Immersive Environments—The Impact on Training

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ABSTRACT

Immersive technologies are greatly enhancing the ability to transfer knowledge and create stronger learning outcomes for all types of learners. Among the advantages we've already seen from industry leaders in the adoption of immersive tech are: higher levels of motivation, higher levels of student engagement combined with a higher desire to succeed, higher levels of knowledge creation, a higher level of successful learning, and a safe learning environment that is more accessible, both geographically and to those with disabilities and learning challenges. However, what we know now relative to immersive technologies is the tip of the iceberg. What lies below the waterline yet to be discovered will continue to revolutionize this pedagogical approach.

With that being said, we need not only to employ immersive technologies to achieve a higher level of learning amongst our trainees, but we also need to learn how best to use immersive technologies to achieve successful training results. In this presentation, I will discuss the best practices for effectively utilizing immersive technologies in a training environment, alongside the best approach for minimizing the barriers to entry (equipment costs, costs of training, and resource costs, to name a few) to enable a broader, more effective, and accelerated adoption of immersive training across the military and defense communities.

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Laura's background is in education. A PhD Candidate in English Literature, Laura has been teaching students on various subject matter in an academic setting and has seen first-hand the need to modernize training and learning methodologies. Her passion for learning and her eagerness to explore the potential of new immersive technologies to transcend limitations previously imposed on learning scenarios feeds her ability to work within the VR/AR technology industry, bringing advanced digital solutions to the enterprise, and supporting entrepreneurship and the growth of the tech sector in Atlantic Canada.

The Future of Training Starts with Immersive Tech

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"We stand on the brink of a technological revolution that will fundamentally alter the way we live, work, and relate to one another. In its scale, scope, and complexity, the transformation will be unlike anything humankind has experienced before." –Klaus Schwab

INTRODUCING THE NEW LEARNING MODALITIES OF A DIGITALLY FUSED WORLD

There is a reason the word "smart" today stands simultaneously for human intelligence and advanced technological capability. Technological development has always played a key role in governing learning modalities. If we look back through a chronology of the reformations that impacted learning institutions, we can see direct correlations between significant revolutions in learning structures and core technological innovations. From a socio-political perspective, the first industrial revolution's factories ignited the spark not only for union regulation, but also for the child labor laws that would establish new mandates for education across all social levels (Child Labor, 2020). On a more innovation-specific level, the invention of technologies that enabled us to record information (the pen, the pencil, the typewriter, the computer), to visualize information (slide projectors, chalk boards, overhead projectors), and to mobilize information (the printing press, the internet) transitioned us from the learning modalities of an oral culture to those of a literate or written culture. And today, standing at the forefront of the fourth industrial revolution, where "a fusion of technologies [blurs] the lines between the physical, digital, and biological spheres" (Schwab, 2016), we are looking forward to the new learning modalities of a digitally fused culture.

Digital Pervasiveness and the Need for Modern Adaptations of Learning

Not only has "technology…always been at the forefront of human education," but now more than ever, "when most students are equipped with several portable technological devices at any given time, technology continues to push educational capabilities to new levels" (Purdue Online, 2020). The fusion between digital, physical, and biological spheres is directly connected to the pervasiveness of innovative new digital technologies—technologies that include biometrics, machine learning and artificial intelligence, haptics, and immersive interfaces (Purdue Online, 2020). In a study on the relationship between immersive interfaces and learning engagement, Chris Dede observes that "the information technologies used by children during their formative years influence their learning strengths and preferences" (Dede, 2009). He goes on to conclude that "immersive interfaces," particularly due to the fact that they are such an "increasingly prevalent type of media," are able to "aid in designing educational experiences that build on students' digital fluency to promote engagement, learning, and transfer from classroom into real-world settings" (Dede, 2009). In other words, to create learning environments that remain adaptive to the changing needs of modern learners, be they within classrooms or industry training centers, we need to be integrating the technological forms that those learners are familiar and experienced with into their learning environments; this will allow us to leverage the technical formats learners are already 'programmed' to interact with to achieve higher and more compatible levels of knowledge and skill transfer. In their study on the use of immersive virtual reality in learning science, Jocelyn Parong and Richard Mayer concur that using VR technologies, due to their nature as well as their familiarity to modern learners, allows interaction with multimedia lessons to become "easy and intuitive," and in enabling "the educational task to become much more intuitive," "information is passed between the environment and the student with increased efficiency and selectivity" (Parong, 2018). This increase in learning efficiency suggests that incorporating new technology into these learning spaces isn't merely following the technological "trend," but is actually a necessary part of the adaptation of learning environments to meet the needs, expectations, and higher learning potential of a technologically advanced modern culture.

