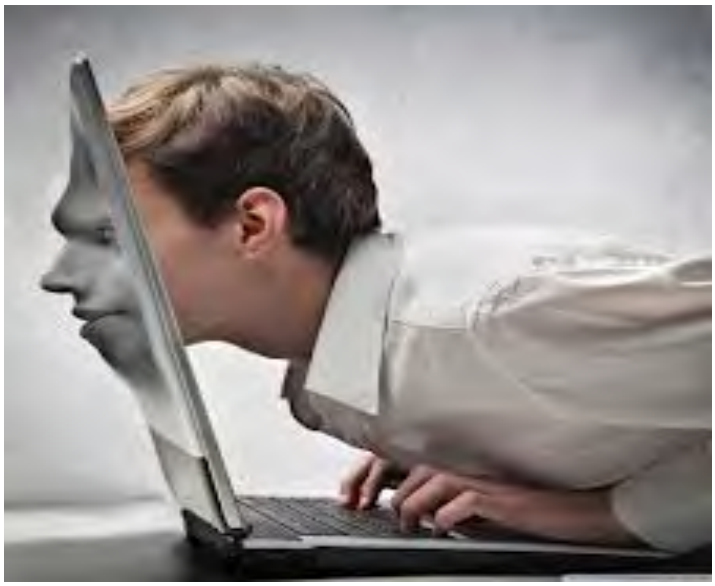

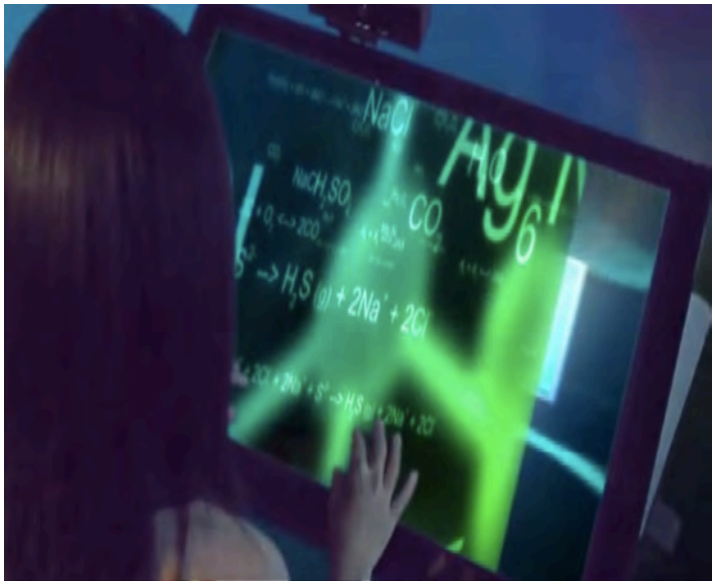

Drexel UNIVERSITY | ONLINE

The Online Classroom of the Future

Exploration of the digital ecosystem with an in-depth focus on the virtual learning environment of the future.

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Drexel UNIVERSITY | ONLINE

Online Classroom of the Future

It's the start of a new week. John awakens to a beautiful morning. "Light on," John commands. ViLA (Virtual Individual Learning Assistant) perks up, "Good morning, John, would you like to prepare for learning today?" John responds, "Yes, ViLA. Great! Let's get started." John's schedule for the day is instantly displayed on the mirror for him to view as he brushes his teeth.

"ViLA, play introductory module video", John commands. The video displays on the mirror and the learning begins while he gets ready. ViLA asks, "Shall I provide a quick assessment to prepare for your test this week, John?" With a positive response, ViLA verbally questions him as he shaves.

"Play as hologram," John directs ViLA, so he can continue watching while dressing. As the video ends ViLA offers a holographic model he can manipulate to practice and reinforce learning from the video.

Now ready to head out, John has a little bit of time before his first meeting at work. He checks his smart watch to make sure the assignment he submitted has been received by his instructor and receives the following response: "Your assignment is under review. There are no outstanding assignments due today at this time. You have a virtual lab that must be completed by Friday, your chemistry project is due two weeks from tomorrow, and your research paper for Business Communications is due the following Thursday."

John clicks on the Virtual Lab app so he can schedule time for the digital microscope to finish his virtual lab later in the evening and sees it is immediately available. As he works through the lab assignment, John struggles with one problem. He quickly clicks for help and a chatbot (an

artificial intelligence device that conducts conversation) begins interacting with him. Not able to resolve his issue, John clicks on Yup (an on-demand digital tutoring service), takes a snapshot image and is instantly connected to a live tutor and the help he needs.

Virtual lab completed, it's time to head out. John sets his watch to play the most recent podcast from his business professor as he drives to his meeting.

