectively these are known as triggers). Mobile augmented reality educational apps emerged in 2010 and had a rocky start. The demand diminished in 2012-2013, but came roaring back in 2014 and the first half of 2015. This is due to the proliferation of new AR hardware and software being developed and marketed by large companies like Microsoft, Sony, Google, Intel, Apple, and Qualcomm and the booming demand for industrial and field-based augmented reality learning in the corporate segments across the planet.

Until recently, the most successful mobile augmented reality learning apps were consumer-facing Mobile Learning products for astronomy, anatomy, and tourism. Popular augmented Mobile Learning apps include Star Chart with 18 million global users and Star Walk with 10 million users across the planet.

All of the major mobile players are now in the augmented reality market; they have entered the market by acquisition and internal product development. In May 2015, Apple acquired Germany-based Metaio.
developed the popular augmented reality platform called Junaio; this is a strong validation of the AR market. The vast majority of apps developed with Junaio are travel and tourism guides.

The major advantage augmented reality has in training is quantifiable performance support. In July 2015, Boeing shared the results of an internal study on the assembly of a wing unit using three groups; one group with paper PDF instructions, one group with the PDF instructions on a tablet, and one group with AR objects and guided instructions overlaid on the assembly on a tablet screen. "The AR-tablet group were 30 percent faster and 90 percent more accurate on their first tries than the other groups."

**Game-based Learning**

Game-based Learning is a knowledge transfer method that utilizes "gameplay," which includes some form of competition (against oneself or others) and a reward/penalty system that essentially functions as an assessment method. Game-based Learning products (edugames) have explicit pedagogical goals. A user "wins" an edugame when they achieve the learning objectives of the gameplay.

All educational games are designed for behavior modification (learning), pedagogical intervention, or cognitive remediation. The first two are well known but the third is relatively new.

There are remediation edugames designed to alter behavior attributed to developmental or cognitive challenges (such as dyslexia.) There are also remediation edugames used to strengthen appropriate (and mitigate inappropriate) behavior in areas of health and wellness, diversity, conflict management, team building, and leadership.

Virtual worlds designed for children often embed edugaming in semi-immersive environments. Whyville, JumpStart, and Mingoville are good examples of virtual worlds that include edugames designed for children. Most virtual worlds for children under ten include edugames.

Virtual worlds that embed edugames illustrate the difference between Simulation-based Learning and Game-based Learning. The "environment" is indeed simulated but the knowledge transfer method is game-based. In Simulation-based Learning, the simulation itself is the knowledge transfer method.
Definition of Game-based Learning
In Metaari's Research Taxonomy, Game-based Learning is defined as a knowledge transfer method that utilizes "game play" comprised of some form of competition (against oneself or others), increasing levels of complexity, and a reward/penalty system that essentially functions as an assessment method. Game-based Learning is often linked to the constructivism theory of education, defined as the process of Experiential Learning, Discovery Learning, and Situated Learning.

Figure 7 - The Ten Types of Edugames in Metaari’s Pedagogical Framework

The instructional concept of scaffolding is an inherent component of Game-based Learning. "Scaffolding refers to a variety of instructional techniques used to move students progressively toward stronger understanding and, ultimately, greater independence in the learning process." In Game-based Learning, learners are introduced to greater levels of complexity once they master the current level, which is by definition a scaffold.

Metaari categorizes ten types of edugames mapped to the domains in Bloom's Taxonomy and Gagné's Conditions of Learning Theory; the most widely used educational taxonomies in the education and training industry.
The taxonomies are used by the majority of academic, government, and corporate instructional designers.

Bloom identified three learning domains: Cognitive, Affective, and Psychomotor. Most classroom-based instruction is based on the six processes in the Cognitive Domain: remembering, understanding, applying, analyzing, evaluating, and creating (formerly called synthesizing). The Affective Domain deals with the emotional processes involved with learning. The more sophisticated brain trainers and behavior modification products map to the Affective Domain.

Bloom's Psychomotor Domain deals with physical mind-body learning and motor skills. Sports training is a good example. Until the advent of Location-based Learning and virtual reality edugames, edugames based on the Psychomotor Domain were non-existent.

Gagné's Conditions of Learning Theory identifies five categories of learning: intellectual skills, cognitive strategies, verbal information, motor skills, and attitudes. His work is best known for his Nine Steps of Instruction (also known as the events of instruction) that are deployed by instructional designers that develop content and by teachers and trainers in the classroom. The use of Gagné's nine steps is endemic in all systematic approaches to instructional design (SAID) widely used in organizational training and education scenarios. The nine steps are:

1. Gain attention
2. Inform learners of objectives
3. Stimulate recall of prior learning
4. Present the content
5. Provide learning guidance
6. Elicit performance (practice)
7. Provide feedback
8. Assess performance
9. Enhance retention and learning transfer to the job

All nine steps are closely related to classical game theory that implements similar steps in an implicit manner. Instructional designed implement the nine steps in an explicit manner. Gagné's model is not only used to develop and deliver learning, it is also used to evaluate the effectiveness of the instruction. This allows designers and teachers to tweak the material to improve learning outcomes. It is well known in the training and certification industry that collective pass rates on certification exams below 50% or above 90% indicate serious problems with the training content.
Game-based Learning products can also be classified as enabling declarative or procedural knowledge (knowing and doing). Declarative knowledge is knowledge about facts and can usually be verbalized and tested. Procedural knowledge involves how to perform mental or physical tasks.