The potential for unlocking this higher level of learning is clear when we examine the number of people who are already using the technologies that enable access to immersive and other technological advancements. Statistics show that approximately 3.5 billion people around the globe use smartphones, and that number "is forecast to further grow by several hundred million in the next few years" (Statistica, 2020). Nearly 50% of private households have a computer, and in the US alone, 66% of individuals own at least two digital devices, while 36% own all three (smartphone, PC, and tablet) (Pew Research Center, 2020). According to further statistics, there are more than 171 million VR users worldwide, and as many as 78% of Americans are already familiar with VR technology. Demand for standalone VR devices is expected to grow more than 16 times between 2018 and 2022 (Statista, 2020). The global pervasiveness of technology has already created the opportunity for industrial and academic learning institutions: the majority of their learners already have access to the necessary technologies, and as certain advancements cause these technologies (such as VR headsets) to become more affordable, while others enable the same immersive lessons to be accessed remotely from multiple devices, allowing users to access advanced learning without having to purchase new hardware, the capacity for accelerating learning to higher levels of potential is almost limitless.

The current need for advanced learning capabilities isn't limited to the classroom. While incorporating the technologies capable of unlocking a higher knowledge retention and skill transfer level in young learners is important for establishing deep learning retention in the fundamental years, training within enterprise is also entering a period of high necessity. That necessity is similarly connected to the growing pervasiveness of digital technologies, and the potential for internal optimization and external revenue opportunities that these technologies present. Combining the fact that the majority employees already have access to the necessary technologies with new advanced potentials for optimization using web hosting, online servers, and integrated interfaces, and industries are presented with a centralized digital system that is accessible by any device over any network to operate at the core of their infrastructure providing unlimited scalability potential—but this increasing internal digitalization of industries causes a direct shift in the skill requirements needed to support a technologically enhanced workplace. This digitalization was just accelerated to critical levels by a global pandemic that would force industries across the globe to rapidly adopt the technologies required to enable remote operability. Already, a recent report on the World Economic Forum had estimated that, by the close of 2020, nearly 35% of the top skills required for all job families would change, requiring the appropriate training to support that skill shift (Schwab, 2016). COVID-19 has dynamically increased that need. Industries were already spending $362.2 billion (USD) on corporate training initiatives worldwide (Statista, 2020). To accommodate the added training demands of digital and remote work environments, organizations need to adopt the technologies that can optimize training processes for affordability, remote accessibility, and effectiveness—and they can accommodate this by integrating training technologies that are capable of accelerating the required learning outcomes with the efficiency of advanced and intuitive learning technologies.

IMMERSIVE TECHNOLOGIES AND TRAINING SUCCESS

What Is an Immersive Learning Experience?

The pervasiveness of innovative new technologies has not only increased accessibility to immersive learning applications, but it has also increased the types of immersive learning experiences that are available. As Salsabeel F. M. Alfalah points out, this introduces the increasing possibility for new educational modalities (Alfalah, 2018); however, it also establishes a plurality of "immersion," and the nuances of this plurality are often overlooked. For instance, while the terms VR (Virtual Reality), AR (Augmented Reality), and XR (eXtended Reality), are often used interchangeably, there are distinct differences between the types of technologies that are needed to access each variation of "reality," and the type of immersive experience that is enabled by each.