He dons his smart glasses to continue studying as he waits for his order at Starbucks, then opens his digital newspaper to peruse customized and personalized content that dynamically changes as he interacts with learning links, resources and self-assessment tools.

Near time for the meeting to begin, John clicks to set up collaborative huddle times with his online classmates later in the day. He commands ViLA to use his smart glasses to play the holographic image of several molecular structures, as he completes one final review for his chemistry assessment that afternoon.

His busy day has already been quite productive, and John feels good about all that has been accomplished, learned and applied so far this week. He particularly enjoyed the virtual project he did as part of the "OJT practical application" partnership with a Fortune 100 company. The digital storytelling platform enabled John to make a multimedia movie to give an overview of his approach to solving the problem presented in the project. He then designed an immersive 3D experience, by creating a virtual reality world demonstrating the solution in action. While he is thinking about it, John stores both works in his lifetime professional e-portfolio.

As John leaves his job at the end of day, it's time for the synchronous huddle with his classmates. Fortunately, he can use his smart watch to begin the videoconference while driving home. Once there, the videoconference automatically switches to the telepresence robotic display. John's classmates have chosen to use

holographic projection, sitting around the table. No problem – one command and ViLA adjusts to the preferred environment. Software removes the background of his messy living room,

replacing it with a pleasant color of choice. Today's huddle requires extensive virtual collaboration tools.

With the huddle completed and content captured and stored, John is ready to have some downtime and a pleasant evening with family. He is amazed at how much he accomplished in a day with work, school and family time. John recalls how several friends had told him it was too much to take on another degree plus work. "ViLA, set a reminder to tell Nadir and Ireni about Drexel University Online. They are going to want to do this too."

Classroom of the Future – Rethinking the Virtual Learning Environment

Seamless. Simple. Powerful with the click of a button or voice command.

These attributes should be the cornerstone of the online classroom of the future. To imagine the virtual learning environment (VLE) of tomorrow, we must consider new methodologies augmented with technologies that enable us to create active, authentic and customized virtual learning experiences.

The classroom as the center point, must be diverse to meet the profile of any given discipline, subject area or level of education. Each environment will look different – scalable and unique, with its own design. Whether teaching general concepts or concrete skills, these environments must vary in design to fit courses as dissimilar as organic chemistry is to medieval history.

Like Socrates said, "As society goes so goes education." In designing these classrooms, we must consider what society looks like today and where it is headed. Students and educators, alike, live in a technology-driven world, where by simply browsing the Internet, they have access to smart recommendations and personalized solutions, delivered through multiple modalities on any device. So, to replicate that experience in the academic world, we must create a VLE that is every bit as powerful and multi-faceted.

Virtual Learning Environment Parallels Everyday Culture

> Today's online classrooms are more often than not, counter cultural.

In reality, however, today's online classrooms are more often than not, counter-cultural, with students struggling to work in a VLE that is devoid of digital capabilities they have grown accustomed to using in their personal and professional lives. Thus, to ensure a more seamless and effective experience, the learning environment should be more closely aligned to everyday culture.

As such, expectations are dictated by the marketplace, rather than by the institution – which means that education in the future must mirror both the technology we use and the connected world in which we live, with its ever-evolving access to expert knowledge. It stands to reason then, that by exploiting the digitals tools their students use to retrieve, construct and consume this knowledge on their own, educators will have the capacity to create powerful learning experiences that meet the demands of a changing world and a changing workforce.

In a well-conceived VLE, students will receive real-time and useful information to help them learn what they need, when they need it, while instructors will have the ability to personalize the educational experience in line with those needs. Likewise, the right digital tools and apps will enable both to curate content quickly in a world where new knowledge is evolving at an exponential speed.

Connected from All Angles

Consider that 65-70% of the population now participates in higher education at some level. Moreover, these learners cover the spectrum of age and ability, educational background, experience and life circumstances – which means they need access to a diverse selection of academic options and delivery formats, preferably within the context of a robust virtual learning environment.

Equally important, the VLE must be designed to connect their learning, work and life experiences; personal interests, abilities, and learning preferences, grounded in an individualized learning persona or "Learning Identity" that is unique to each of them.

Student Learning Persona

Socrates also said, “To be a good teacher, you need to know the soul of your students.”

Beyond personalization, the student’s “Learning Persona” not only customizes content and learning experience, but also tells his or her story in such terms as skills acquired, accreditation levels achieved, and informal learning completed. Imagine a digital ecosystem where all sources of learning for each student’s entire life are cataloged in a knowledge graph that conveys “who and what I am,” making it possible for instructors and employers to better understand the student’s unique personal and professional identity.

