

MAD SCIENTIST

LEARNING IN 2050

8-9 AUGUST 2018



**U.S. Army
Training and
Doctrine Command**

**Georgetown University
Center for Security Studies**



Co-Authored by:

Mr. Ian Sullivan – Assistant G2, ISR and Futures TRADOC G-2

Mr. Matthew Santaspirt – RDECOM-ARDEC Intelligence Representative to TRADOC G-2

Mr. Luke Shabro – Deputy Director, Mad Scientist Initiative, TRADOC G-2

Ms. Marie Murphy – Analyst, TRADOC G-2

20 December 2018

Contents

Key Findings	2
Old Human vs. New Human.....	4
Personalized Learning	6
Future Jobs and Skillsets	8
Continuous and Accelerated Learning	10
Conclusion.....	11

Key Findings

The convergence of technology, the speed of change, the generational differences of new Recruits, and the uncertainty of the Future Operational Environment will dramatically alter the way Soldiers and Leaders learn in 2050.

The Learning in 2050 conference generated the following key findings:

- **The New Human, who will be born in 2032 and be our new recruits of 2050, will be fundamentally different from the Old Human of today.** They will not just be digital natives but natives to embedded and integrated sensors, artificial intelligence, mixed reality, and ubiquitous communications.
- **Learning in the future will be personalized and individualized with targeted learning taking place at the point of need.** It will be tailored to the individual, not only in terms of subject matter but also in timing, duration, and learning style, to maximize effectiveness.
- **Teachers, students, mentors and learners in the future will not need to be physically co-located.** The ubiquity of connectivity, the growth of the Internet of Things, the introduction of universal interfaces, major advances in modeling and simulations, and social media innovation all converge to minimize the importance of brick and mortar schools and learning institutions.
- **Many future jobs and skillsets have not yet been defined or articulated.** Today's hobbies (drones) and recreational activities (Minecraft/Fortnite) could easily become occupations or Military Occupational Specialties (MOSs) in the future.
- **Learning in the future will be continuous, self-initiated, and may require obtaining knowledge and skills through non-traditional means.** The pace of learning is rapidly increasing, and software-defined applications, frequent and iterative technological change, and hyperconnectivity means that learning is outpacing current Army systems, techniques, and institutions.

The dynamic nature of technological change and the evolving way in which humans receive, process, and integrate information will force a paradigm shift in Army learning. This raises a number of questions that will challenge the future force. Will the Army of the future still conduct conventional training and education – Basic Training, Advanced Individual Training, Professional Military Education – in the same linear sequence and formalized structure? Will learning prior to unit training – Joint Readiness Training Center, National Training Center, and Joint Multinational Readiness Center rotations – take advantage of a virtual and synthetic training environment? How will the Army integrate New Humans into its ranks? How will it handle recruits who are digital natives with embedded technology? How will the Army recognize when new MOSs are

required, and can it be flexible enough to dynamically implement this type of institutional change?

To explore the effect that the convergence of technologies, systems, and concepts will have on the future of Army learning, the United States Army Training and Doctrine Command (TRADOC) co-hosted the Mad Scientist: Learning in 2050 Conference with Georgetown University on 8 – 9 August 2018 in Washington, D.C. The conference explored future learning technologies, personalization and customization, accelerated learning, and the effect of each on Army training, education, and readiness. In support of the event, Mad Scientist published several submissions from our “Call for Ideas” writing contest. Conference attendees included representatives from private industry, academia, and a host of government and military organizations including the State Department, the Army S&T enterprise, Defense Advanced Research Projects Agency, and the Intelligence Community. Keynote speakers discussed a number of topics ranging from Targeted Neuroplasticity Training to intelligent tutors to the future of work. Additionally, several hundred other global participants viewed the conference via livestream on the Internet.

Old Human vs. New Human

The recruit of 2050 will be born in 2032 and will be fundamentally different from the generations born before them. Marc Prensky, educational writer and speaker who coined the term digital native, asserts this “New Human” will stand in stark contrast to the “Old Human” in the ways they learn and approach learning¹. Where humans today are born into a world with ubiquitous internet, hyper-connectivity, and the Internet of Things, each of these elements are generally external to the human. By 2032, these technologies likely will have converged and will be embedded or integrated into the individual with connectivity literally *on* the tips of their fingers. The challenge for the Army will be to recognize the implications of this momentous shift and alter its learning methodologies, approach to training, and educational paradigm to account for these digital natives.