Game-based Learning products have explicit pedagogical goals. A user "wins" an edugame when they achieve the learning objectives of the gameplay. All educational games are designed for behavior modification, pedagogical intervention, and/or cognitive remediation. The first two are well known but the third is relatively new.

**Table 3 – Ten Mobile Edugame Types Mapped to Knowledge Transfer Methods, Domains in Bloom's Taxonomy, and Gagné’s Category of Learning**

<table>
<thead>
<tr>
<th>Game-based Learning Product Type</th>
<th>Primary Knowledge Transfer Methods</th>
<th>Bloom's Taxonomy Domain</th>
<th>Gagné's Category of Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive edugames &amp; brain trainers</td>
<td>Psychometrics</td>
<td>Affective</td>
<td>Cognitive Strategies, Attitudes</td>
</tr>
<tr>
<td>Knowledge-based games</td>
<td>Behaviorism, Mnemonics</td>
<td>Cognitive</td>
<td>Intellectual Skills, Verbal Information</td>
</tr>
<tr>
<td>Skills-based games</td>
<td>Constructivism</td>
<td>Cognitive</td>
<td>Cognitive strategies</td>
</tr>
<tr>
<td>Language learning games</td>
<td>Connectivism</td>
<td>Cognitive</td>
<td>Intellectual Skills, Motor Skills</td>
</tr>
<tr>
<td>Early childhood learning edugames</td>
<td>Social Cognition Learning</td>
<td>Affective</td>
<td>Verbal Information</td>
</tr>
<tr>
<td>Assessment and evaluation edugames</td>
<td>Psychometrics</td>
<td>Affective</td>
<td>Cognitive Strategies</td>
</tr>
<tr>
<td>Experiential role-playing edugames</td>
<td>Experiential Learning</td>
<td>Affective</td>
<td>Cognitive Strategies, Attitudes</td>
</tr>
<tr>
<td>Location-based learning edugames</td>
<td>Situated Learning</td>
<td>Psychomotor</td>
<td>Attitudes</td>
</tr>
<tr>
<td>Augmented reality edugames</td>
<td>Connectivism</td>
<td>Cognitive</td>
<td>Intellectual Skills, Motor Skills</td>
</tr>
<tr>
<td>Virtual reality edugames</td>
<td>Kinesthetic Learning, Experiential Learning, Observational Learning</td>
<td>Psychomotor</td>
<td>Intellectual Skills, Motor Skills</td>
</tr>
</tbody>
</table>

There are remediation-based edugames designed to alter behavior attributed to developmental or cognitive challenges (such as dyslexia, anxiety disorders, phobias, PTSD, and attention deficit.) There are remediation
edugames that are also used to strengthen appropriate (and mitigate inappropriate) behavior in areas of health and wellness, diversity, conflict management, team building, and leadership.

So-called virtual worlds (that are not actually virtual) that embed edugames illustrate the difference between Simulation-based Learning and Game-based Learning. The "environment" is indeed simulated but the knowledge transfer method is game-based. In Simulation-based Learning, the simulation itself is the knowledge transfer method.

**Cognitive Edugames and Brain Trainers**

Second and third-generation brain trainer and brain fitness games in the 2016 market are based on cognitive science, neuropsychology, and brain-based learning theories emerging from educational psychology and educational neuroscience. It is an instructional method that targets the neuro-physiological processes involved in learning and has little in common with traditional instructional design principles.

They are meta-cognition products that enable users to modify cognitive behavior (learn) by understanding and manipulating the learning process itself. Meta-cognition was defined by the educational psychologist John W. Santrock in 2008 as the information process that, "includes knowledge about when and where to use particular strategies for learning or for problem solving."

Researchers and suppliers have a growing body of empirical evidence to show that people who use brain training products can condition and train the brain to improve memory, attention, visual and spatial awareness, auditory processing, linguistic skills, planning skills, and problem solving. Despite criticism of the effectiveness of brain trainers, there is empirical evidence proving otherwise.

Perhaps the most persuasive evidence is the research done by Jaeggi on the use of so-called dual n-back tasks in brain training. The dual n-back tasks require users to process information simultaneously from two different sensory domains. She found that performing dual n-back tasks "accrues transferable benefits in Gf (fluid intelligence), over and above any gains in working memory capacity. This finding merits particular attention because Gf has traditionally been viewed as highly heritable and stable and is positively correlated with a large number of desirable outcomes including academic success, and neurological, psychological and physical health."
Jaeggi's research has been replicated by other researchers. "These findings constitute preliminary evidence that intensive cognitively demanding brain-training can improve not only our abstract problem-solving capacity, but also ameliorate cognitive control processes (e.g. decision-making) in our daily emotive environments." (National Center for Biotechnology)

As of June 2016, there are dozens of brain trainers on the market that use the n-back method. The majority of these edugames are mobile apps. Many are free and offer fee-based premium content. BrainScale.net provides a free brain trainer based on the n-back method and sells subscription-based premium upgrades for $2.99 a month or $14.99 a year.