Harvard professor Todd Rose said, “With the absence of more precise and specific data about individual students, we often jump to generalities and broad-swath solutions that hold the potential to do more harm than good.” Consequently, the VLE will need a suite of tools that enable instructors to “know” their students at a glance, in a manner that is quantified, so they may differentiate instruction around individual needs.

In an instructor-led, artificial intelligence-supported system, a holistic understanding of the student can systematically leverage resources and technologies to adapt to these immediate needs. As such, the VLE can be customized on the fly both to the course or lesson and to a student’s learning style and preferences. Consider the variance between a research student versus one who needs to learn the basics of coding.

Under this scenario, the online classroom of the future, or VLE, will depend on the digital ecosystem, in that the cloud of knowledge follows each student, with disparate platforms and networks feeding seamlessly into the VLE system. By capturing and using both big data and micro-data feedback, artificial intelligence (AI) can work behind the scenes, constantly adapting to how students choose to learn and where they spend more time, thus providing the right content in the right format for consumption.

AI and data analytics become key to creating the “Student Persona” or learning identity that follows the student and customizes the learning, when it comes to helping the instructor know what tool to use for achieving the desired outcome. This approach can be entirely different from one student to the next.

Virtual Learning Environment Design

A typical learning management system (LMS) has some combination of essential elements, including learning pathways, profiles and communities; digital portfolios,

analytics tools, social elements and learning applications; coaching tools, flags and alerts.

Some say the LMS is dead. Others say we either need LMS 4.0, or to begin envisioning a CORE LEARNING TECHNOLOGY SYSTEM (CLTS) or Next Generation Digital Learning Environment (NDGLE), with which to replace the traditional LMS.

Gordon Freeman, Blackboard Board Member, advised the company's leadership that they must move to the next level in order to be successful in the future. He suggests that an AI model, which will capture and analyze keystrokes and searches to customize the learning experience validating the capture of big data to transform teaching and learning.

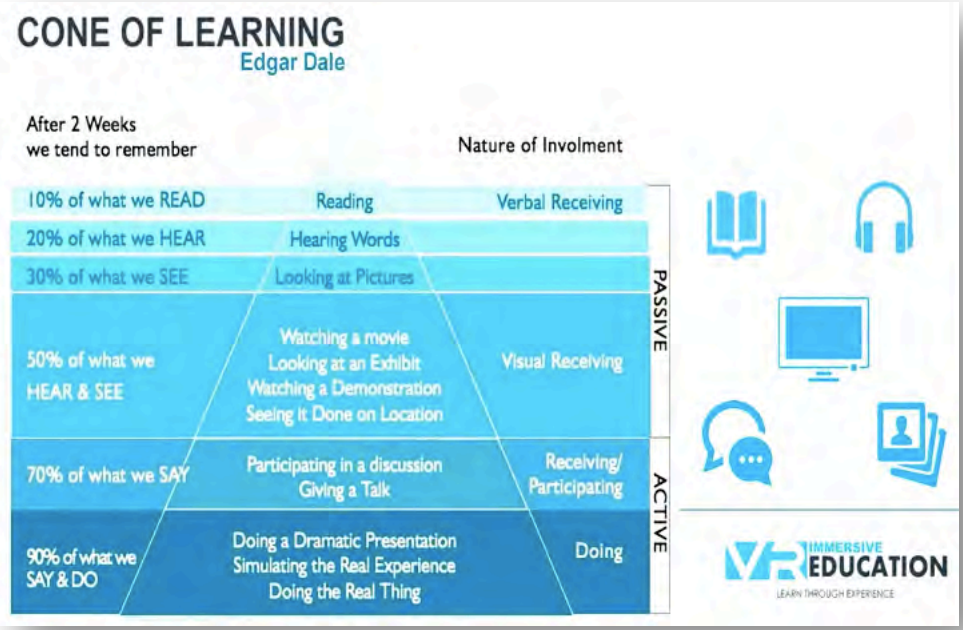
Drexel University Online envisions developing a virtual learning environment with a supporting platform and ecosystem – and designing the right VLE for the future is critical to success. It must be a place for data, communication and content in an All-in-One Dashboard.

This new platform will be AI-driven and incorporate a diverse assortment of multi-sensory media, with which to provide a rich learning experience. It will also provide catalog-style access to a myriad of curated content and resources that is both searchable and accessible on-demand, providing students and instructors with the capacity to grab content, as well as to search for and share information instantaneously. Likewise, the VLE will integrate digital tools and applications that ensure a connected and measurable learning experience.

This robust platform will also shape both the method and practice of instruction in response to what the student is doing. By constantly running analytical tools in the background, it will track student progress, while providing the appropriate response to teaching and learning design, thereby empowering instructors to focus more on *how* they teach.