These New Humans will be accustomed to the use of artificial intelligence (AI) to augment and supplement decision-making in their everyday lives. AI will be responsible for keeping them on schedule, suggesting options for what and when to eat, delivering relevant news and information, and serving as an on-demand embedded expert. The Old Human *learned* to use these technologies and adapted their learning style to accommodate them, while the New Human will be born into them and their learning style will be a *result* of them. In 2018, 94% of Americans aged 18-29 owned some kind of smartphone.² Compare that to 73% ownership for ages 50-64 and 46% for age 65 and above and it becomes clear that there is a strong disconnect between the age groups in terms of employing technology. Both of the leading software developers for smartphones include a built-in artificially intelligent digital assistant, and at the end of 2017, nearly half of all U.S. adults used a digital voice assistant in some way.³ Based on these trends, there likely will be in the future an even greater technological wedge between New Humans and Old Humans.

	Any cellphone	Smartphone	Cellphone, but not smartphone
Total	95%	77%	17%
Men	95%	80%	16%
Women	94%	75%	19%
Ages 18-29	100%	94%	6%
30-49	98%	89%	9%
50-64	94%	73%	21%
65+	85%	46%	40%

<http://www.pewinternet.org/fact-sheet/mobile/>

¹ Prensky, Mark, Mad Scientist Conference: Learning in 2050, Georgetown University, 9 August 2018

² <http://www.pewinternet.org/fact-sheet/mobile/>

³ <http://www.pewresearch.org/fact-tank/2017/12/12/nearly-half-of-americans-use-digital-voice-assistants-mostly-on-their-smartphones/>

New Humans will be information assimilators, where Old Humans were information gatherers. The techniques to acquire and gather information have evolved swiftly since the advent of the printing press, from user-intensive methods such as manual research, to a reduction in user involvement through Internet search engines. Now, narrow AI using natural language processing is transitioning to AI-enabled predictive learning. Through these AI-enabled virtual entities, New Humans will carry targeted, predictive, and continuous learning assistants with them. These assistants will observe, listen, and process everything of relevance to the learner and then feed them information as necessary.

There is an abundance of research on the stark contrast between the three generations currently in the workforce: Baby Boomers, Generation X, and Millennials.⁴⁵ There will be similar fundamental differences between Old Humans and New Humans and their learning styles. The New Human likely will value experiential learning over traditional classroom learning.⁶ The convergence of mixed reality and advanced, high fidelity modeling and simulation will provide New Humans with immersive, experiential learning. For example, Soldiers learning military history and battlefield tactics will be able to experience it ubiquitously, observing how each facet of the battlefield affects the whole in real-time as opposed to reading about it sequentially. Soldiers in training could stand next to General Patton and witness him explain his decisions firsthand.

There is an opportunity for the Army to adapt its education and training to these growing differences. The Army could—and eventually will need—to recruit, train, and develop New Humans by altering its current structure and recruitment programs. It will become imperative to conduct training with new tools, materials, and technologies that will allow Soldiers to become information assimilators. Additionally, the incorporation of experiential learning techniques will entice Soldiers’ learning. There is an opportunity for the Army to pave the way and train its Soldiers with cutting edge technology rather than trying to belatedly catch up to what is available publicly.

Evolution in Learning Technologies

- | Emerging Technology |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> • AR/VR – Oculus Rift, Vive, Google Glass, HoloLens, Mobile Games. • Digital Assistants – Siri, Alexa, Google, Cortana. • Wearables – Smart Watches, FitBit. |

- | Future Technology |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> • Omnipresent narrow AI – Intelligent tutor assistants with you at all times. • Embeds/Implants – AR, communication, biological diagnostics. • Communications infrastructure – Advanced cellular and broadband networks. |

⁴ <https://www.nacada.ksu.edu/Resources/Clearinghouse/View-Articles/Generational-issues-in-the-workplace.aspx>