**Knowledge-based Edugames**

Handheld and mobile knowledge-based learning games are designed to help users learn and memorize concepts, principles, facts, patterns, and rules (such as verb conjugation.) These edugames are often designed as quizzes, flashcards, mnemonic apps, or trivia games. They are increasingly being used in museums and tourist attractions to impart knowledge about the exhibits.

The pedagogical foundations of mnemonic apps and flashcard software are instructional methods called elaborative encoding and spaced repetition. Elaborative encoding is a mnemonic technique that maps information to pre-existing memories and knowledge. The mapping can be visual imagery, spatial landscapes and architectural structures, or audio anchors. One of the most common forms of elaborate encoding is the visualization of objects inside structure where the user "pins" information on objects in the structure. The user can recall the information by "walking" through the structure.

Spaced repetition is a memorization method that parses information out in sequentially longer periods of time (interval reinforcement at graduated intervals). For example, a foreign language word is presented once a week for two weeks, then once every two weeks. The theory maintains that retention is enhanced by spreading out the display across time.

Spaced repetition is a common component of language learning apps and particularly useful for learning vocabulary. Spaced repetition is also used in medical schools where students must learn a great deal of information in relatively short timeframes.
According to professor Henry L. Roediger, the co-author of *Make It Stick: The Science of Successful Learning*, "Retrieving knowledge from memory is more beneficial when practice sessions are spaced out so that some forgetting occurs before you try to retrieve again. The added effort required to recall the information makes learning stronger. It also helps when retrieval practice is mixed up — whether you’re practicing hitting different kinds of baseball pitches or solving different solid geometry problems in a random sequence, you are better able later to discriminate what kind of pitch or geometry problem you’re facing and find the correct solution."

Mobile knowledge-based games are relatively easy to design and there are commercial development tools coming on the market that are making it even easier to develop these games. In September 2015, Muzzy Lane Software announced their new Game-based Learning authoring tool, one of the first commercial Game-based Learning development tools on the market.

Knowledge-based games are now common in primary, secondary, and tertiary institutions. They have been in wide use in the military and are now gaining traction in the corporate segment. All the commercial eLearning authoring tools (like Adobe's Captivate) include game modules.

A common method of compiling new product information for sales people is creating what are known as "battle cards" that include product details and competitive messaging. These can be quite complex. A simple knowledge-based edugame modeled on the Concentration game show is now common in game-based battle cards used by sales organizations.

Knowledge-based edugames are now recognized as effective mnemonic devices. Test prep edugames for standardized exams are in demand in most countries of the world. Medical and nursing students must memorize a great deal of information and it is no surprise that healthcare-related edugames are top sellers in the app stores.

**Skill-based Edugames**

A skill is the ability to apply knowledge in the context of a performance. skill-based games are designed to improve hand-eye coordination, improve performance on physical tasks, and hone psychomotor skills of players. For example, a math game is considered a skill-based game. Memorizing the rules of math is knowledge-based. Applying that knowledge in calculations is a skill. Memorizing facts for a driver's license written test is knowledge-based, while applying those rules in the car is a skill.
The most innovative skill-based edugames on the market in 2016 use robots as an integral part of the edugame. South Korean operator SK Telecom sells the smartphone-enabled Albert robot bundled with the Smart Robot Coding School training program developed by SK Telecom teach children how to develop software. The product bundle has been sold to schools in South Korea, Spain, France, Brazil, Colombia, Taiwan, and Malaysia. In May 2016, SK Telecom signed an MOU with the Central State Government of Paraguay to supply 10,000 units of the smart learning robot to schools in the country.

Many new educational robots designed to teach kids programming and related skills have entered the market over the past year including the Vortex, the Kamibot, the Fisher-Price Code-a-Pillar, Codeybot, Aisoy, Ozobot, and CogniToys' Dino

CogniToys' robot is integrated with the IBM Watson AI-based machine learning platform. "The CogniToys Dino grows with children by listening to their questions and in turn, adapting to their age and educational abilities. Recommended for kids ages 5 to 9, CogniToys have custom content modules such as questions and answers, storytelling, and games that include vocabulary, math and more to engage children in educational play."

These companies are attracting a significant amount of venture capital. A company called Wonder Workshop (formerly Play-i) has obtained $35.9 million in funding since 2013 include a $20 million investment in late July 2016. They make the educational robots Dot and Dash that are designed to teach children coding.

**Language Learning Edugames**

Memorizing foreign words is knowledge-based, while using those words in speech and writing is a skill. Metaari breaks out language learning edugames for suppliers because they are part of the greater language learning market and a very distinct revenue opportunity.

This type of mobile edugame has been a staple in the Japanese market and now games like this are being adopted across the planet. The language "coaching" games for the Nintendo devices are good examples of this genre. Speech recognition and real time translation are now being used in the more sophisticated language learning games.
Language learning games are commonly used in the early grades in primary school, but there are language learning games designed for all age groups.

As of July 2016, the vast majority of language learning edugames are mobile and consistently rank in the top twenty best-selling educational apps in almost all the 122 countries tracked by Metaari.

**Early Childhood Learning Edugames**

Edugames for very young children under four years old are quite unique. They focus on shapes, sounds, music, colors, numbers, letters, hand-eye coordination, movement, and spatial awareness. Most of them use cartoon characters that interact with the children.