The ultimate platform must *engage every sense* to create deeper learning - visual, audio, oral, touch, and smell. At the same time, the learning system will intuitively discern what to deliver, making it easier to create and drive the narrative. Equally

important, the VLE will be designed to move students from passive learning to active engagement, in line with Edgar Dale's Cone of Learning diagram below.



Given the social nature of learning, an effective VLE environment must enable instructors to infuse their courses with collaborative learning strategies and tools. For example, students should be empowered to work on authentic, complex tasks in small groups, with the help of team-based learning strategies that encourage them to dive more deeply into the content than they might simply working on their own. But to meet these requirements, we will need to design the right platforms, using the latest digital tools.

VLE Components

Because *simplicity* is key when it comes to creating the right virtual learning environment, it's important to steer clear of features that make it heavy, clunky and complicated, in favor of components that work together in a carefully blended, seamless and transparent format to provide:

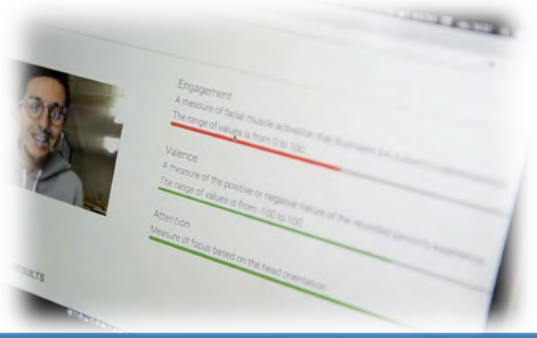
- Multi-modal interaction that is pedagogically scalable
- User-friendly instructional design and delivery
- Learning content available in multiple forms
- Analytics for assessing student progress

- Active engagement in authentic learning experiences, within the context of real-world problems and scenarios, which allow for a smooth transition from coursework to career
- A “cohort effect” using social networking to facilitate robust discussions and build meaningful relationships – both in and beyond the classroom.

Moreover, to ensure that these components are not only present, but also optimized around effective learning, it is essential to invest in the appropriate hardware, software and digital tools, with which to support them. For example, there are video-on-demand systems that run consumption analytics to capture and assess how students study. So, when an instructor observes that most students are repeatedly reviewing one section of a recorded lecture, she can adjust the pedagogical approach in response to the precise point at which they are feeling lost.

There are also new technologies, such as Binumi, for streamlining instructional design. This app provides access to editing tools and content that include more than 3.5 million royalty-free footage, images and audio clips, which instructors can use to quickly and easily build multimedia movies without having to rely on video editing skills.

Facial recognition and eye tracking software is yet another essential component in the classroom of the future. In two online classes, ESG business school in Paris implemented software called Nestor, which employs AI and facial analysis to determine whether students are paying attention in class.



FACIAL RECOGNITION and EYE TRACKING software can measure visual facial expressions to determine level of student engagement and respond.

Video technology tracks facial responses to determine engagement or points of confusion without needing electrodes, wearables or attachables.

It can also be used for verifying student identity.

