WHITE PAPER

DIGITAL TRANSFORMATION OF LEARNING

Why we need another "Apollo Effect"

VALAMIS

INTRODUCTION

We are approaching a point in time where the rapid acceleration of technology related to education, course development and learning has produced large amounts of content and knowledge concepts within fingertip reach of learners of all ages providing they have access to the Internet and a computer or mobile device. Learning to learn and acquiring the skills necessary to search and, more importantly, curate the numerous sources to select just the right information and/or to interact with just the right subject-matter-expert (SME) at just the right time is critical.

According to George Siemens (ref. 1), know-how and know-what are being replaced by know-where and by what I contend will be the know-whos (just the right person with just the right information at just the right time) easily found and connected through a ubiquitous network. The ability to search and curate necessary information effectively, is a critical skill for autonomous learning. In addition, to be able to understand and to apply that knowledge to solve real-world problems will be one of the keys to enabling a digital disruption in the fields of education, workforce development, and complex problem solving.

Creating the right digital platform which easily connects all elements of the ecosystem in a seamless manner and, more importantly, allows the analysis and evaluation of the interactions of all the elements of that ecosystem will help us to understand the interconnected nature of learning; all learning (individual, network, and organizational).

Hence the idea of a "Collaboratory" for learning and problem solving and what came to be called the "Epic Challenge" program were conceived. The Collaboratory is a start at developing a framework to capture experiences and study the learning process and to inspire and motivate the next generation of scientists and engineers. The Collaboratory would serve as a test bed to experiment with different pedagogies for learning (e.g., inquiry-based, problem-based, and phenomenon-based) and their effectiveness with students and for solving real-world problems of epic proportions by applying the concepts they learn. The Epic Challenge (e.g., sustaining humans on Mars) provides the inspiration and motivation to sustain learning at higher and higher levels in pursuit of solutions to problems related to things like the survival of the species, world hunger, clean water, and human colonization of the solar system. It is through real-problems and context that learning becomes meaningful, understanding is realized; and knowledge is remembered, stored, and related to other elements of knowledge.

The digital environment can show the connected knowledge concept landscape and easily define the necessary connected elements, thereby highlighting the path/trajectory to master any subject desired and how it is applied to solving a problem of extreme interest to the student. It can also map the multidisciplinary nature of all complex problems and the interfaces/interactions of the associated domains and skills needed to solve such problems. The guiding premises being: people/students of all ages love to solve problems; the more challenging/epic the problem the more the student will be motivated (provided they are properly guided); there are epic challenges in every field to engage and motivate learning at all levels; and systematically aligning a student's personal interest/passion with the correct challenge may provide the sustaining force necessary for them to realize their potential.

Individual life-long learning, learning as part of a connected network of learners and how the nodes/knowledge/people on those networks relate and interact to enable organizational learning will become the lifeblood of workforce development and effective learning organizations. More importantly, although most of the technology is either available and mature or will become so soon, whether or not and how that technology is adopted within an established ecosystem will be critical (ref. 2).

Keywords: Digital Transformation of Learning, Phenomenon-Based Learning, Workforce Development, Digital Workplace, Adaptive Learning, Innovative Problem Solving

Audience: This white paper is aimed at CIOs, CHROs, CEOs, and other persons responsible for learning and development in organizations.

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Janne Hietala started his own consulting company at the age of 21. With Arcusys he has been leading the company's commercial operations since 2008. Since 2010, he has been spearheading the Valamis - Learning Experience Platform development and commercialization of Finnish EdTech for global markets. Janne was selected as a Young Entrepreneur of the Year in 2012. Currently he is working towards the Digital Transformation of Learning vision with leading global organizations by leveraging the most important learning technologies like social learning, mobile learning, OpenBadges, Experience API, gamification and learning analytics.

DR. CHARLES CAMARDA
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Charles Camarda received his undergraduate degree in Aerospace Engineering from the Polytechnic Institute of Brooklyn in 1974. Upon graduation, he began work at NASA's Langley Research Center (LaRC), received his M.S. from George Washington University in Mechanical Engineering in 1980 and a Ph.D. in Aerospace Engineering from Virginia Polytechnic Institute in 1990. He was Head of the Thermal Structures Branch at LaRC and led the structures and materials efforts of two national programs: The National Aero-Space Plane (NASP) and the Single-Stage-to Orbit Program (SSTO). He was selected to be an Astronaut in 1996 and flew on the Return-to-Flight mission of the Space Shuttle following the Columbia Accident, STS-114, in 2005. He was selected as Director of Engineering at JSC in December 2005 and is now the Sr. Advisor for Engineering Development at NASA's Langley Research Center.

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DIGITAL TRANSFORMATION

Digital transformation is happening in various fields related to media, communication, manufacturing and digital workplace in general. We can identify the key patterns in the industries in which this has already happened and apply the evidence-based information to help understand the digital transformation of learning.

Digital transformation in media

FIGURE 1: EXPECTED IMPACT OF INTERNET INTO MEDIA REACH
Source: Bryan Cheung, Liferay Keynote, LRNAS 2013. (ref. 3 https://www.youtube.com/watch?v=HP6aXQ-zAeo).