Augmented Reality involves an overlay of computer-generated content onto a real-world environment that can superficially interact with the environment in real-time. With AR, there is no occlusion between computer generated (CG) content and the real-world. Technologies like the Microsoft HoloLens, Magic Leap, and AR compatibility on most new smartphones are enabling increased access to AR functionality.

Virtual Reality describes the simulation of an artificial 3D environment that resembles the real world and can be physically interacted with in a realistic way. VR encompasses all immersive experiences, whether they are created using real-world content (360 Video), synthetic content (CG), or both. VR also enables users to participate in immersive experiences through a number of different technologies, from VR headsets to PCs, and even through some mobile devices; however, it is important to note that the level of immersion that can be experienced is connected to the device being used. For instance, accessing VR through a PC instead of a VR headset restricts the level of immersion by placing the learner behind the computer screen instead of directly in the immersive environment.

Mixed Reality involves an overlay of synthetic content onto a real-world environment that anchors the synthetic content to the surrounding real-world environment and enables interaction both in real time. Mixed Reality experiences exhibit occlusion, which means the computer-generated objects are visibly obscured by objects in the physical environment. Many flight simulators demonstrate mixed reality environments, where the user is participating in a simulated experience that also requires interaction with physical control panels or switchboards. Any interaction with the physical objects would have a direct impact on their simulated experience.

eXtended Reality is the umbrella term now being used to describe Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR) technologies. XR refers to all real-and-virtual combined environments, and to all human-machine interactions that are generated by computer technology and wearables. XR incorporates such innovations as haptic technologies, which enable a user to experience touch sensations, and digital scent technologies, which provide learners with olfactory representation.

Use of these various technologies introduces learners to different classifications of immersion based on the degree of presence that is enabled (Alfalah, 2018). "Fully immersive systems detach the user from reality using HMDs (Head Mounted Displays), while semi-immersive systems remain anchored to the real-world during the simulated experience, and non-immersive systems allow the user to experience the simulation while remaining physically external to it. Regardless of the level of immersion presented, they key feature of an immersive experience is its ability to establish "presence" for the user. This occurs "when the multimodal simulations (images, sound, haptic feedback, etc.) are processed by the brain and understood as a coherent environment in which we can perform some activities and interact" (Alfalah, 2018).

What often sits "at the heart of the immersive experience," and remains one of the most recognizable aspects, "is the presence of the learner or user as an 'avatar' in the virtual space. This avatar represents the embodiment of the user in the virtual space and facilitates a greater sense of control within the immersive environments, allowing users to more readily engage with the experiences as they unfold in real time" (De Freitas, 2009). However, while the embodiment of the learner within the immersive experience is paramount, Chris Dede discusses that the other critical component of an effective immersive experience "is the subjective impression that one is participating in a comprehensive, realistic experience" (Dede, 2009). This involves "the willing suspension of disbelief, and the design of immersive learning experiences that induce this disbelief draws on sensory, actional, and symbolic factors" (Dede, 2009).

Sensory Immersion, according to Dede, "replicates digitally the experience of location inside a three-dimensional space" (Dede, 2009). He adds that "total sensory interfaces utilize either head-mounted displays or immersive virtual reality rooms, stereoscopic sound, and—through haptic technologies that apply forces, vibrations, and motions to the user—the ability to touch virtual objects" (Dede, 2009).

Actional Immersion "empower[s] the participant in an experience [that initiates] actions impossible in the real world that have novel, intriguing consequences" (Dede, 2009).

Symbolic Immersion, he continues, "involves triggering powerful semantic, psychological associations" by incorporating content experiences that "[draw] on the participant's beliefs, emotions, and values about the real world" (Dede, 2009). Scenarios that invoke fear or attempt to recreate the intensity of an emergency response situation are drawing on this principle.