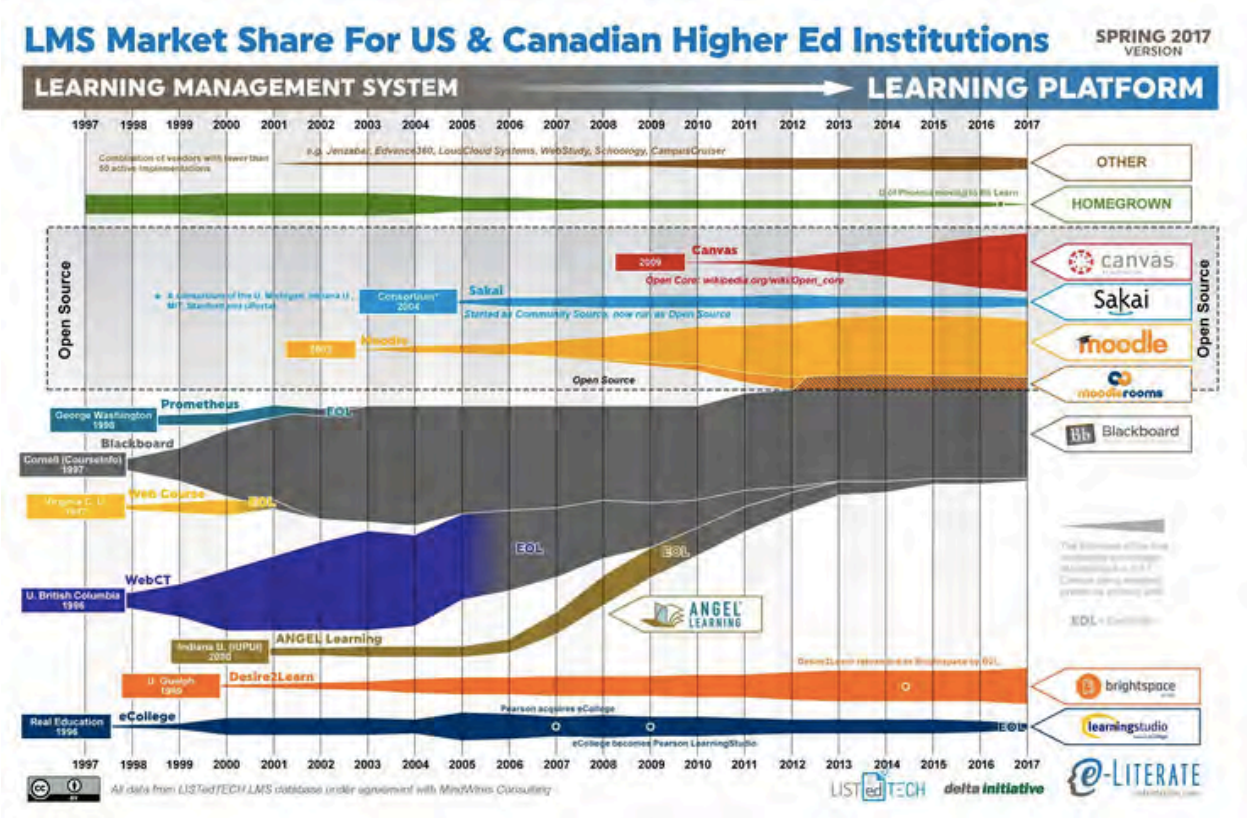
On a much larger scale, Osmosis is a good example of a future-focused adaptive learning platform. It grabs and sends content to students based on their current class schedules and syllabi, while also providing pertinent resources according to their learning styles in spaced repetition. Whether furnishing these resources as videos, flash

cards or mnemonic devices, they are delivered within a two- or three-dimensional environment, designed to make learning stick. Likewise, quick assessments enable the system to ascertain and drive knowledge acquisition and retention.

LMS and Next Generation Digital Learning Environment Platforms

Powerful VLEs begin with the right platform.

When Content Management Systems (CMS) were created in 1998 nobody expected that they would evolve into the Learning Management System (LMS) of today, with more than 70% of higher education institutions adopting this platform by as early as 2003. Although Blackboard and Moodle now claim a majority of the worldwide LMS market, there are two companies quickly invading their space, with a third right behind them.



Canvas Infrastructure is the fastest growing LMS in the U.S. because of its focus on intuitive ease-of-use, which requires very little to no training. While the company's claim to enable quick adoption across institutions is well-founded, it's effectively enhanced LMS design holds even greater promise when it comes to setting the bar for the future.

Blackboard, for example, has traditionally taken the approach of pushing their customers to use Bb tools within the LMS, thereby discouraging the use of third-party applications. On the other hand, Canvas has taken a “bring them on” approach. In fact, its own Canvas App Center makes it possible for even the least tech-savvy teachers to easily browse a library of interoperable tools and install them in a single click — no IT help necessary. Some say it brings “enjoy-ability” to the mix.

Desire2Learn’s Brightspace joins the “top four” list of LMS companies, by pushing the status quo toward becoming less cumbersome and more intuitive. The third up and comer, Schoology, is most revered for both its feature-richness and emphasis on social communications. Although it originally focused on the K-12 market, this company has recently entered the higher education arena, where it is experiencing great success among small, private universities.

While the LMS world is no longer monolithic, these systems are still most often used as a logistical and administrative platform, because as some believe, it empowers instructors to get the cumbersome stuff out of the way and focus more on teaching.

So, is the direction that Canvas and Schoology are going the future? Or is it in other platforms like Google or Amazon?

Although Google Classroom is taking the K-12 market by storm, the company seems to have very little interest in capturing the higher education market. Some say the company doesn’t want to deal with deeper enterprise issues like gradebook problems, so it is simply letting this market grow organically.

On the other hand, Amazon is gradually moving into the higher education market, predominantly through Amazon Web Services (AWS), which, interestingly enough, LMS companies like Canvas are using on their platforms. With that in mind, does Amazon already have bigger sights on this market, or is it looking for the right institutional partner to help define its strategic direction in this arena?