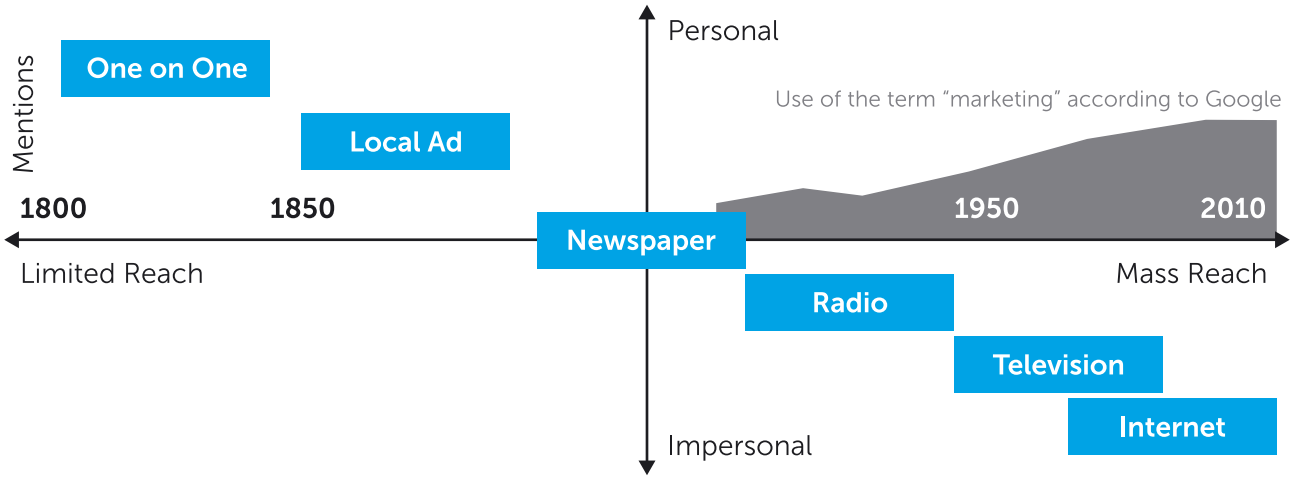
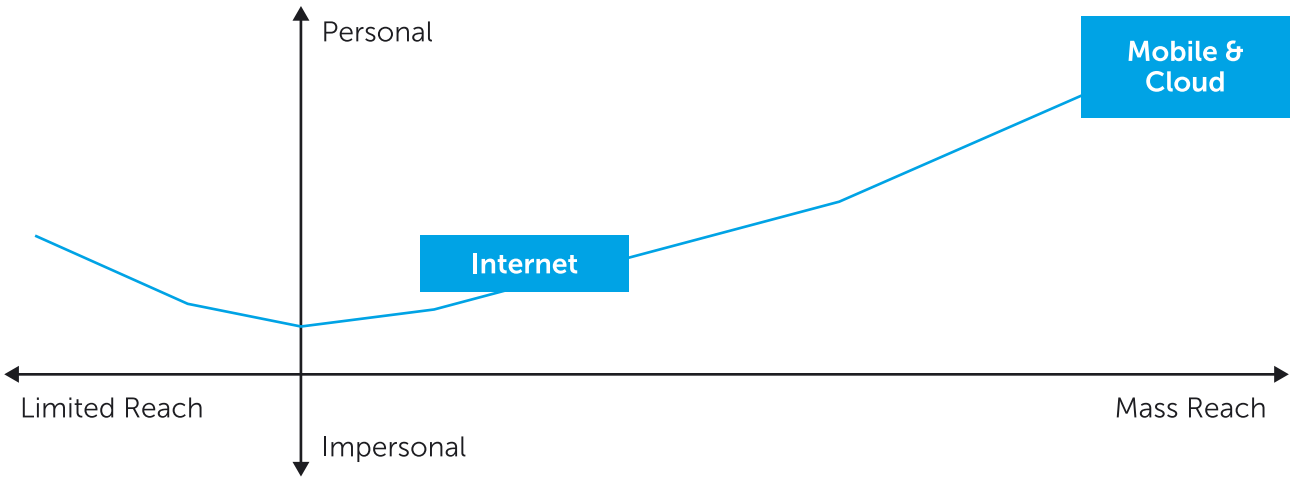


FIGURE 2: ACTUAL IMPACT OF INTERNET, MOBILE AND CLOUD INTO MEDIA REACH.
Source: Bryan Cheung, Liferay Keynote, LRNAS 2013. (ref. 3 https://www.youtube.com/watch?v=HP6aXQ-zAeo).



We can follow patterns from transformations of media and manufacturing to the digital era as shown in figure 1. It was expected, that the Internet would continue the trend in media development by allowing even broader reach as shown by the lower right quadrant of figure 1. However, the advent of mobile and cloud services caused the trend to shift from impersonal to personal interactions as shown by (the shaded curve of mobile and cloud mentions in the upper right quadrant of figure 1) and as depicted in figure 2.

The digital transformation of media actually made a very unexpected turn, requiring a major strategy shift from media organizations. This took many media organizations by surprise and required a transformation of their business model from mass reach and impersonal to a very personalized digital communication with mass reach (ref. 3).

Digital transformation in manufacturing

The term "Industry 4.0", as described by reference 4 "originates from a project in the high-tech strategy of the German government, which promotes the computerization of manufacturing. As shown in figure 3, the first industrial revolution mobilized the mechanization of production using water and steam power. The second industrial revolution then introduced mass production with the help of electric power, followed by the digital revolution and the use of electronics and IT to further automate production." (ref. 4)

Researchers at the Faculty of Behavioral Researchers at Center for Activity Theory and Developmental Work Research at University of Helsinki distinguish the historical development process of work and production in chronological order to five development stages: craft,mass production, process enhancement, mass customization, and the co-configuration (ref. 5). Kickstarter and maker-culture have taken co-configuration one step further into co-creation and co-funding of new products. The trend of producing something in larger quantities has suddenly jumped towards much more personal, individual experience where end customer can be part of almost whole life-cycle of an product and get it when he or she needs it in the quantity required.

Kickstarter and maker-culture have taken co-configuration one step further into co-creation and co-funding of new products.

While emergence of Industry 4.0 continues to thrive, the maker generation creates and shifts the paradigm (e.g., going from mass production into digitally distributed manufacturing of custom single products). Technology advances in

additive manufacturing is transforming several industries, such as spare parts manufacturing. The Maker movement has had an impact on open source hardware and has grown into work swarm initiatives like reference 6, Open Source Ecology - Civilization Starter Kit.

The nature of work has changed dramatically when moving from Industry 1.0 to Industry 4.0 and the change accelerating as we speak. As the work environment is changing and becoming more complex, it also requires new work procedures from the employees.

Gartner discusses about different scenarios to help visualize the future workplace. They recommend "for IT leaders and business leaders an open, organizational discussion on the changing nature of work, workforce demographics and the impact of emerging workplace technologies." (ref. 7)

This discussion includes an aspect on how the work is allocated in an organization. Figure 4: Characteristics of the vertical axis represents the way an enterprise organizes its work. "Those with a fluid organizing model encourage people to participate in enterprise social networks, communities and projects, based on their interests and passions. Enterprises with a traditional corporate structure simply assign people to projects." (ref. 7)

FIGURE 3: FROM INDUSTRY 1.0 TO INDUSTRY 4.0

source: http://www.engineersjournal.ie/wp-content/uploads/2014/05/Domhnall_Carrol-006.jpg.