Fingerprint sells a mobile early childhood learning education platform and has over 200 developer partners in over 40 countries. Their white-label platform allows major brands to get educational games up and running quickly. Well-known brands that use the Fingerprint platform include Mattel, National Geographic, Toca Boca, Sylvan Learning, TinyTap, US-based BabyBus, PBS KIDS, and Nickelodeon. By March 2016, they had over 2,000 apps for kids on the platform and announced in the press that they expected to double this by the end of 2016.

TinyTap is similar to the Fingerprint platform. They have a free version that enables rapid development of mobile edugames. Their subscription-based TinyTap Go Pro product is a vetted library of edugames built by teachers.

In October 2015, Samsung launched a new subscription-based educational service for children built on Fingerprint's platform. The service runs on the Galaxy Tab 3 Lite tablet and provides "fun and educational content children will love, while offering parents the peace of mind that comes with a safe, ad-free, mobile environment for their children.

The content is provided by the major educational publishers including DreamWorks Animation, The Jim Henson Company, Highlights for Children, Cengage Learning's National Geographic, PBS KIDS, and Sesame Workshop.

One of the most successful early childhood learning suppliers is Age of Learning, which sells the immensely popular ABCmouse app. Their app consistently ranks in the top best-selling educational apps in over 100 countries in the world. They garnered an unprecedented $150 million in
private equity in May 2016; this is the highest amount invested in a Game-based Learning company in the history of the learning technology industry.

**Assessment and Evaluation Edugames**

Assessment edugames evaluate the user on knowledge and skills in a particular domain. These are quite common in test prep for standardized exams and in recruitment and employee performance evaluations. The knowledge transfer is usually embedded in the score that defines the level of ability; players learn about themselves.

Barclays recently released a mobile stock-trading edugame called Stockfuse, developed by SHFuse to attract and evaluate potential job applicants. "The game allows users to practice trading skills and, if their virtual portfolio performs well enough, win a conversation with a Barclays Markets professional." More than 4,500 college students have played the game and dozens have received job offers from Barclays.

A wave of new companies have entered the market for corporate-facing edugames in the last 2-3 years selling products based on psychometrics used to assess the abilities of job recruits.

A company called Scoutible launched in May 2016. They have developed a gaming platform that combines gameplay with job hunting. "The company aims to improve hiring and retention by using immersive games to find the right candidate for different positions. Scoutible offers users the chance to play a 20-minute game to learn about themselves. It uses proprietary game technology from Harvard and Stanford that learns from the player’s unique actions in the game to measure their skills and discover their talents."

An Australian company called Revelian sells an job recruit assessment edugame called Theme Park Hero. "Theme Park Hero is underpinned by a validated predictive psychometric framework. This means the reports you receive will contain valuable, reliable information to reveal which people on your shortlist have high potential." In May 2015, Revelian's CEO stated in the press that the company was generating $10 million in annual revenues.

**Experiential Role-based Edugames**

Players take on the role of particular characters (fictional or real) in role-based edugames. Players interact with the game in that role. These are found in edugames developed for all of the segments and for players of all ages.
Role-playing edugames are by definition a form of Experiential Learning, also known as Discovery Learning.

Experiential Learning is a learning theory developed by David A. Kolb. The theory posits a cyclical model of learning consisting of four phases: concrete experience (doing), reflective observation, abstract conceptualization, and active experimentation.

There are role-playing serious games for business communication, business management, sales, finance, law, customer service, negotiation, conflict resolution, diplomacy, healthcare, cybersecurity, first responder, hazardous waste, disaster recovery, and public safety for adults. Role-playing games for children usually relate to academic subjects, particularly civics, health, math, history, and science.

Role-based edugames are common in so-called Games for Good, or humanitarian and environmental games. Filament Learning (a division of Filament Games) sells range of role-playing edugames for a variety of academic subjects including biology, astronomy, math, archeology, and civics.

**Location-based Learning Edugames**

Location-based Learning is one of the "native" types of Mobile Learning defined by Metaari. This new Mobile Learning type emerged in 2009. Developers are designing learning experiences triggered at geotagged physical locations and in time. Interestingly, the time-based triggers can provide learning experiences relating to the past, present, or future.

Location-based Learning suppliers have been leveraging the technology innovations that have been driving location-based services (LBS) from 2-D and 3-D bar-code services to mobile augmented reality technologies; and have taken advantage of proximity marketing—the localized wireless distribution of content.

RFID chips, GPS chips, barcodes, SMS short codes, image recognition, and augmented reality technologies are often used in Location-based Learning games, particularly in clinical healthcare environments, first responder situations, consumer and patient education, museums, galleries, tourist attractions, navigation applications, and in the travel industry.
Location-based Learning products are used in many venues, particularly in clinical healthcare environments, first responder incidents, consumer and patient education, museums, tourist attractions, parks, and exhibitions.

**Figure 8 - Mobile Location-based Learning: Proximity Triggers Knowledge Transfer**

Tour and exhibition guides are among the fastest growing type of Location-based Learning. Suppliers create their own apps to sell directly to consumers and offer a range of custom content services for organizational buyers that provide museum tours, gallery tours, history tours, nature tours, and city tours to tourists and patrons.

**Augmented Reality Edugames**

Virtually all of the augmented reality edugames on the market are mobile. Mobile augmented reality (AR) overlays images, schematics, multimedia, 3D objects, animation, location data, and other forms of digital content on real-world objects and locations using the device’s camera and sensors; most AR content is interactive.