For now, what is driving the move toward the next generation digital learning environment (NGDLE)? What impact will today’s market demand have on the future? And where will these LMS companies come out with respect to controversy around third-party tool adoption, given the move to integrate disparate networks with the ability to use these tools in the service of teaching and learning?

Integration of Disparate Systems/Networks

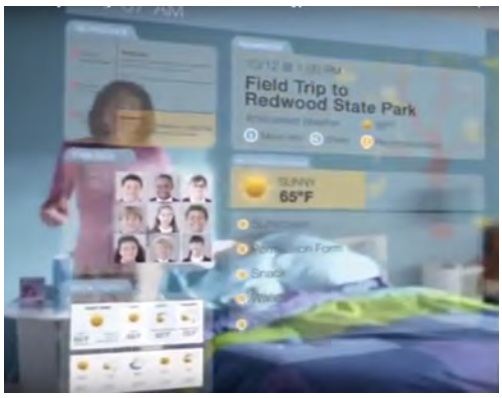
According to Mark Millron, CEO of Civitas, “We are experiencing mass digitization. Our student information, HR and finance systems have been integrated; learning management systems have been launched; customer relationship systems leveraged; and even digital texts, online games and engaging interactivity are on the rise. And yet our ability to pull these data streams together and leverage the best of data science to really understand what’s working and what’s not is hamstrung. For the most part, we lack a fully integrated data platform that can responsibly and strategically integrate disparate systems to tell a coherent story about student success or failure on their learning pathways.”

Systems must responsively share data to amplify one another’s capabilities. Likewise, open standards play a significant role, while avoiding proprietary software that isn’t compatible with others is key. Consequently, to ensure cross-system interface, it’s important to select systems that follow and meet open and international standards.

Selecting technologies from companies that have Software Development Kit (SDK), Learning Tools Interoperability (LTI), and Application Program Interface (API) capabilities/apps will make interacting optimal. LTI is a standard set of specifications for easily integrating third-party learning applications (external tools) into the LMS. An API allows software programs to interact with one another, whereas an SDK is a set of tools that can be used to develop software applications targeting a specific platform. When selecting which technologies work best for the VLE, it is imperative to consider their ability to play well together, as well as the amount of front-end work it will take to integrate systems or apps.

When designing a platform to power a digital ecosystem, there are companies that do the work for you, overseeing the app integration process, while also, in many cases, creating customized apps for universities, granting them the intellectual property rights and providing the source code.

Simple. Transparent. Multi-Modal. Integrated. Seamless.



Ideally, the digital ecosystem and VLE should appear to be a one-stop-shop with automatic workflow between systems that are seamlessly integrated and transparent to end users. Not only should all systems, tools and apps remain behind the scenes, where they are accessible through single sign-on, but so should all content repositories and resources – which brings us to how the interface of the future will be configured.

The Dashboard

The dashboard is the face of the portal. Because the layout is based on the individual viewer's needs, instructors' dashboard and tools look and feel different from those of their students. Instructors using a smart VLE will receive substantial support from the power of the platform, with AI and analytics operating in the background. Thus, it will enable them to act as subject matter experts, while depending upon the system to assist in curating content for each class. Likewise, the dashboard is customizable, with output in a variety of formats – same content/different way to digest it.