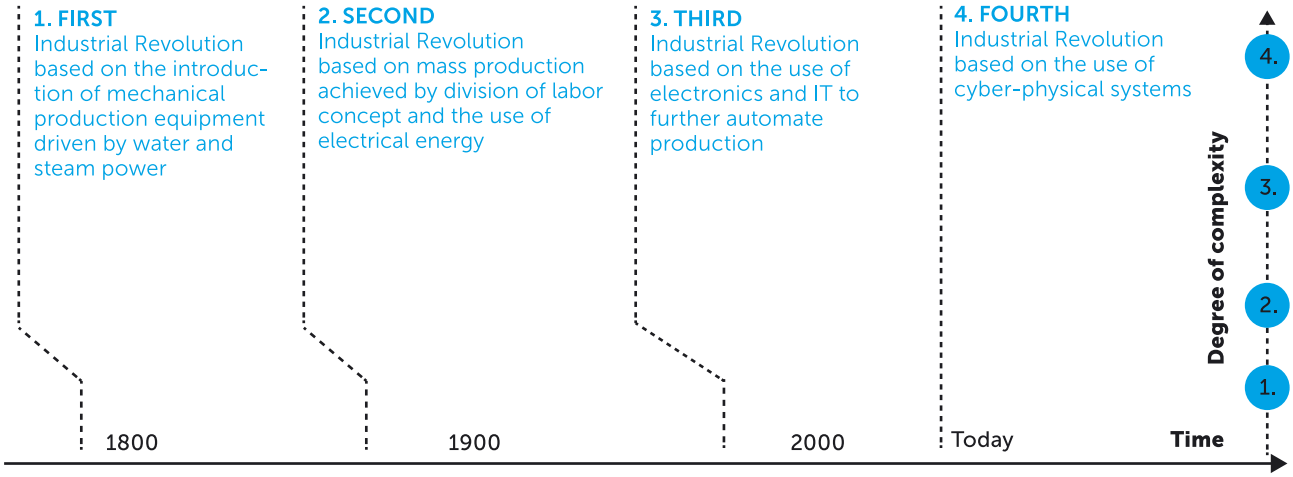
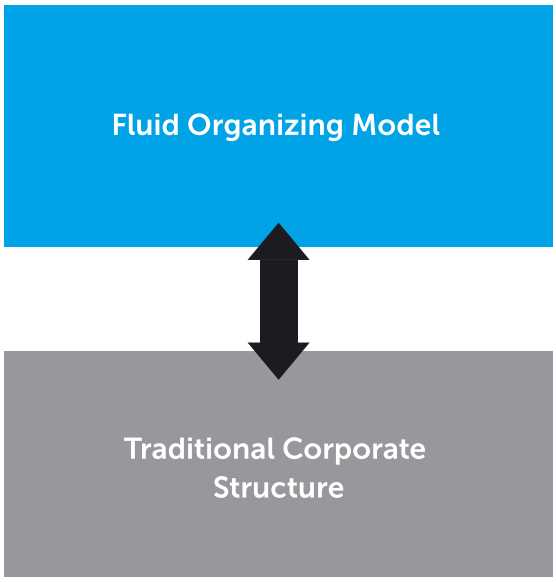


FIGURE 4. CHARACTERISTICS OF THE VERTICAL AXIS

Source: Gartner (February 2015)



Characteristics:

- Participation based on interests and passions
- Skills and expertise markets, freelancers
- Work from "alternative" locations or hubs
- Work extends beyond the enterprise, crowdsourcing
- Horizontal and vertical collaboration
- Public, reputation-based participation
- Individuality – roles and opportunity

Characteristics:

- Participation based on management assignment
- Hierarchical organizational model
- Management determines roles and opportunity
- Hire for current and future organizational needs
- Chain of command communication process
- Workers outfitted with technology required

Digital Transformation in Education

Higher education is facing a crisis as evidenced by both declining enrollment and retention rates. Massive Online Open Courses (MOOCs), once envisioned to disrupt higher education by providing a seemingly endless supply of high quality education to the masses, have failed to realize their projected potential. In fact, Gartner (ref. 8) says "MOOC is off the Hype Cycle because we deemed it Obsolete Before Plateau in terms of a sustainable business model in 2014." The digital transformation of education has become more elusive than originally thought. Online universities faced the same challenges as their brick and mortar counterparts. Retention rates, while initially relatively high due to a much broader reach, have started to decline even faster than traditional, in-classroom education. It is not enough for long-term transformation to simply put out massive amounts of courses and lessons and expect students to stay engaged and motivated to complete them.

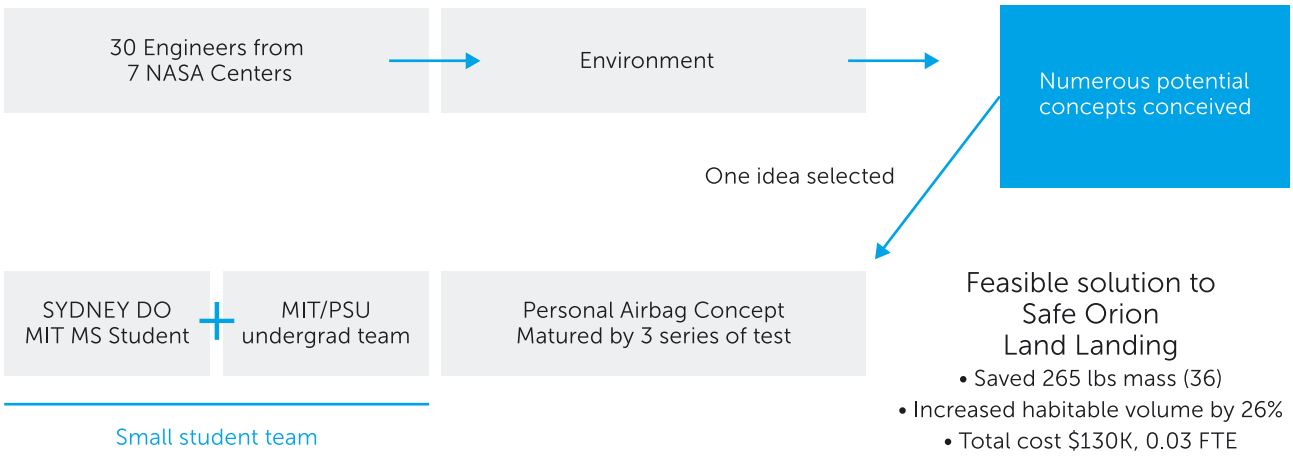
The Finnish education system has been the proving ground for advanced pedagogy. It is known throughout the world to be efficient and effective. Phenomenon-based learning was introduced into the national curriculum on an experimental basis in 2010. It combines aspects of problem-based learning, explorative learning, and project-based learning. The leading education researchers in Finland recognized that, even though the Finnish education system was ranking top in the PISA studies (OECD, PISA - Finland: Slow and Steady Reform for Consistently High Results, 2010 (ref. 9)), further change in pedagogy was needed to take full advantage of the digital transformation. The digital transformation and the way students currently interact and share information was recognized and is reflected in the current PISA requirements criteria which focus more on individual learning skills, critical thinking, and collaborative learning. Phenomenon-based learning is being recognized nationally and will become the primary curriculum in Finland starting in 2016. It has shown promise in increasing both student retention as well as student engagement.

Karlgren et al. (ref. 10) define that in order to manage changes in the society and in the work life, new types of competencies, such as collaborative learning, self-leadership and flexibility, are needed. Educators need models and support for developing teaching methods with digital technologies which aim at supporting students' innovation skills and digital competence but are not too challenging to apply. Karlgren et al. state that the digital tools introduced were considered helpful; using numerous separate tools also creates certain challenges.

Daniel Pink (ref. 11) has expressed what he believes are the requirements for motivation in the 21st century to be: autonomy, mastery and purpose. These three requirements also apply to learning and, by chance, these are all major issues with the current model of education and may offer some reasons why MOOC's have failed. Phenomenon-based learning addresses all three key areas for motivation and can possibly explain the recent increase in student engagement. In phenomenon-based learning, context and problem solving are brought back to the learning process and students are allowed much more autonomy and responsibility for defining the structure and topic of the course. Students are able to choose areas of study that are important to them on a personal level and as a group.