⁵ <https://blogs.uco.edu/customizededucation/2018/01/16/generational-differences-in-the-workplace/>

⁶ <https://www.apa.org/monitor/2010/03/undergraduates.aspx>

“The principal consequence of individual differences is that every general law of teaching has to be applied with consideration of the particular person.” – E.L. Thorndike (1906)

The world is becoming increasingly personalized, and individual choice and preference drives much of daily life, from commerce, to transportation, and to entertainment. For example, your Amazon account today can keep your payment information on file and one click away, suggest new products to you based on your purchase history, and allow you to shop from anywhere and ship to any place while tracking your purchase along the way, including photographic proof of delivery. Online retailers, personal transportation services, and streaming content providers obtain an unprecedented amount of specific individual information to provide a detailed and personalized experience for the consumer.

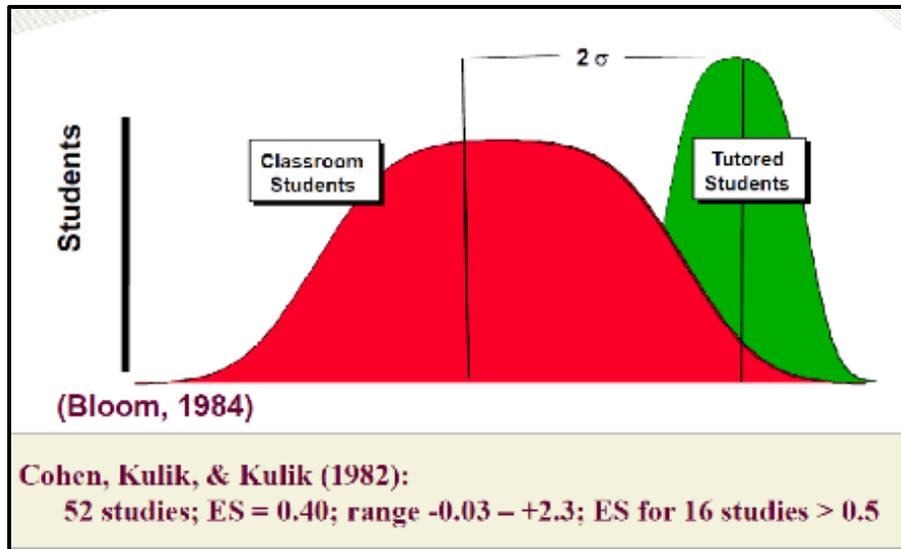
There is an opportunity to improve the effectiveness in targeted areas of learning – skills training, foundational learning, and functional training, for example – if learning institutions and organizations, as well as learners, follow the path of personalization set by commerce, transportation, and entertainment.⁷ This necessitates an institutional shift in the way we educate Soldiers. Instead of training administered based on rank or pre-determined schedule, training is conducted based on need, temporally optimized for maximum absorption and retention, in a style that matches the learner, and implemented on the battlefield, if needed.

An important facet of personalized learning is personal attention to the learner. Tutors have been used in education for 60,000 years.⁸ However, they always have been limited to how many educators could devote their attention to *one* student. With advancements in AI, intelligent tutors could reduce the cost and manpower requirements of one-on-one student impact. Research indicates that students who have access to tutors as opposed to exclusive classroom instruction were more effective learners as seen in the chart below. In other words, the average tutored student performed better than 98 percent of the students in the traditional classroom.⁹ What was a problem of scale in the past – cost, manpower, time – can be alleviated in the future through the use of AI enabled ubiquitous intelligent tutors.

⁷ Smith-Lewis, Andrew, Mad Scientist Conference: Learning in 2050, Georgetown University, 8 August 2018

⁸ Fletcher, Dexter, Mad Scientist Conference: Learning in 2050, Georgetown University, 8 August 2018

⁹ <https://www.edsurge.com/news/2014-08-10-personalization-and-the-2-sigma-problem>



Another aspect of personalized learning is the diminishing importance of geo-location. Education, in general, has traditionally been executed in a “brick and mortar” setting. The students, learners, or trainees, physically travel to the location of the teacher, expert, or trainer in order for knowledge to be imparted. Historically, this was the only viable option. However, a hyper-connected world with enabling technologies like virtual and augmented reality, high-bandwidth networks with low latency, high fidelity modeling, simulations, and video, and universal interfaces reduces or eliminates the necessity for physical co-location. This allows Soldiers to attend courses hosted virtually anywhere, participate in combined arms and joint exercises globally, and experience a variety of austere and otherwise inaccessible environments through virtual and augmented reality¹⁰.