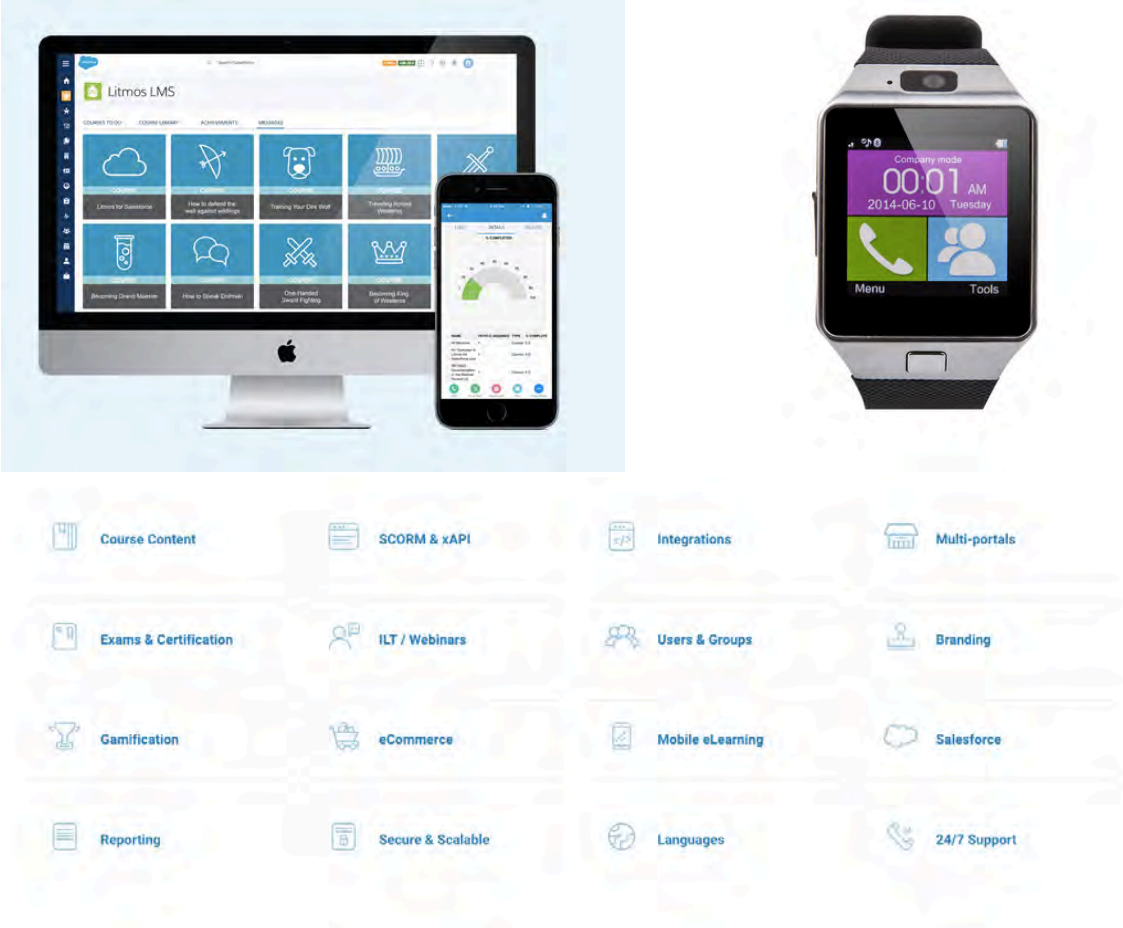
Students will have the ability to manage the look and feel of their VLE, as well, while adapting their dashboards or content access points on the fly. Harry Potter fans will recognize the ever-morphing digital publication that adapts to each reader. As content changes, so does the way it is delivered - in a live interactive manner, of course. Videos play right from the page.

Though the following is a play-off of Harry Potter, the idea is to create an environment, in which content displayed evolves based on the consumer. Each section is interactive

content acquired from multiple sources, apps and repositories, delivered in multiple modalities, customized to meet the needs of an individual student or instructor.

Features should be designed for quick set-up, simplicity and infinite scalability, with the goal of engaging learners on any device and at any time. Just as in the “Day in the Life

of John" story, with proper analytics and AI running in the background, the VLE can pull content, resources, apps and more to create the digital environment.



Student Dashboard

Students need a place to think, create and discover. It must encourage design thinking and enable self-assessment and self-monitoring, as well as external collaboration and review (critique, revision and iteration).

As in the Harry Potter style digital dashboard, where the pictures are always moving *because it is magical*, there is a place for "dynamic" course basics (the fundamental components of an online learning environment), as well as learning links, resources and self-assessment tools. Quick links to other tools or components, such as personal e-portfolios, are also accessible here. While the Student Dashboard is the learning interface, another area provides the Analytics Dashboard, along with other components of the digital ecosystem. Although those components will not be discussed in this paper, pedagogical tools and formats will be addressed in a section below.

Instructor Dashboard

Regardless of the support system in place to provide instructors with instructional design and technical expertise, the VLE of the future holds tremendous promise.

The technology now exists to enable a new and far more powerful generation of interactive instruction. Consider how AI and learning analytics can streamline teaching. Well-designed dashboards empower instructors to "know" their students at a glance; to see overall and individual progress instantly; to have tools that allow them to quickly and easily create content.

The instructor's dashboard, like the student's, will dynamically change given the influx of data generated by both AI and learning analytics (predictive intelligence). By aligning systems and connecting to a plethora of tools and resources, the instructor can customize content for each individual course.

Likewise, in the VLE of the future, the instructor will be able to easily connect learning to practical application and workplace experiences; coordinate peer-to-peer collaboration; and drive continuous improvement of course material and delivery. Authoring courses for inquiry-based learning with next generation learning principles will be simple. The LMS will handle the bulk of administrative and logistical duties, freeing the instructor to focus on teaching and learning. Additionally, a section of each instructor's dashboard will be dedicated to his/her own personal learning and lifetime professional portfolio.

Instructor presence within the VLE will be an important component of both the student and the instructor dashboards. Because first impressions are crucial in any learning environment, this technology will enable an online instructor to *virtually* make a great impression.