Augmented reality and virtual reality are not the same, although the distinction is becoming less clear. In AR, digital information is overlaid on the real world. In virtual reality, the user is totally immersed in a simulated environment. Almost all AR educational products on the market are mobile.

For more information about this research, email: contact@metaari.com
and Metaari categorizes AR-based learning products as a native type of Mobile Learning.

The augmented elements are "triggered" by object recognition, print-based markers, barcodes, and geotags (collectively these are known as triggers). Mobile augmented reality educational apps emerged in 2010 and had a rocky start. The demand diminished in 2012-2013, but came roaring back in 2014 and the first half of 2015. This is due to the proliferation of new AR hardware and software being developed and marketed by large companies like Microsoft, Sony, Google, Intel, Apple, and Qualcomm and the booming demand across the planet for industrial and field-based augmented reality learning in the corporate segments.

Until recently, the most successful mobile augmented reality learning apps were consumer-facing Mobile Learning products for astronomy, anatomy, and tourism. Popular augmented Mobile Learning apps include Star Chart with 18 million global users and Star Walk with 10 million users across the planet.

All of the major technology players are now heavily invested in augmented reality and virtual reality including Google, Apple, and Microsoft. Apple entered the AR market when they acquired Germany-based Metaio in March 2015. This essentially validated the AR market and turned out to be a catalyst for AR.

Although not a game, one of the most sophisticated AR products on the market is DAQRI’s Smart Helmet, which is a hardhat that has a visor that displays procedural data over objects (machinery, construction sites, etc.) as a worker performs job tasks in the field. They are targeting the industrial verticals with the helmet. "Reduce talent and experience gap with repeatable, fully modularized, and contextualized training capturing experts’ knowledge and experience; avoid costly human teaching errors with the use of precise data driven decision-support training." This product merges the knowledge transfer and learning transfer processes into a simultaneous experience.

**Virtual Reality Edugames**

VR-based learning products are by definition a type of Simulation-based Learning and the latest innovations utilize mobile devices placed inside viewer headsets. Many education suppliers define their products as virtual, despite the fact that they are not truly virtual. For example, screen-based virtual worlds are semi-immersive. Essentially all of the virtual worlds for
young children include edugames. Whyville, Math Blaster, and Mingoville are good examples. Mingoville is a "virtual" world that teaches English to children. Metaari defines these products as Simulation-based products since they are not immersive.

The latest innovations in VR edugames are 100% immersive and experienced while wearing a headset or using a 3D viewer like Google's Cardboard or Samsung's Gear. These new immersive Game-based Learning products are what Metaari defines as virtual reality edugames.

In January 2015, the game developer Nival launched a new division called NivalVR that focusses on mobile educational VR games. Their first game was inMind and their inCell app came out in September 2015. The edugames cost $6.

Cerevrum "is a cutting-edge software development group with a focus on progressive educational VR projects." Their first VR edugame was a brain trainer. "Cerevrum helps you learn and improve cognitive abilities in virtual reality. Cerevrum is rethinking learning itself and designing fun VR neurogaming experiences."

In June 2016, Google released the commercial version of their Expeditions Cardboard VR platform. "Google has over 200 expeditions available right out of the gate, all of which have dedicated pieces of information that you can listen to and watch while exploring the area."

In this report, revenue forecasts are not provided for mobile VR edugames. This type of edugame is too new to establish baselines for calibrating revenue forecasts. For a new product on the market, it typically takes 2-3 years to establish revenue baselines. It should be noted that augmented edugames were surrounded by hype in 2010, but sputtered with slow growth until reinvented in 2015. What is different for VR-based education products is the presence of the major technology players in the market including Google, Apple, and Microsoft.

In July 2015, a company called Touchstone Research released the results of a survey of 500 children on the topic of VR. 79% of the kids were aware of VR. But the interesting thing is what they said they wanted to do with VR: 64% wanted to visit another country, 64% wanted to go someplace they could not go in reality (like space or another planet), 62% wanted to go on an adventure, and 58% wanted to travel back in time (not surprisingly, most of them wanted to go back to see dinosaurs in their natural surroundings.)

For more information about this research, email: contact@metaari.com
This is invaluable information for suppliers developing educational VR apps for children.

**Cognitive Learning**

Webster's Dictionary defines learning as "modification of a behavioral tendency by experience." Technology-based Cognitive Learning products are behavior modification products designed to improve or enhance perception, working memory, comprehension, emotional states, decision making, fluid intelligence (general problem solving), and reasoning.

They are meta-cognition products that enable users to modify cognitive behavior (learn) by understanding and manipulating the learning process itself. Behavior modification is a fundamental component of learning theory. Learning and behavior modification are synonymous; **behavior modification is structured learning.**

Meta-cognition was defined by the educational psychologist John W. Santrock in 2008 as the information process that, "includes knowledge about when and where to use particular strategies for learning or for problem solving."