The teacher's role in phenomenon-based learning is to act as a coach, guiding students through the learning process and addressing possible gaps and weaknesses in their learning

FIGURE 5. - ICED METHODOLOGY AND SUBSEQUENT DEVELOPMENT OF INNOVATIVE SOLUTION TO THE ORION SPACE CAPSULE LAND LANDING PROBLEM (REF. 15).



skills. This "Teacher/Educator-as-a-Coach" idea fits nicely with identifying preferential learning styles and abilities and connecting the students with the necessary "Student-Centric Learning" (ref. 2) format which will accelerate their progress/growth. Phenomenon-based learning is usually applied as a collaborative learning process. Social learning and learning in a group have proven to be more effective ways of gathering new knowledge and skills, where part of the group can choose to specialize in one or a selected number of specific topics more deeply.

As phenomenon-based learning brings context back to the learning process, we have seen an increase in student engagement. The more connected the phenomenon is on a personal level, the more the student is engaged. There is also a direct correlation between the level of challenge ("epicness" of the problem) being solved to student engagement. Students, like "gamers", want to feel they are part of something bigger than themselves, to change the world for the better whatever the underlying motivation (e.g., social, technological, medical, environmental, etc.) (ref. 12).

In 2008, Dr. Charles Camarda initiated a program for teaching engineers to creatively solve complex problems (ref. 13), which uses a strategy specifically developed for the program called Innovative Conceptual Engineering Design (ICED). The inspiration for the program came from the Space Shuttle Columbia disaster in 2003 and the need to rapidly work towards a successful return-to-flight strategy for the Space Shuttle Program (ref. 14). Two astronauts worked "under the radar" in a small garage/lab space to develop innovative solutions for the in-orbit repair of a damaged reinforced carbon-carbon (RCC) wing leading edge (it was determined that a piece of foam debris struck Columbia's port wing leading edge, critically damaging it and causing the vehicle to be destroyed during the entry heating phase of flight). They were able to rapidly prototype, test, and fail multiple times, evaluating numerous design ideas fast and furiously, discover, learn and improve their ideas quickly.

This model/method of working is related to swarm work patterns and other rapid innovation models. The environment was psychologically safe and "failure was not an option, but a requirement". This strategy for innovative problem solving was further developed into the ICED-methodology (refs. 13 and 15). Results from the original one-week course at Penn State led to dozens of innovative solutions to the proposed "Epic" challenge, developing a safe land landing system for the Orion Space capsule. One of the ideas was selected for further study by a small team of students from MIT and Penn State. Results from that study (fig. 5) led to a feasible solution to the land landing of a space capsule, called a "Personal Airbag", which saved considerable mass and increased in-orbit habitable volume (ref. 16).

An Epic Challenge Program was conceived as a year-long learning project immersing students and engineers into the epic challenge at hand and building cross-disciplinary teams from different levels of education trying to solve it (figure 6). The program, as described in a presentation at the Siemens PLM Analysts Meeting in Boston, 2014, attacks several impediments to learning and innovative problem solving: motivation, culture, and recognition of the importance of failure in the learning process (ref. 17). The organizational framework and ecosystem of the Epic Challenge Program is purposefully designed to include students of all ages (e.g., graduate, undergraduate, high-school and middle-school students), faculty, educators, subject-matter-experts (SMEs), technical assistants (TAs), peer- and near-peer mentors, and role models. Students of all ages can immerse themselves into whatever aspect of the "Epic" challenge they so desire, and learn at whatever

level, and whatever pace they choose. The challenges are selected to be complex, multidisciplinary and expansive in breadth and, thus encompassing learning opportunities in a variety of multiple domains or subject areas.

When a similar working environment and culture were achieved by the students (virtually and in the classroom), as previously with the engineers working with the Return-to-Flight challenge, the results were often groundbreaking as shown in figure 5 (ref. 16).

When the collaboration with Finnish learning technology experts and NASA started an Epic Challenge, it was quickly concluded that the ICED-methodology and Phenomenon-Based Learning had a lot of similarities and ICED was nicely suited as a strategy to combine a new learning pedagogy with a hands-on, innovative problem solving methodology. One important addition this year, is that phenomenon-based learning is being applied using a virtual platform, which integrates a scientific framework and ability to measure and analyze the effectiveness of learning (ref. 18).

In his book "Disrupting Class" (ref. 2), Harvard Business Professor Clayton Christensen identifies some of the key agents/elements operating within the education ecosystem and suggests several possible strategies to enable an effective disruption and the ubiquitous application of digital technologies for educational progress. Some of the attributes of digital learning and how they can be effectively applied to enable a revolution/disruption in education include:

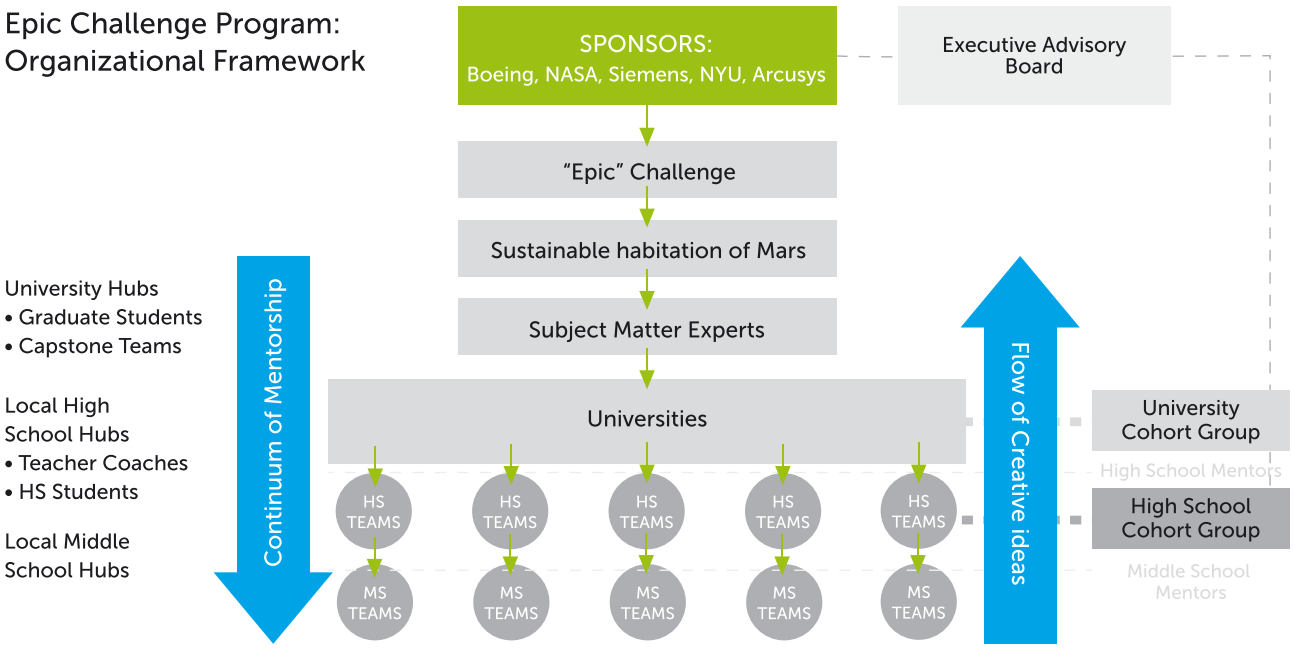
1 "Student-Centric" Learning (SCL) - all students learn differently, according to Gardner (ref. 19), and using digital learning technologies and computer-based learning (CBL) will enable learners to select preferential learning modalities best suited to enhance and accelerate their performance. Teachers acting like coaches/guides can facilitate and customize the learning path for individual students.