Based on these trends and emerging opportunities to increase efficiency, the Army may have to re-evaluate its educational and training frameworks and traditional operational practices to adjust for more individualized and personalized learning styles. **When personalized learning is optimized, Soldiers could become more lethal, specially skilled, and decisive along a shorter timeline, using lesser budget resources, and with reduced manpower.**

¹⁰ Titus, Amy, Mad Scientist Conference: Learning in 2050, Georgetown University, 8 August 2018

The U.S. Army currently has almost 200 Military Occupational Specialties (MOSs) each requiring a Soldier to learn unique skills, capabilities, and qualities. The emergence of a number of new technologies – drones, AI, autonomy, immersive mixed reality, big data storage and analytics, etc. – coupled with the changing character of the battlefield means that many of these MOSs will need to change, while others will need to be created. This already has been seen in the wider U.S. and global economy, where the growth of Internet services, smartphones, social media, and cloud technology over the last 10 years has introduced a host of new occupations that previously did not exist. **The future will further define and compel the creation of new jobs and skillsets that have not yet been articulated or even imagined.** Today's Hobbies (drones) and recreational activities (Minecraft/Fortnite) that potential recruits engage in every day could become occupations or MOSs of the future.

The training of tens of thousands of new Soldiers in existing MOSs already is a colossal undertaking. A great expansion in the jobs and skillsets needed to field a highly capable future Army, replete with modified or new MOSs, would add a considerable burden to Army's learning systems and institutions. These new requirements almost certainly will present an opportunity for the Army to capitalize on intelligent tutors, personalized learning, and immersive learning to lessen costs and save time in Soldier and Leader development.

Some of the newly required skills may be inherent within the next generation(s) of Recruits, particularly if they are the "New Humans" referenced above. Many of the games, drones, and other everyday technologies that already or soon will be very common – narrow AI, app development and general programming, and smart devices – will yield a variety of intrinsic skills that recruits will have prior to entering the Army. Just like we no longer train Soldiers on how to use a computer, games like Fortnite, with no formal relationship with the military, will provide players with militarily-useful skills like communication, resource management, foraging, force structure management, and fortification and structure building, all while attempting to survive against persistent attack. Due to these trends, Recruits may come into the Army with fundamental technical skills and baseline military thinking attributes that flatten the learning curve for Initial Entry Training (IET).¹¹

While these new Recruits may have a set of some required skills, there will still be a premium placed on premier skillsets in fields such as AI and machine learning, robotics, big data management, and quantum information sciences. Due to the high demand for these skillsets, the Army will have to compete for talent with private industry, battling them on compensation, benefits, perks, and a less restrictive work environment – limited to no dress code, flexible schedule, and freedom of action. In light of this, the Army may have to consider adjusting or relaxing its current recruitment processes, business practices, and force structuring to ensure it is able to attract and retain expertise. It also may have to reconsider how it adapts and utilizes its civilian workforce to undertake these types of tasks in new and creative ways.

¹¹ Schatz, Sarah, Mad Scientist Conference: Learning in 2050, Georgetown University, 8 August 2018

The Recruit of 2050 will need to be engaged much differently than today. Potential Recruits may not want to be contacted by traditional methods¹² – phone calls, in person, job fairs – but instead likely will prefer to “meet” digitally first. Recruiters already are seeing this today. In order to improve recruiting efforts, the Army may need to look for Recruits in non-traditional areas such as competitive online gaming. There is an opportunity for the Army to use AI to identify Recruit commonalities and improve its targeted advertisements in the digital realm to entice specific groups who have otherwise been overlooked. The Army is already exploring this avenue of approach through the formation of an eSports team that will engage young potential Recruits and attempt to normalize their view of Soldiers and the Army, making them both more relatable and enticing.¹³ This presents a broader opportunity to close the chasm that exists between civilians and the military.