Dede argues that, "the more a virtual immersive experience is based on design strategies that combine actional, symbolic, and sensory factors, the greater the participant's suspension of disbelief that she or he is 'inside' a digitally enhanced setting," thereby enabling a more enhanced educational experience (Dede, 2009).

Not All "Immersive" Experiences Are the Same

While it is evident that immersive technologies can empower learners "to experience a fully immersive sensory experience in almost any space imaginable," and that this can "encourage them to engage in deeper learning," gauging the success rate of this type of learning experience is dependent on more factors than simply the presence of an immersive experience (Parong, 2018). Other factors that play a critical role in learner success include the level of immersion and the type of immersive experience, the pedagogic model that is being used to inform the immersive experience, the interactions enabled within the experience, and the context created for the learning experience itself (De Freitas, 2009). Each of these factors is outlined in what Freitas et al. refer to as the "Four-Dimensional Framework" of learning (see Figure 1).

The four dimensions of learning consist of: "the learner, the pedagogic models used, the representation used, and the context within which learning takes place" (De Freitas, 2009). In the first dimension, the learning requirements, types of interactions, and methods of providing feedback are considered (De Freitas, 2009). The second dimension involves applying a pedagogical structure to the lesson that informs the means through which the learner will gain knowledge (De Freitas, 2009). The third takes into consideration the simulation itself in terms of fidelity, level of immersion, and the type of interactivity it promotes (ie: guided versus free roam) (De Freitas, 2009). Finally, the fourth dimension applies to the context of the learning environment, factoring in how it is accessed, the learner's surroundings while engaged, and the supporting resources that are provided alongside the immersive lesson (De Freitas, 2009).

Four Dimensional Framework	
Learner Specifics	**Pedagogy**
Profile	Associative
Role	Cognitive
Competencies	Social/Situative
Representation	**Context**
Fidelity	Environment
Interactivity	Access to learning
Immersion	Supporting resources

Figure 1: The Four-Dimensional Framework (De Freitas, 2008).

The four-dimensional framework was established in an attempt both to acknowledge the variety of factors that combine to affect a learning outcome, and to reconcile the fact that the traditional learning pedagogy could not be understood in the same way once immersive technologies were introduced. De Freitas et al. argue that the introduction of these technologies into the learning space essentially creates a cross-disciplinary approach to learning, and that requires a pedagogical shift from a traditionally singular modality of learning to one that contains more plurality, centered upon experience and exploration using multi-modal interfaces, cognitive-based interactions, and non-linear learning trajectories. As de Freitas, et al. suggest, "our interactions with the environment and our social interactions with others are adopting an approach towards constructing learning experiences as a process of 'choreography' rather than based around data recall strategies," and this requires us to reconsider not only the structure of learning that informs the immersive experience, but also how we can accurately measure success within a learning environment that promotes such a plurality of skill transfer (De Freitas, 2009). "This approach reorganizes how we produce and develop learning activities, with a greater emphasis upon learner control, greater engagement, learner-generated content and peer-supported communities, which jointly may increase learning gains" (De Freitas, 2009). In other words, the success of any learning experience can't be limited to the capabilities of the immersive technology itself. The varying possibilities for the immersive experience need to be considered in parallel with a multi-dimensional framework of learning pedagogy in order to result in a learning experience that is capable of expounding the desired levels of knowledge or skill retention, and the types of skills that are transmitted in this process may not be as effectively calculated by evaluations that consider data recall alone.