2 Developing a digital platform that is modular, non-interdependent, and utilizes an open architecture will ensure compatibility with numerous existing open source learning software products. These platform features will help enable SCL to become a reality.

3 Disruptively deploying computers in potentially new/low-consumption markets to allow time for technology to advance in areas where it is needed (e.g., AP courses in schools where not offered, homebound/home-schooled population, free private tutoring, make-up credits, etc.).

4 Ability to improve education research using data analytics on the complete ecosystem at a high-enough level to be able to ascertain actual effectiveness of education (pedagogies, demographics, etc.) and move from "descriptive" to "prescriptive" research (where theories are well-grounded in causality and, hence anomalies and failures can be predicted).

FIGURE 6. ORGANIZATIONAL FRAMEWORK OF THE EPIC CHALLENGE PROGRAM.



WORKFORCE DEVELOPMENT

Understanding how to improve the effectiveness of learning and training is of interest to all enterprises and organizations. Ability to develop business is often related to an organization's ability to measure the performance of business. Enterprises have adapted methods to measure actual performance to expected value. These methods include examples like Key Performance Indicators, Balanced Scorecards etc. Digital Marketing has brought tools with which we can measure performance of the marketing, experiment and do A/B testing. Digital measurement tools allow us to experiment and fail faster to see what works and what does not.

This transition has also affected human resource organizations and workforce development within corporations. There is now more emphasis and value on organizational culture in the workplace. Employee satisfaction and management and leadership skills are being evaluated on a constant basis. Yet these are more indirect observations of an organization's capabilities and health. It is very difficult to measure an organization's culture or capability for change. Yet, in today's business environment, the ability to change and adapt your business and organizational capability is a requirement for survival.

In today's business environment, the ability to change and adapt your business and organizational capability is a requirement for survival.

The digital economy is forcing organizations to remaster old business models. Gartner states that "in order to transform the business, people need to work differently because the old ways of working no longer add the value they once did." (ref 20). Supporting the formation of teams and bringing in the subject-matter experts at the right time is critical for enabling faster problem solving and pattern-sensing strategies. This creates a requirement for a more effective approach for defining competencies and capabilities than just relying on an individual's CV/resume. To drive rapid solutions to complex problems requires connecting with just the right person that has exactly the right expertise at just the right time (the "Know-Who" with the "Know-How") (ref. 21). Work swarms are often partially external, meaning that the team will be working in ad-hoc collaboration with experts outside the parent organization. Teamwork and collaboration is emphasized over individual activities having similar patterns with development of educational models.

The emerging patterns indicate, that the processes of digital work and digital learning are overlapping, meaning that the technologies supporting these activities need to be fully integrated and transparent experience.

Building and maintaining a successful digital business requires more than just a technology. As the nature of work is changing, organizations need to create new strategies to support digitalization. HR and IT management need to work closely together in order to integrate technology and digitalization smoothly into the organizational culture. Only after employees have truly adopted the digital mindset, it is possible to take full advantage of technology when answering to the current and future challenges brought by the digitalization.

In addition, accurate digital portfolios of student/employee accomplishments based on validated certificates/badges, achieved by applying learning to directly solve real-world challenges/problems, will help ensure a successful match for employee/employer and a reduction in early attrition and significant financial loss.

Digital transformation of learning is applying positive pressure for organizations to analyze and improve their workforce development models. This is creating effective learning processes, motivating and engaging the employees; and being able to measure and analyze the learning success in determined metrics will be one of the critical success factors in the future. Being able to constantly learn and create new, innovative ways of improve workforce development will create a massive competitive advantage compared to those organizations that refuse to transform.

Workforce retirement is creating huge challenges for industries where human capital is the biggest resource. In the next case, we can read how NASA is attempting to solve this problem.

Case: NASA

NASA is both similar and different to large, multi-national, high-tech companies such as Boeing with respect to its workforce makeup and development needs. NASA is a government organization with slightly over 17,000 civil service employees. NASA typically develops one-of-a-kind, high-tech solutions to unique and challenging aerospace problems (e.g., Mars rovers, Space Shuttles, the Hubble Space Telescope, etc.). Boeing Commercial Aerospace, for example, relies on a large network of employees, suppliers, and product developers from around the world to develop and integrate components to manufacture and sell sufficiently large numbers of similar aircraft to capture market share and realize a sufficient profit or return on investment (ROI). While NASA is not a multinational corporation, it does work on some of the world's most challenging problems with partners from around the world (e.g., the construction of the International Space Station which was successfully constructed in orbit, working with over 15 partner countries and various government, industry, and academic entities).

The workforce demographics of NASA and a typical NASA research center like Langley is shown in figure 8. Due to the Baby-Boomer surge in birth rates and associated hiring in aerospace during the Apollo era, NASA is experiencing a much higher average age in its workforce compared to the rest of the United States and a surge of those employees retiring. The average age at NASA LaRC is 50 years old and over 85% of the current workforce is over 40 years old. A large percentage of the employees at research centers have degrees in science and engineering (S&E) (e.g., approximately 65% of employees at LaRC work in S&E). In addition, a very large percentage of NASA's experienced engineers will be retiring in the coming years (60% of all employees eligible to retire today come from S&E backgrounds).

Maintaining a technically excellent, high performing team-oriented workforce is a growing concern with a decreasing number of STEM-qualified students graduating with the skills necessary to fill all the necessary job openings expected to be waiting for them.