The overall dynamic landscape of the future economy, the evolving labor market, and the changing character of warfare will create an inflection point for the Army to re-evaluate longstanding recruitment strategies, workplace standards, and learning institutions and programs. This will bring about **an opportunity for the Army to expand, refine, and realign its collection of skillsets and MOSs making Soldiers more adapted for future battles, while at the same time challenge the Army to remain prominent in attracting premier talent in a highly competitive environment.**

¹² Davies, Hans, Mad Scientist Conference: Learning in 2050, Georgetown University, 9 August 2018

¹³ <https://www.stripes.com/news/uncle-sam-wants-you-to-play-video-games-for-the-us-army-1.555885>

Continuous learning, or the process of repeatedly engaging in activities designed to learn new information or skills, is a natural process that will be necessary for Soldiers and Leaders in 2050. The future workforce will define and drive when, where, and how learning takes place. Continuous learning has the advantage of allowing humans to learn from past mistakes and understand biases by “working the problem” – assessing and fixing biases, actively changing behavior to offset biases, moving on to decision-making, and then returning to work the problem again for further solutions. Learners must be given the chance to fail, and failure must be built in to the continuous learning process so that the learner not only arrives at the solution organically, but practices critical thinking and evaluation skills.¹⁴

There are costs and caveats to successful continuous learning. After a skill is learned, it must be continually practiced and maintained. Amy Titus explained how skills perish after 3-5 years unless they are updated to meet present needs and circumstances. In an environment of rapidly changing technology and situational dynamics, keeping skills up to date must be a conscious and nonstop process. One of the major obstacles to continuous learning is that learning is work and requires a measure of self-motivation to execute. Learners only effectively learn if they are curious, so learning to pass a class or check a box does not yield the same result as genuine interest in the subject.¹⁵ New approaches such as gamification and experiential learning can help mitigate some of these limitations.

The concept of accelerated learning, or using a compressed timeline and various approaches, methodologies, or technological means to maximize learning, opens up several questions: what *kinds* of technologies accelerate learning, and *how* does technology accelerate learning? Technologies useful for accelerated learning include the immersive reality spectrum – virtual reality/augmented reality (mixed reality) and haptic feedback – as well as wearables, neural stimulation, and brain mapping. These technologies and devices enable the individualization and personalization of learning. Individualization allows the learner to identify their strengths and weaknesses in learning, retaining, and applying information and provides a program structured to capitalize on his/her naturally favored learning style to maximize the amount and depth of information presented in the most time and cost-effective manner.

Digital learning platforms are important tools for the tracking of a Soldier's progress. This tool not only delivers individualized progress reports to superiors and instructors, but also allows the learner to remain up to date regardless of their physical location. Intelligent tutors may be integrated into a digital learning platform, providing real-time, individual feedback and suggesting areas for improvement or those in need of increased attention. Intelligent tutors and other technologies utilized in the accelerated

¹⁴ Taylor, Christopher, Mad Scientist Conference: Learning in 2050, Georgetown University, 9 August 2018

¹⁵ Masie, Elliott, Mad Scientist Conference: Learning in 2050, Georgetown University, 8 August 2018

learning process, such as augmented reality, can be readily adapted to a variety of situations conforming to the needs of a specific unit or mission.

Besides external methods of accelerated learning, there are also biological techniques to increase the speed and accuracy of learning new skills. DARPA scientist Dr. Tristan McClure-Begley introduced targeted neuroplasticity training (TNT), whereby the peripheral nervous system is artificially stimulated resulting in the rapid acquisition of a specific skill. Soldiers can learn movements and retain that muscle memory faster than the time it would take to complete many sets of repetitions by pairing nerve stimulation with the performance of a physical action.

Accelerated learning does not guarantee positive outcomes. There is a high initial startup cost to producing mixed, augmented, and virtual reality training programs, and these programs require massive amounts of data and inputs for the most realistic product.¹⁶ There are questions about the longevity and quality of retention when learning is delivered through accelerated means. About 40 percent of information that humans receive is forgotten after 20 minutes and another 40 percent is lost after 30 days if it is not reinforced.¹⁷

Most learners attribute mastery of a skill to practical application and not formal training programs.¹⁸ TNT attempts to mitigate this factor by allowing for multiple physical repetitions to be administered quickly. But this technique must be correctly administered, or psychological and physiological pairing may not occur correctly or occur between the wrong stimuli, creating maladaptive plasticity, which is training the wrong behavior.