Note: Cognitive Edugames and Brain Trainers is one of the few product types in Metaari's Research taxonomy that are included in two product categories: Game-based Learning and Cognitive Learning

There are six primary types of Cognitive Learning products on the market including:

- Cognitive Edugames and Brain Trainers
- Psychometric-based Assessment and Evaluation Products
- AI-based Cognitive and Intelligent Tutors
- Social and Emotional Learning (SEL) Platforms
- Cognitive Remediation and Behavior Modification Platforms
- AI-based Robotic Cognitive Intervention Products

Brain training and brain fitness products are based on brain-based learning theories emerging from educational psychology and educational neuroscience. Researchers and suppliers have a growing body of empirical evidence to show that people who use the products can condition and train the brain to improve memory, attention, visual and spatial awareness, auditory processing, linguistic skills, planning skills, and problem solving.
The most innovative Cognitive Learning products in the current market are the new assessment and evaluation edugames based on psychometrics. They are rapidly gaining traction in the US corporate segment as they have proven to be efficient and cost-effective job candidate screening tools.

Psychometrics is the science that focusses on statistical measurement of psychological states. Psychometric instruments measure knowledge, abilities, skills, attitudes, and personality traits.

There is a flood of next-generation Cognitive Learning products hitting the market. These new products integrate with a range of technologies including emotion analytics, affective computing, neurosensing, attention network training (also called executive attention network), galvanic skin response (GSR), heart rate variability (HRV), and, most importantly, artificial intelligence.

Cognitive and intelligent tutors are meta-cognition technologies that simulate the behavior of a human mentor and provide personalized responses, remediation, and interventions in real time based on the knowledge, behavior, and cognitive abilities of a particular user.

One of the big game changers for Cognitive Learning is the number of new products that are built on top of IBM's Watson cognitive computing platform. IBM claims that IBM Watson Education "is bringing education into the cognitive era. We are transforming the learning experience through personalization. Cognitive solutions that understand, reason and learn help educators gain insights into learning styles, preferences, and aptitude of every student. The results are holistic learning paths, for every learner, through their lifelong learning journey."

In April 2016, Sesame Street announced a three-year partnership with IBM to develop educational products using IBM's artificial intelligence platform Watson. In the press, IBM stated "As part of a three-year agreement, Sesame Workshop and IBM will collaborate to develop educational platforms and products that will be designed to adapt to the learning preferences and aptitude levels of individual preschoolers. Using Watson's cognitive capabilities, the app will analyze a child's response in real-time and then intervene with content just for that child because each of us learns in a very, very different way."

On their website, the Collaborative for Academic, Social, and Emotional Learning (CASEL) defines Social and Emotional Learning (SEL) as "the process through which children and adults acquire and effectively apply the
knowledge, attitudes, and skills necessary to understand and manage emotions, set and achieve positive goals, feel and show empathy for others, establish and maintain positive relationships, and make responsible decisions."

CASEL reports that "for a growing number of schools and districts, SEL has become a coordinating framework for how educators, families, and communities partner to promote students’ social, emotional, and academic learning. SEL is embedded in their strategic plans, staffing, professional learning, and budgets. It guides their curriculum choices and classroom instruction — both direct practice in SEL as well as integrated instruction with reading, math, history, and other core subjects."

Until recently, companies that specialized in health and wellness products marketed to consumers. A dramatic shift has occurred in the last few years with companies selling platforms that can scale to corporate demand. Large scale deployment are now being rolled out as the large healthcare providers and payers adopt the products.

**Mobile Learning**

Metaari defines Mobile Learning as knowledge transfer events, content, tools, and applications accessed on handheld computing devices. In our taxonomy, laptop and netbook computers, while perhaps mobile, are not considered handheld devices.

Many types of handheld devices are used for Mobile Learning including:

- Dedicated gaming devices
- Personal media players (PMPs)
- Handheld tablets and slates
- Handheld eReaders
- Personal learning devices (PLDs) designed solely for learning and performance support
- Mobile phones (feature phones and smartphones)

Mobile Learning now represents a product substitution threat to Self-paced eLearning courseware and there is clear evidence that it is cannibalizing courseware revenues, particularly in Asia, Africa, and Latin America.

Large rural populations across Asia, Africa, and Latin America are now avid users of Mobile Learning technology, while very few have experienced
Self-paced eLearning on a desktop. In developing economies, PC penetration is often low, yet mobile subscriptions are relatively high.

For example, only 15.1% of the total African population has access to the Internet via a computer. In contrast, 76.4% of the population accesses the Internet via a mobile device.

**Native Mobile Learning Products and Services**

Metaari defines four major types of "native" Mobile Learning products: Mobile Decision Support, Location-based Learning, and Mobile Learning VAS (value added service).

- **Mobile Decision Support** is an interactive application that provides sequential performance and decision support based on the input provided by the user. Handheld Decision Support is very common in corporate mobile field force, industrial, government, first responder, and clinical healthcare environments. The latest innovations are decision support displayed on headsets and smart glasses.

- **Location-based Learning** products are built on location-based services (LBS) technology. It is a type of knowledge transfer enabled by wireless network interfaces and sensors responding to the actions of a user at a specific location *in space and time* to create a situated learning experience. RFID chips, GPS chips, barcodes, Quick Response (QR) codes, Short Message Service (SMS) texts, and image recognition are used in Location-based Learning.

- A **Mobile Learning VAS** is a subscription-based product sold directly to consumers and organizations by telecom network operators, device makers, and content suppliers. The content is usually delivered over mobile networks via audio, SMS, or Interactive Voice Response (IVR). To date, Mobile Learning VAS products are heavily concentrated in Asia, Africa, and Latin America.