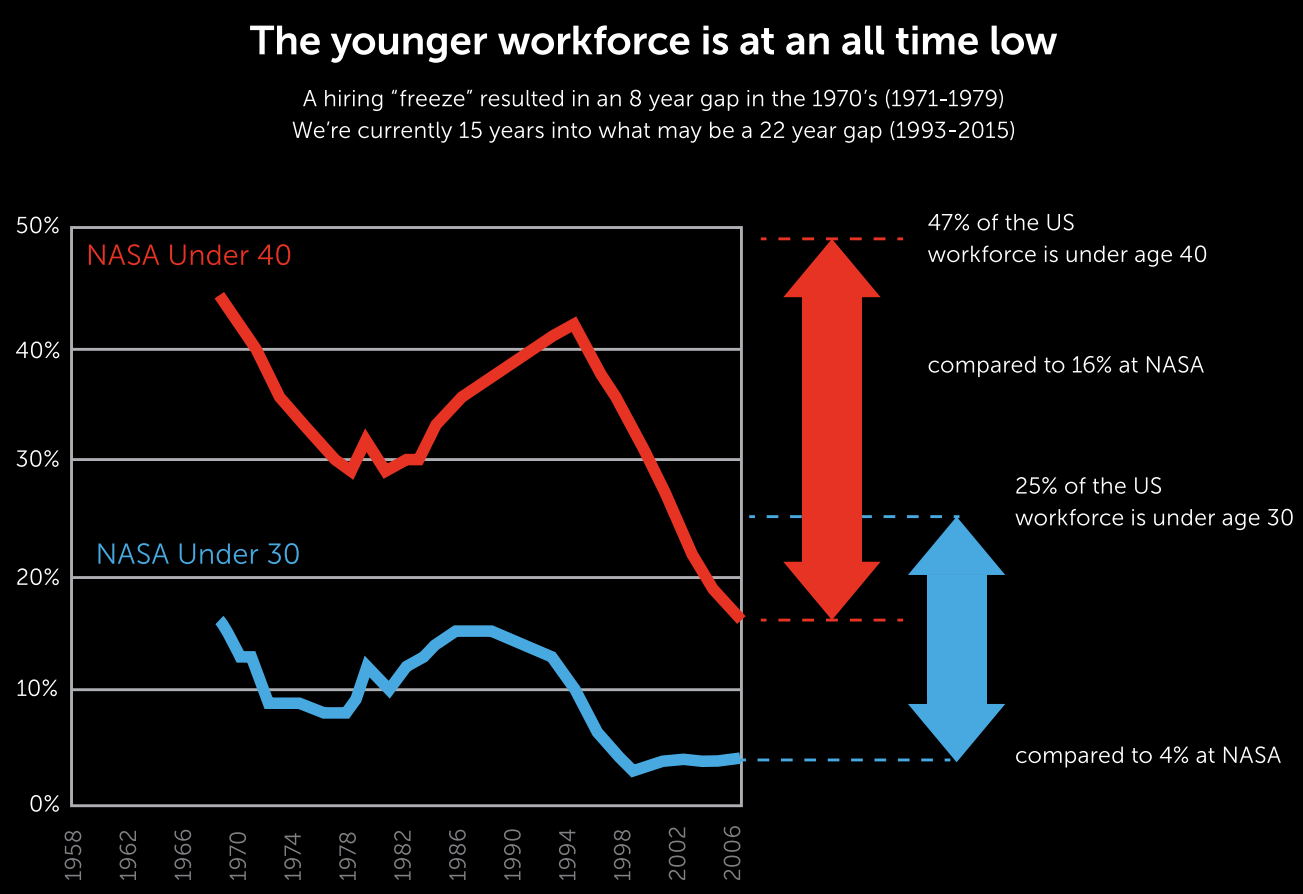
NASA is also struggling with how to provide cost-effective advanced education and training for its employees. Methods to capture lessons learned and the knowledge and expertise of world-class subject matter experts (SMEs) prior to their retirement rank high on the priority list for NASA's workforce strategic planning committees as well as methods for mentoring NASA's new hires.

For the United States to be a leader in aerospace, NASA must return to its roots as a research and development powerhouse which can focus on its long-term vision and develop cutting edge use-oriented research tools and technology. To do this, NASA must be able to attract the best and brightest graduating engineers and scientists from a dwindling pool of graduates. It is also imperative that NASA is able to offer advanced education to its employees. Toward that end, NASA is developing partnerships with online education providers, education technology developers, and learning scientists to co-create advanced courses and to develop the tools to conduct the data analytics to assess the effectiveness of the courses developed. It is also measuring the ability of its employees to apply the knowledge gained to solve real challenges the Agency is facing. The "Collaboratory", described in a later section, is being developed to provide such a collaborative work environment where swarms/teams of researchers can immerse themselves in challenges and connect with the information and people necessary to learn and to help conceive timely solutions.

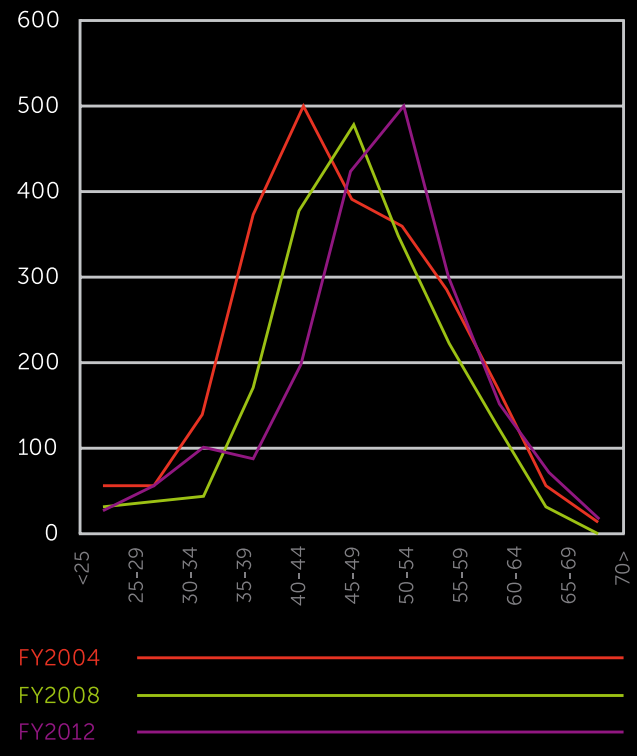
NASA must be able to attract the best and brightest graduating engineers and scientists from a dwindling pool of graduates.

While NASA is similar to high-tech aerospace companies like Boeing, with its need for a high percentage of sustaining engineers, it must also develop a high percentage of senior-level research engineers and scientists that have an advanced "research"-level understanding of the various domains and can conduct research and development studies and advanced modeling and simulation tool development. One such Space Act Agreement (SAA) with Boeing and MIT/edX will develop the first in a series of courses in systems engineering entitled: "Introduction to Model-Based Systems Engineering." It is hoped that the use of SMEs from industry and NASA will add context and real-world experience to the academic material to engage, inspire and motivate and to highlight and demonstrate the acquired skills.