An increased emphasis on continuous and accelerated learning could present the Army with an opportunity to have Soldiers that are lifelong learners capable of quickly picking up emerging required skills and knowledge. However, this focus would need to account for peak learner interest and long-term viability.

Conclusion

¹⁶ Hill, Randall, Mad Scientist Conference: Learning in 2050, Georgetown University, 9 August 2018

¹⁷ Goodwin, Gregory, Mad Scientist Conference: Learning in 2050, Georgetown University, 8 August 2018

¹⁸ Masie, Elliott, Mad Scientist Conference: Learning in 2050, Georgetown University, 8 August 2018

The future of training and educating Soldiers is on the precipice of change and the Army is faced with a difficult decision in how to respond. Technology is evolving at an exponential rate, enabling learners to master skills in less time, with fewer resources. With enabling technologies like intelligent tutors powered by AI integrated into our everyday personal devices, learners in the future will have on-demand access to a nearly exhaustive data set. This trend will foster the creation and development of *New Humans* whose learning styles will be a result of these new technologies and will bear stark generational differences to those who came before them. **The Recruit of 2050 will be a New Human who will present learning challenges to the Army for which it is not currently structured or prepared.** A deliberate and concerted effort may be needed to re-align the Army's learning and education institutions, as well as their educators, with the new learning styles of tomorrow's Soldiers.

The emergence and application of new technologies coupled with the burgeoning class of New Humans will drive the rise of jobs and skillsets that have not yet been defined or even imagined. **This expansion of technology, skillsets, and learning styles may impose significant force structuring and manpower changes to the Army.**

Learning will further evolve from a system geared to reach a mass audience toward a more individual focus. Personalized learning will become the norm where knowledge is imparted to the individual and administered in his or her learning style at the optimal time and place for absorption and retention. The advancement of technologies that enable ubiquitous and high quality communication will reduce or eliminate the need for learners and educators to be physically co-located. **While not every facet of Army learning and training can be personalized, a re-emphasized focus on the individual learner could instill more capability, confidence, lethality, and even resiliency in future Soldiers.**

There is an opportunity for the Army to benefit from continuous learning by fostering an environment that celebrates intellectual curiosity and rewards self-motivation. Accelerated learning, enabled by point-of-need and biological technologies can help the Army flatten the learning curve and compress training timelines while reducing resource expenditures. **Combining continuous and accelerated learning could provide Soldiers with rapid knowledge and skill acquisition abilities while stimulating enduring intellectual curiosity.**

The combination of these trends and events is leading to a potential changing character of learning. This change will be enabled by a leap in technology and produce new jobs and skillsets not yet discovered or defined. The Army will be faced with potential recruits who possess specific and valuable skills but will need to adapt its recruitment process to obtain them, as private industry also will be competing for their talent. The Army also will benefit from modifying or augmenting its current force structure to incorporate and integrate these skillsets and jobs into the force. To keep pace with the changing character of learning, the Army will need to take advantage of accelerated learning enabled by tools within the immersive learning spectrum. Mixed reality along with personal digital and intelligent tutors will allow Soldiers to learn and adapt quickly, acquire new and mission-specific skills, and do so at the point of need.

While the Army can benefit from such changes in approach to education and training, there are serious ethical questions to consider. Personalized learning will

require an immense amount of private data collection to be effective. The Army will be challenged to collect this information and utilize it while maintaining the privacy and rights of its Soldiers. Their introduction into Army training will bring about challenges from **unprecedented data collection and exploitation, security and privacy, and cultural challenges in learning relationships.**

The new character of the learning environment, the learner, and institutions and organizations that facilitate them, present the Army with a unique opportunity to capitalize on novel recruiting strategies, learning approaches, and training models to leap ahead of private industry and competitors alike. **The rapidly evolving nature of this future learning landscape presents the Army and larger DoD with the opportunity to make significant structural, manpower, and process changes that could lead to competitive overmatch in Soldier capability and lethality.**