HOW IMMERSIVE LEARNING CAN MAKE A DIFFERENCE

Disrupting the Learning Curve

Disrupting the traditional modality of learning by introducing a multi-dimensional educational approach may seem like a daunting prospect, but the innovative learning methodology that is invoked by immersive technologies have seen some strong successes when it comes to breaking down the barriers that earlier modalities struggled to overcome. In particular, immersive learning experiences have demonstrated higher retention rates, higher levels of dynamic engagement, a higher learner reach, and an overall more efficient and effective learning pathway. As Alfalah describes, immersive technologies are "capable of [transforming] the educational process from being teacher-centered to being student centered" (Alfalah, 2018). The process uses what Alfalah defines as "constructivist learning theory," or "discovery learning," which enables learners to "discover and explore their own knowledge," and to "use their experiences to actively construct understanding that makes sense to them, rather than have understanding delivered to them in already organized form" (Alfalah, 2018). The fact that learners need to construct their own learning narrative prevents passive learning by requiring learners to immediately engage and actively participate in the facilitation of their own learning, thereby creating deeper knowledge and resulting in stronger comprehension (Alfalah, 2018). In other words, at the same time that immersive technology is causing instructors to re-evaluate their learning modalities, immersive learning environments are minimizing the dependency on the overall teaching process by enabling learners to establish their own pedagogies for learning (Alfalah, 2018).

Discovery learning forms a "powerful pedagogy" that enables learners to construct their own pedagogical experiences from within a four-dimensional framework when it combines "authentic contexts, activities, and assessment …with guidance from expert modelling, mentoring, and 'legitimate peripheral participation'" (Dede, 2009). Consider it like having numerous learning inputs that combine in a realistic experience where students can learn based on their own experience and intuitions, informed by real-world consequences. However, the impact of learner perception shouldn't be overlooked. Immersion in a digital environment—the ability to become the avatar—allows learners to shift between an exocentric (view of an object from the outside) and an egocentric (view from within the object) frame of reference, and this "ability to change one's perspective"—the bicentric experience—provides "a powerful means of understanding a complex phenomenon" (Dede, 2009). The egocentric experience that is involved in "becoming the avatar" not only impacts a learner's suspension of disbelief, thereby triggering a more powerful learning experience, but it also allows learners to distance themselves from the learning context while adopting their new egocentric experiences. Current studies have suggested that the psychological impacts of this type of learning may be contributing to the fact that "many academically low-performing students do as well as their high-performing peers" during immersive learning activities, and it has been suggested that part of the reason is attributed to the fact that these students are able to escape their self-identification as low-performers through the adoption of new perspectives (Dede, 2009). "This suggests that immersive media may have the potential to release trapped intelligence and engagement in many learners" (Dede, 2009). In other words, immersive learning experiences could be helping learners shed their own self-imposed limitations by empowering them with opportunities to gain new perspectives in an environment that also denies traditional, and thus recognizable, evaluative structures.

The impacts of this pedagogical shift to multi-modal student-centric learning are significant. Immersive training technologies have been able to disrupt one learning problem that has pervaded for centuries: retention. In 1885, Herman Ebbinghaus came up with a theoretical approach to the problem of retention (Shrestha, 2017). He described the phenomenon as the 'Forgetting Curve,' observing that the brain demonstrated a consistent decrease in its ability to retain memory over time and theorizing that the length of time during which something can be remembered is directly dependent upon the strength of that memory (Shrestha, 2017). In order for something to be remembered well into the long-term, the initial piece of information needs to be strengthened, either through the continuous review of the knowledge, or by allowing that information to be learned in a strong, impactful way (Shrestha, 2017). Following traditional methods, Ebbinghaus's calculation (as seen in figure 2) shows the forgetting curve to be exponential: "Memory retention is 100% at the time of learning any particular piece of information. However, it drops rapidly to 40% within the first few days. After which, the declination of memory retention slows down again" (Shrestha, 2017). This figure is corroborated in numerous studies, where it is demonstrated that individuals will forget 90% of course content after only a month away from training (Burch, 2017).