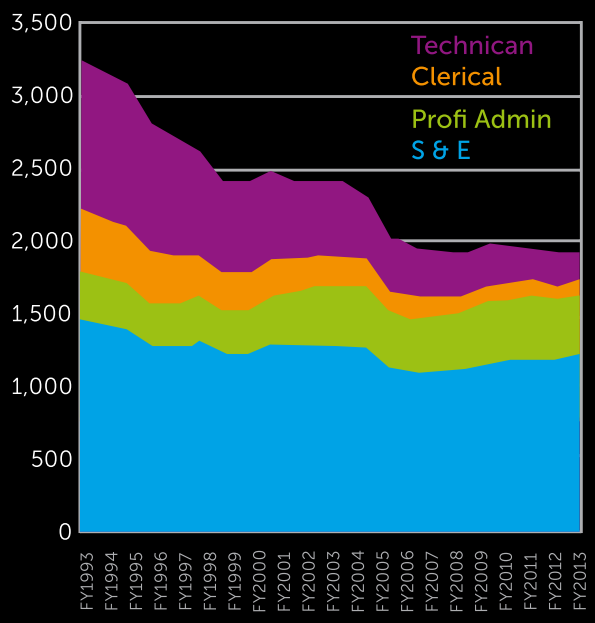
FIGURE 7. - WORKFORCE DEMOGRAPHICS AND NASA LANGLEY RESEARCH CENTER



NASA LaRC Age Distributions (2000 to 2012)



NASA LaRC Workforce skill Types - Historical



DIGITAL LEARNING EXPERIENCE PLATFORM

The pressure to improve learning experience online has existed for a while. The traditional Learning Management Systems (LMS) have focused on managing online courses or instructor-led training. LMS's originally adopted for education have been used also in workforce development, though the user experience has been poor and focus has been more on learning content interoperability. The emergence of new standards such as Experience API (xAPI, also known as TinCan API), Open Badges and LTI (Learning Tools Interoperability) has expanded the interoperability standards support outside the LMS scope. Managing digital portfolios and capturing learning experiences to Learning Record Stores are appearing as the tip of the iceberg of Digital Transformation of Learning.

Talent management and human competence management business areas have created a domain of enterprise software vendors. Many of these software vendors have started from Enterprise Learning and expanded towards career management and other human resource related functionalities. This need has been driven by organizations needing to find and identify top talent, from a recruitment perspective, with less emphasis on learning and development.

The 70:20:10 concept (figure 8) has been transformational in combining the different approaches to managing digital learning experiences. The model defines that 10% of learning is formal, 20% is learning by coaching or mentoring and 70% is learning by doing. The concept of social learning has gained momentum by trying to capture better the learning happening in informal scenarios. Many organizations struggling with an aging workforce as described above are scrambling to capture the hidden tacit knowledge in the most senior workers before losing forever to retirement the experience gained.

There are various initiatives and concepts supporting social knowledge transfer and capture in digital domain. Concepts like gamification, peer-to-peer knowledge sharing and valuation, micro credentials and adaptive learning are adaptive learning are used by leading analyst organizations as the most important learning technologies in 2015.These partially address the engagement issues in digital learning platform but require very careful consideration and planning when rolling these into any organization. The learning experience must be defined as a world-class digital experience, which is fun and engaging to use providing ubiquitous access through all different devices. It needs to follow simplistic and clutter-free design principles where less is more.

The digital approach defines a requirement that it needs to scale to hundreds of thousands or even millions of users. These users might be located on several different continents and in several time zones and use different devices to access the platform.

FIGURE 8. - THE 70:20:10 MODEL (DEVELOPED ORIGINALLY BY MORGAN MCCALL, ROBERT W. EICHINGER AND MICHAEL M. LOMBARDO)

The Learning Experience Platform (ref. 18) is converging the three approaches to a unified digital platform:

1. It is a virtual environment where the individual chooses to work in the digital domain connecting to experts around the world when required to solve engaging problems.
2. It is an environment where you constantly learn informally, formally and you are being coached in a socially engaging environment.
3. It is a platform where competencies and capabilities can be defined, measured, analyzed, and transformed from an individual level all the way through to an organizational level.

Case Collaboratory - solving the most Epic Challenges facing humanity

The discovery of large amounts of water on Mars has increased the probability of sustaining humans on Mars and is creating significant global interest in space almost reminiscent of the Space Race and the Apollo Program. The successful exploration of another planet which can sustain a growing colony of humans is an epic challenge which can have huge benefits for humanity on Earth in very important ways. Similar effects on science and engineering graduate rates, patents, and the economy, such as those seen during the "Space Race" (figure 10), can be realized in our near future if we so choose to embark on the next great challenge, the colonization of Mars. The space race of the 50s and 60s had a slightly delayed but very identifiable effect on the retention and graduation rates between 1975 and 1980 (figure 9).

Currently interest and graduation rates in STEM (science, technology, engineering and mathematics) subjects is at an all time low and declining. For some industries like aerospace, a large percentage of employees are eligible for retirement and this number is increasing. Drastic measures and complete reform would required to supply the workforce demand. It is almost at a point, where we need another "Apollo Effect" to increase the STEM graduation rates. Fortunately, we have an opportunity to take advantage of another epic engineering challenge: sustaining humans on Mars.

During the space race and the Apollo Program, the world was a very different place: a) there was tremendous tension and pressure for both countries involved (the US and USSR) creating an intense sense of competition motivated by fear (fueled by the Cold War), ideology (democracy vs. communism), technical bragging rights, etc.; b) the goal of landing a person on the surface of the Moon could be accomplished within the budget of one of the large nations (US or USSR); c) the programs required to solve such "Epic" problems utilized systems engineering and program management structures which were very hierarchical in nature and dominated by rules, processes, and procedures; and d) without the internet, most communication and interactions were physical and contained to local geographic boundaries.

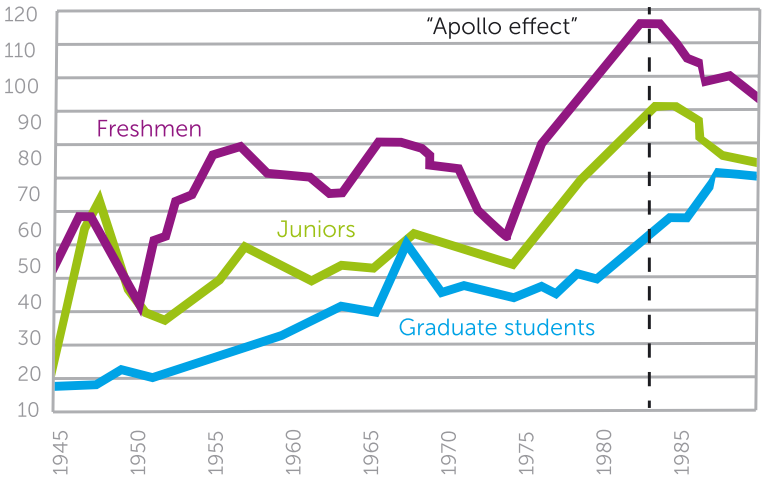
If we so desire to take on the Mars challenge at this time, the world and the technology is very different: a) knowledge and learning is much more autonomous and can be easily acquired online; b) with the advent of the internet and gaming, the nature of work, as mentioned earlier, is changing toward online work swarms with a very flat organizational structure; c) sending humans to Mars will be so complex and expensive that it will require the collaboration of multiple countries to be successful (much like the cooperative nature needed to complete the International Space Station (ISS); and d) it will be a global collaborative/cooperative venture which will serve to unite countries and cultures around the world.