Subscription-based Mobile Learning content sold as a value-added service is quite new on the market and *essentially represents a new type of Mobile Learning product – a fusion of packaged content and services. Metaari has labeled this new product type "Mobile Learning VAS".*

The mobile network operators (MNOs) initially launched their Mobile Learning VAS products in developing economies and are now expanding into the developed economies. Combining the Mobile Learning VAS...
products with the "legacy" Mobile Learning market in the developed economies exposes the clear contours of a cohesive worldwide Mobile Learning market. So far, language learning content is the most popular type of Mobile Learning VAS, which obviously threatens the revenues of the other language learning products. It is no surprise that the major educational publishers with language learning content are partnering with the carriers.

**Robotic Tutors**

The market for an entirely new type of learning technology solidified in 2015 and 2016. Education robots have been on the market for at least a decade, but the early products were very expensive and relatively primitive. That changed in the last 2-3 years with very sophisticated and relatively inexpensive robotic tutors hitting the market.

The new robotic learning technology products on the market are primarily used to teach children, so far. These products first emerged in China, Japan, and South Korea and are now gaining rapid traction around the globe.

In the current market there are four primary types of Robotic Tutors:

- Language learning tutors
- General purpose tutors
- Behavior modification therapeutic tutors (also called socially assistive robots)
- AI-based tutors.

The latter two are also called Robotic Intelligent Cognitive Tutors. The new therapeutic and AI-based intelligent robotic tutors are proving particularly effective at providing behavioral intervention to children with disabilities such as autism.

Educational robots are designed specifically for knowledge transfer and are different form so-called companion, social, and family robots. Many companion robots (like Blue Frog Robotics' Buddy robot) do have education content for young children but they are not designed exclusively for education.

According to the report, *Executive Summary World Robotics 2016 Service Robots* published by the International Federation of Robotics (IFR), "About 3 million robots for education and research are expected to be sold in the period between 2016 and 2019."

For more information about this research, email: contact@metaari.com
In February 2016, the US Toy Industry Association (TIA) reported that the "hottest robots of the year will be customizable and teach kids important concepts, including coding, engineering, problem-solving and building."

There are companies that sell robot construction kits to the schools. These are not tutoring robots. The kits are designed to teach children how to build a robot as part of a STEM curriculum and while often branded as educational robotics, these products are not robotic tutors and Metaari does not track investment to robot kit companies.

There are smart toys designed for early childhood learning, like China's voice-activated YYD Learning Robot for preschoolers which tutors young children in counting, vocabulary, and letters. The robot sings and tells children's stories.

The price points for educational robots used to be exorbitantly expensive, but a range of sophisticated cost-effective products have come on the market in the last two years. These new companies are just starting to attract private investment.

**Subcategories of Learning Technology Products**
Metaari defines five sub-types of learning technology products and services for our seven product types. While some suppliers offer a full catalog of products, most tend to specialize in specific areas. The four sub-types are:

- Retail packaged content
- Custom content services
- Value added services (VAS)
- Authoring tools and learning platforms
- Robotic-compatible Components

Not all of the eight learning technology products have all of these subcategories yet, and Robotic Components are mostly confined to Robot Tutors although suppliers often refer to the AI-based chatbots as "robots".

**Retail Packaged Content**
Packaged content includes self-contained products delivered on tangible media such as DVDs, as well as mobile and web-based content. Retail packaged content is sold as a discrete product. An educational app that is sold in the app stores is a packaged content product.

For more information about this research, email: contact@metaari.com
Packaged content types include (but are not limited to) a wide range of subject matter including:

- IT-related
- General academic textbooks, courses, and references
- Exam and test preparation
- Hobbies and "how to" guides
- Tourist guides
- Vertical professional skills and professional development
- Channel, partner, and supplier education
- Continuing education (CE) and continuing medical education (CME)
- Professional licensure and certification
- Internal and external sales
- Decision and performance support
- Business processes
- Customer, patient, or constituent education
- Business and finance
- Organizational, management, and leadership development
- Compliance and mandated learning
- Language learning

Metaari can break out each of these content types to provide clarity for content suppliers. For example, language learning can be broken down further by revenues for specific languages. Likewise, exam and test prep can be broken down by specific tests.

**Custom Content Services**

Custom content services cover a wide range of services including analysis, design, development, conversion, delivery, localization, translation, and maintenance of courseware content.

Content services is a complex global industry with literally thousands of regional suppliers offering services to local businesses, major national brands offering services to large companies, business process outsourcers (BPOs) offering services to global buyers, and well established "courseware factories" in Canada, Ireland, India, China, Russia, and Pakistan selling retail services directly to companies and selling wholesale services to BPOs.

Metaari no longer considers hosting services in our forecasts. Cloud-based products are now the norm and cannot be considered learning technologies, per se.
**Value Added Services (VAS)**

It should be noted, that not all education-related value added services (VAS) are mobile. For example, McGraw Hill, Pearson, and Houghton Mifflin Harcourt provide value added services designed for PCs. Yet, it is the mobile versions of educational value added services that are having the most dramatic impact on the global Mobile Learning industry.