The Immersive Learning Effect: Increased Learner Engagement and Knowledge Retention

Immersive training disrupts this pattern by introducing simulated, interactive environments that automatically create stronger learning memories out of active learning modalities that require heightened levels of engagement. Immersive learning environments combine sensory (visual, tactile, and auditory) perception and psychomotor skills (muscle memory) in a practical, or "situated" learning environment that demonstrates realistic cause-effect response scenarios (Dede, 2009). Humans, by nature, are used to learning by doing, by using their eyes, hands, and muscle memory, and by perceiving the critical impacts of their actions. Immersive technology enables learners to enter a realistic simulation of any training environment, where they can learn and make mistakes safely, supported by responsive functionality and the true-to-life physics of the simulation, in combination with added educational content (pictures, videos, documents, parts and equipment labels, instructions, or live sensor data). The result is an increased engagement to a

100% attention rate, and a strong training memory with a resulting 75-90% rate of knowledge retention (Shrestha, 2017).

Learning "Transfer" Skills

Immersion in a digital environment creates situated learning experiences with enhanced learning outcomes that include higher engagement and retention, and one of the key reasons behind this success is "transfer" (Dede, 2009). According to Dede, "Transfer is defined as the application of knowledge learned in one situation to another situation and is demonstrated if instruction on a learning task leads to improved performance on a transfer task, ideally a skilled performance in a real-world setting" (Dede, 2009). Dede points to two key methods that allow transfer to be measured: through sequestered problem-solving, and through preparations for future learning (Dede, 2009). "Sequestered problem-solving tends to focus on direct applications that do not provide an opportunity for students to utilize resources in their own environment (as they would in the real world); standard tests are an example of this" (Dede, 2009). As Dede notes, the theoretic at play during sequestered problem-solving is known as "near-transfer," which provides problem solving instruction to learners for a set of standard problems, and then evaluates their ability to apply their learned knowledge "to a similar context with somewhat different surface features" (Dede, 2009). It is referred to as near-transfer because the gap between given knowledge and requested application is not very big; there are enough similarities built into the context to make the required transfer of knowledge simpler to grasp.

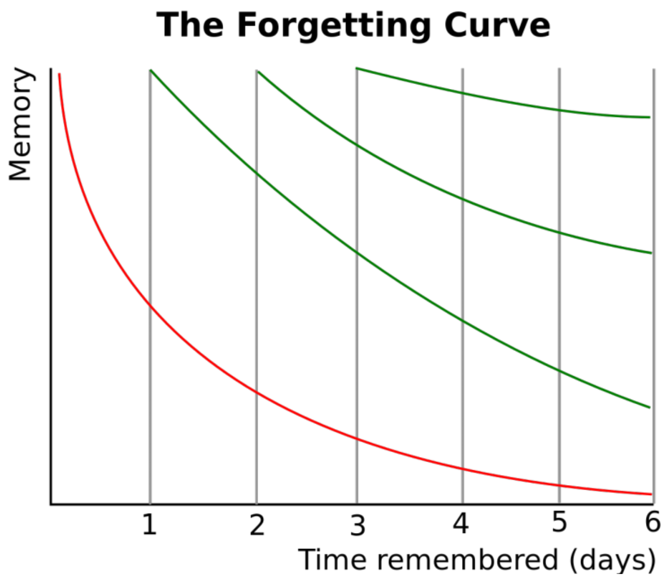

Figure 2: The Ebbinghaus Forgetting Curve (Shrestha, 2017).