NASA is currently working with top industry and academic partners in order to develop a virtual platform for the Epic Challenge research program. The project aims to renew, expand and modernize the NASA Epic Challenge program using a virtual platform (called the Collaboratory) which can be easily scaled for massive amounts of users. The program has created a pilot environment for the Collaboratory using the Learning Experience Platform approach and in 2015 there are several multi-national teams working

FIGURE 9. - THE APOLLO EFFECT ON EDUCATION (SOURCE: ENGINEERING MANPOWER BULLETIN, APRIL 1990) AND THE NEED FOR A NEW CHALLENGE: THE MARTIAN EFFECT.

"Apollo" effect on education, innovation and the economy ...

Inspired generations of scientists, engineers and explorers!



- Graduate rate doubled during Project Apollo
- More science graduates lead to more patents, greater technology base and new industries
- The multiplication effect of these factors will enhance the economy

...We need a new "Epic Challenge"

The "Martian" effect

- Collaboration Model (ISS)
- Not doable with one Nation's economy
- Flat Structure/Open Engagement
- Global/Virtual

virtually to find solutions to sustainable human habitation of Mars. This is a huge challenge that has sparked a level of student engagement rarely seen in traditional classes. Education research is conducted using data analytics to understand how learning and problem solving could be made more effective.

NASA is currently working with top industry and academic partners in order to develop a virtual platform for the Epic Challenge research program.

Using the platform, students can solve problems or challenges utilizing all the information they have learned by individual research, from team members/peers, or from subject-matter-experts. The teams share information regarding to the problems and solutions and the information is continuously curated. Utilizing phenomenon-based learning and storytelling has had a positive effect in the way the group of students gets immersed and engaged when solving the problem. While they work, they are required to rapidly analyze, design, prototype, test, fail, discover, learn, and share results on the digital platform.

With the help of the social learning and learning analytics functionalities, it is possible to follow up and authenticate the learning processes of the students. The model has been proven to be effective, since, in addition to the teaching, the platform also suits well in international interdisciplinary research projects, where the aim is to develop new models for innovative problem solving and team learning for the future generations of scientists and engineers.

The virtual platform is used to allow scaling up the amount of students, experts and teachers participating and collaborating to solve piece by piece one of the most epic challenges facing humanity.

Key findings: What you or your organization should expect from the digital transformation of learning

There are certain emerging patterns for digital transformation of learning. Similar to the transformation of media, the transformation of learning is taking a turn into a more personal, on-demand-based learning. This is seen in education as well as within organizations. Workforce development and digital workplace initiatives are becoming the main drivers for organizations in a need of new skills to keep up with the rapid changes in their business.

The following key takeaways summarize how organizations should prepare themselves for the digital transformation of learning.

1. Utilize digitalization in all forms of learning

Learning is becoming more measurable, developable, student centric, and goal-oriented. Deciding when and where individuals learn is no longer time and place dependent. Thus, accelerating learning with the help of digitalization is becoming a critical success factor for organizations.

2. Understand the changing nature of work

Work is becoming more spontaneous, virtual, and hyperconnected. Also, working and learning have started to blend in a digital transformation, which creates challenges for many organizations. The ability to find, curate, and share information effectively will start accelerating development of organization's strategic capabilities.

3. Be prepared for rapid changes

Doing business is getting more globalized and the workforce in several industries has started to retire. Due to retirement, many organizations are at risk of losing a large amount of hidden tacit knowledge. Thus, in a rapidly changing environment, organizations need to be agile and able to transform faster than ever. By properly preparing for the digitalization of learning, organizations can raise their ability to transform and gain competitive advantage against their competitors.

4. Launch digital workplace initiatives

Internal initiatives are in a key role when organizations prepare themselves for a smooth transition into a digital economy. In order to maximize the effectiveness of a digital workplace, it is critical to understand how the sources of motivation and engagement vary between different generations of workforce. By internally implementing digital workplace initiatives, it is easier for organizations to increase employee agility, engagement, and effectiveness in the transition.

5. Enhance organizational capability

As work is becoming more spontaneous and hyperconnected, organizations need to develop their organizational capabilities to respond to the new operating models introduced by the digitalization. It is critical to engage people in changing their mindset and behavior to suit the new ways of working, such as working virtually in swarms. Without a proper understanding of the digitalization and the changes it brings along, it is challenging for the workforce to absorb the transforming nature of work.

6. Ensure cooperation between CIOs and HR

Organization CIOs and HR need to work closely together to define the technology capabilities for digital work, digital learning, and digital workforce development designed to facilitate the change. Note, that it is not enough to aim at replicating the physical world processes, as the working skills required in the digital domain are different.

7. Measure and analyze learning

Today learning and problem solving often happen in social and informal scenarios. Whether formal or informal, it is crucial for companies to have tools to both measure and analyze all types of learning activities. Take into account that the ability to measure learning will be closely tied to the actual ability to execute.

Concluding Remarks

Due to the rapid changes in the nature of work, organizations need to adopt new ways of learning, innovating and problem solving. Learning and working are blending together and becoming time and place independent, which encourages leading learning organizations to utilize the latest learning methods like phenomenon-based learning or gamification in their processes. Most advanced organizations can even create collaboratories where learners can solve complex challenges.

In today's high-tech world, we are inundated with information and the question is not anymore where we find the needed information but how we utilize it, with whom we use it and what is the digital platform for the multilevel learning processes. Organizations should pay attention to the selection of the digital learning experience platform. Selecting an appropriate tool that fulfills the future workforce needs and the challenges that are outlined in this white paper may prove critical for future success.

The digital transformation of learning affects all organizations within different industry sectors, but especially those ones whose biggest resources are human capital resources and intellectual capital. Workforce retirement is a challenge which concerns many organizations' management. How the silent information and know-how is transferred to next generations is another critical success factor which should also concern industries with high labor turnover.

Learning experience management extends outside workforce development into their customer's experience. The ability to measure the effectiveness of learning creates a new set of tools for digital marketers and digital media. Engagement design for any digital service is a major piece of the puzzle between the success or a failure of a service. Today, any successful organization should be focusing on measuring the effectiveness of learning against the real world performance.

Offering the learners, whether they are employees or students, motivating and engaging learning experiences which can be measured and analyzed at the individual or group level is the solution to creating the modern "Apollo Effect" through digital transformation of learning.

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