Mobile Learning has spread like wildfire across the planet primarily due to the launch of dozens of successful Mobile Learning value-added service (VAS) products sold directly to consumers and organizations by telecom network operators, device makers, and content suppliers.

On average, 5-6 new Mobile Learning VAS products are launched somewhere in the world every month. Most of them are sprouting up in developing economies. This has major implications for the Mobile Learning industry. *Suppliers in developing countries are now driving the innovation in Mobile Learning*

**Authoring Tools and Learning Platforms**

The current Self-paced eLearning authoring tool market is dominated by products marketed as "rapid learning" tools. Many of these tools originated as screen capture utilities and have been modified to create self-paced courseware as well.


**Robot-compatible Components**

Robotic Components include software, hardware, and peripherals. Some of the most sophisticated Cognitive Tutors are using IBM's Watson cognitive computing platform.

Suppliers that sell Robotic Tutors usually bundle the mechanical robots with the products. Buyers can also buy their own robots and the license software...
from Robotic Tutor suppliers. Developers also develop custom content for general purpose robots.

RoboKind sells two robots designed for cognitive intervention with children: Zeno and Milo. Zeno is used in classrooms and Milo (who is two feet tall) is usually used in clinical settings. RoboKind has a software bundle for organizations called Robots4Autism. They have versions of Robots4Autism for the iOS and Android platforms.

US-based Alelo built the interactive robot RALL-E (Robot-Assisted Language Learning in Education) using the Zeno R25 robot built by RoboKind. The robot teaches children Chinese. "The RALL-E robots are Chinese-speaking human-like robots that create a safe environment for learners to practice their conversational skills. These robots create the experience of a conversation through a lifelike range of facial expressions and gestures coupled with Alelo’s innovative language acquisition-based dialog software."

Government agencies are now catalysts for robotic tutors. In 2012, the US National Science Foundation (NSF) awarded Yale University a $10 million grant ("one of its biggest grants ever") for a five-year project known as “Robots Helping Kids” that uses the Nao robot to tutor children in homes and schools. In a press release, Yale University described the purpose of the project was to develop “sophisticated ‘socially assistive’ robots” designed to help children read, exercise, overcome disabilities and enjoy physical activities. “We want them to help children learn language, we want to help them learn better eating habits, and we want them to learn new social or cognitive skills through their interactions with these robots."

The Horizon 2020 program of the European Commission funded a project called L2TOR (pronounced ‘el tutor’) that uses the Nao robot to teach preschool children a second language. The project obtained $3.8 million in funding. The robot provides one-to-one tutoring for English, Dutch, German, and Turkish. "In particular, the project will focus on teaching English as L2 to native speakers of Dutch, German and Turkish, and teaching Dutch and German as L2 to immigrant children speaking Turkish as a native language." The project is funded through 2018.

As part of the Horizon 2020 program, the Nao robot from SoftBank Robotics is being used for language learning for children in the UK, the Netherlands, and Germany. The content is being developed by five universities.

For more information about this research, email: contact@metaari.com
One of the components increasingly being used is IBM's Watson cognitive computing platform. Essentially robots can be taught to teach anything once they are integrated with the AI platform.

SoftBank Robotics' Pepper robot runs on IBM's Watson cognitive computing platform. SoftBank Robotics claims that Pepper has an "emotion engine" that can detect emotions and respond appropriately. Singapore is using SoftBank Robotics' Nao and Pepper robots in the elementary schools.

The Hilton hotel chain in the US is using AI-based "robot concierges" using the Nao robot and running on IBM Watson's cognitive computing platform. The robot is called Connie and "is available to answer questions from customers. Connie knows everything about the hotel, neighborhood restaurants, tourist attractions, and so on." The Connie robot also integrates Wayblazer's location-based intelligence software. They define their software as the "world's first cognitive travel recommendation engine."

The barriers-to entry are dropping fast with cutting edge AI cognitive computing platforms like IBM's Watson available for low monthly subscriptions. Emotion recognition software platforms are also falling in price. There are online portals selling all the components for the inside workings of robots including servos and sensors and the cost of assembling any kind of robot is dropping. That said, in the commercial education robot market, the robots are still relatively expensive.

In 2016, the Nao robot cost between $6,150 and $8,000. As hefty as this price is, it is down from $10,000 in 2015 and half the price it sold for in 2010.

South Korean telecom operator SK Telecom sells an educational robot called Albert robot bundled with the Smart Robot Coding School training program designed to teach children how to develop software. The Albert-based product has been sold to schools in South Korea, Spain, France, Brazil, Colombia, Taiwan, and Malaysia. In May 2016, SK Telecom signed an MOU with the Central State Government of Paraguay to supply 10,000 units of the smart learning robot to schools in the country.

In October 2016, SK Telecom announced that they would deploy education robots to Costa Rica, with co-funding from the Inter-American Development Bank (IDB). "Under the agreement, SK Telecom will provide its smartphone-powered education robot Albert for 300 preschool classrooms to support children's mathematics education. The company will also provide technical expertise on smart-education technologies."
2016, they announced "Based on the result in Costa Rica, **SK Telecom and IDB plan to expand their project to the entire Central and South American region.**"

KT Corp in South Korea sells a robot called Kibot. It has sold over 10,000 units in South Korea. One of the things it does is provide English language tutoring to young children. Kibot can read, sing, and speak to children in several languages.