On the other hand, the "preparation for future learning" models involve "students 'learn[ing] how to learn' in a rich environment and then solv[ing] related problems in real-world contexts" (Dede, 2009). The students are provided with the conventional amount of instruction and problem-solving training; however, in order to fulfill their preparation for future learning, they are required to demonstrate far-transfer skills, which involve "applying knowledge learned in a situation to a quite different context whose underlying semantics are associated, but distinct" (Dede, 2009). Dede points out that "One of the major criticisms of instruction today is the low rate of far-transfer generated by presentational instruction. Even students who excel in educational settings often are unable to apply what they have learned to similar real-world contexts" (Dede, 2009). Immersive learning experiences, he posits, offer an alternative solution that allows real-world problems and contexts to be simulated to enable students to learn and apply the necessary preparation for future learning without requiring far-transfer skills (Dede, 2009). "The potential advantage of immersive interfaces for situated learning is that their simulation of real-world problems and contexts means that students must attain only near-transfer to achieve preparation for future learning" (Dede, 2009). This means that training institutions need to afford less effort to discover methodologies for teaching far-transfer skills and can instead provide more effective and engaging learning experiences that properly prepare students for the problems they will actually experience outside the safety of their learning environments. It also means that more students will be able to effectively meet training expectations without having to acquire the more abstract application skills required for far-transfer.

Enhanced by immersive technologies, Dede argues, "situated learning seems a promising method for learning sophisticated cognitive skills, such as using inquiry to find and solve problems in complicated situations" (Dede, 2009). He points to flight and surgical simulators as particularly prevalent examples of the ability to train near-transfer skills by allowing students to develop psychomotor skills in a digital simulation prior to using near-transfer skills to apply that knowledge to the real-world setting (Dede, 2009). These findings illustrate the potential applications immersive learning environments can present for corporate and military training in particular.

THE IMMERSIVE INVESTMENT: IMPLICATIONS FOR INDUSTRY

An investment in digitalized training using immersive technologies supports the transition from traditional classroom learning to multi-modal, student-centric training, and this shift provides multi-tiered benefits for industries who are looking to optimize their approach to training. According to a study by Capgemini, many early facilitators are already seeing significant instances of these benefits (see figure 3).

Increased Training Efficiency

Primarily, enterprises can benefit from access to increased training efficiency. As technology continues to advance to allow high-fidelity immersive training and education to become more readily available across platforms and networks, immersive training continues to offer a highly effective, easily accessible, and engaging remote training solution. This will increase the number of learners who are able to engage in immersive training during any session. It will also enable learners to review and practice lesson material independently to further enhance their knowledge retention and transfer, and it will minimize the cost and impact of distance by providing enterprises with an alternative solution to sending training experts or learners offsite to fulfill training requirements.

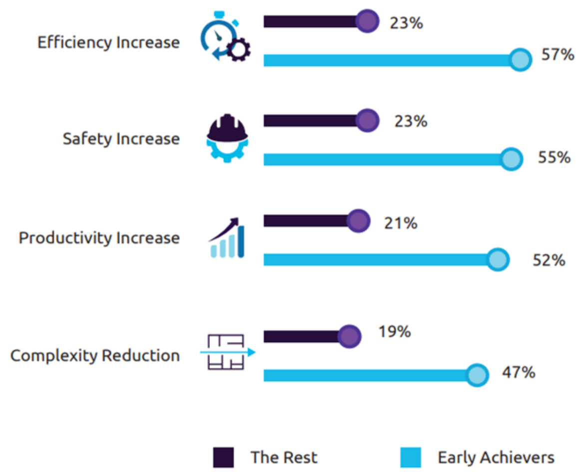

Figure 3: Benefits claimed by early adopters of immersive technologies (Capgemini, 2018).

Increased ROI

Demonstrated ROI is one of the strongest drivers in the adoption of immersive training, and numerous industries are already seeing a positive return on their investment in immersive technologies. According to a Capgemini report, Boeing's use of augmented reality has resulted in a 40% increase in productivity and a 25% reduction in production time (Capgemini, 2018). Similarly, Intel reported that their final assessment calculation following the implementation of their immersive Electrical Safety Recertification training indicated the 5-year ROI potential could be as high as 300% (OneBonsai, 2018).

New Revenue Opportunities

In addition to cost and efficiency savings, enterprises that invest in immersive training create opportunities to use their immersive training as a revenue driver. Once created, immersive training lessons can be sold to end clients, and virtual training environments can be used to improve remote support engagement with clients and affiliate operations.

Futureproof Data

Digitalized training offers advanced user tracking, data collection, and data analysis capabilities, and as such is working to secure an improved dataset—one that can prepare its digital infrastructure for the potential of still-developing technologies, like Artificial Intelligence.

Case Studies

From enabling increased ROI potential through accelerated training initiatives, to providing realistic learning scenarios in a safe environment that maintains critical context with real-world consequences, to benefitting from high-fidelity learning environments that promote precise psychomotor skills, many of the benefits of incorporating immersive training have already been realized by enterprises in manufacturing, aerospace and defense, healthcare, and more (see table 1).

Table 1: Case Study Examples

Company	Use Case	Benefits
Jazz Aviation LP	**Competency Training** - high-fidelity VR training for Aileron Cable inspection on the Jazz Q400 Aircraft - immersive training experience guides learners through a fully functioning, interactive cockpit - students required to follow proper procedures and use proper equipment to inspect for randomized cable damage.	- decreased training time - decreased training costs - access to Q400 not required - immediate feedback - learners can run through training as often as they like to maximize competency.
Royal Canadian Navy	**Offshore Maintenance and Procedural Training** - high-fidelity, fully immersive maintenance and operational training for diesel/electric propulsion engines aboard Harry DeWolf-class Arctic and Offshore Patrol Ships - first of its kind solution in marine sector - enables competency training and evaluation of fault detection abilities showing real-world consequences of mistakes.	- increased competency - training in context of job site - increased learner safety - reduced risk to ship and engines - decreased training costs -enforces real-world consequences.
RENK Group	**Maintenance Training on Specialized Equipment** - Immersive XR training experiences require learners to locate correct tools and follow correct procedures to safeguard assets while performing maintenance operations and troubleshooting procedures - enable training on equipment that can't be interacted with once assembled, and allows end-client training where site visits often not authorized.	- Increased competency - realistic job site environment - "train the untrainable": can enable training on equipment that can't otherwise be interacted with - train end-client technicians remotely.
GE-Healthcare	**Fault-Resolution Training for Critical Systems** - Immersive training simulations on ApexPro Telemetry systems allows for fault recognition and resolution training on vital patient monitoring systems used in hospitals - Learners faced with randomized error code that they are required to properly troubleshoot and resolve to restore system operations. - Learners are scored on their solutions.	- Increased competency - Able to train on-site rather than having to relocate to access specialist for training - No risk of training interfering with operational equipment in hospital - Decreased cost of training

These are just a few examples of the impacts industries are already seeing from the integration of immersive training technologies, yet the benefit of these integrations is clear. Immersive training applications create opportunities for industries to not only benefit from the advanced efficiency and competency of personnel, but also to leverage the same technologies into new avenues of growth. From enhancing training efficiency, to creating new potential revenue lines, to leveraging ROI to upgrade to a full-scale digital infrastructure, immersive technologies hold significant potential for enterprise.

CONCLUSIONS

The technologies that are powering the latest industrial innovation are already creating a dynamic impact on the world. Virtual, augmented, mixed, and extended reality technologies, alongside Artificial Intelligence and Machine Learning, are creating new learning environments that are disrupting the modalities and pedagogies of learning on a fundamental level, resulting in multi-modular, student-centric learning applications that are capable of facilitating new levels of understanding across industries and across learning platforms. And this is only the start of the revolution. If one thing has been made clear about the power of technological innovation, it's that it doesn't limit itself to mere ripples of change; it moves through the world in revolutionary waves, and riding the forefront of those waves are the industries that are the most prepared to embrace the unlimited potential that change has to offer. Today's learners are being led through the world by bleeding-edge, disruptive, and inspiring technological innovations—innovations that are disrupting the perceived limitations of the traditional modalities of learning in order to unlock new levels of learner potential, and thus fuel the limitless potential of future innovation.

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