Social Communication

> The absence of physical presence should never be confused with the absence of social presence.

Instructors should have the ability to communicate with students in a way that makes them feel connected and engaged. And in the online classroom, the VLE must allow instructors to jumpstart the process of personalized instruction, by providing ample opportunities for social sharing - from posting relevant personal and professional "profiles" to hosting on-screen "meet and greets."

According to Dr. Priscilla Connors at the University of North Texas, social presence or “realness” is an emergent construct that is simultaneously traded among the instructor, the learner and the technology, in bridging the virtual classroom’s transactional distance. It is enriched through collective experiences that, over time, build a sense of immediacy and intimacy. Moreover, course design and communication style create learner expectations of both the system and the instructor.

The platform will make it possible for the instructor to serve as both mentor and facilitator, while empowering the student to feel connected and valued as a member of the learning community.

A well-designed course is transparent and logical, welcoming exploration and discovery, while encouraging ready access to critical resources. It motivates students to not only acquire knowledge and perform necessary tasks, but also apply what they are learning to master important skills and concepts, as well as achieve greater insight.

By providing a positive social presence, the ideal platform allows instructors to set the tempo of a course in a way that enhances the learning experience and lessens the transactional distance. For example, online instructors have found that by providing audio feedback, they can create a social presence, which cultivates effective mentoring relationships with their students. In a recent interview, one instructor stated that using simple communications tools, she may increase the amount of feedback she furnishes, while decreasing the amount of time it takes by 75%.

Pedagogical Tools and Format in Dashboard

In exploring both the pedagogical tools and the format needed to drive the VLE of the future, it is important to keep in mind the rapid pace of digital development. In fact, new technologies and device formats are hitting the market daily, prompting educational institutions to rely on IT research companies like Gartner for predictions around strategic technology trends and how they will shape digital business over the next several years.

To meet the needs of 21st century learners, the virtual classroom environment must be designed around an active, rather than a passive learning model, using a variety of technologies to enhance and define the educational experience in a way that makes learning authentic, customized and connected. In accomplishing this goal, the VLE should be multi-modal, multi-dimensional and media rich, integrating such digital tools and formats as: games and simulations; virtual and augmented reality; videos and videoconferencing; MERLOT community portals and open education resources; learning assessments; and study tools like flashcards and mnemonic devices.

Likewise, in choosing appropriate technologies, the instructional design team should consider the following pedagogical strategies:

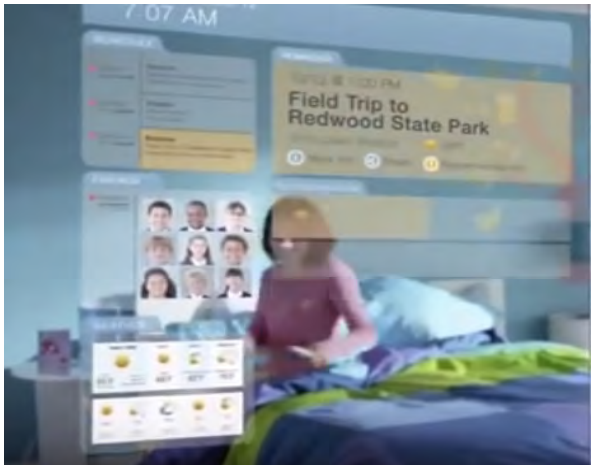
- **Social Presence**: Live online classroom activities could mimic a synchronous, horseshoe-shaped, face-to-face classroom, by using tools like robotic telepresence and interactive whiteboards for collaborative chat, student polling and other capabilities.
- **Connected Learning**: Grounded in design principles that combine best practices in cognitive science with cutting-edge, networked technologies, connected learning merges formal with informal learning, enabling students to access knowledge capital from various locations in and out of the classroom. Consequently, the VLE should integrate such digital enhancements as videoconferencing, video/audio chat, and other collaborative tools that make it easy to connect with subject matter experts and/or apply new knowledge at any time, from anywhere, and for any purpose.

- **Collaborative Learning**: To foster improved student engagement and active collaboration, next generation VLEs must facilitate so-called “huddle spaces” – the digital version of a “war room.” These meeting spaces will enable groups of students to create, organize and share content through hand-drawn sketches, sticky notes, graphical artifacts, and imported documents. What’s more, they would have the capacity to project this content onto multiple displays and devices; in a single session or over an extended period.
- **Multisensory Content Display**: Given that students process information through multiple senses – visual, auditory, and tactile - VLEs must use the full range of multimedia to create dynamic and experiential learning environments and experiences that are accessible to all. For example, in the classroom of the future, visualization will now take on an entirely new meaning.

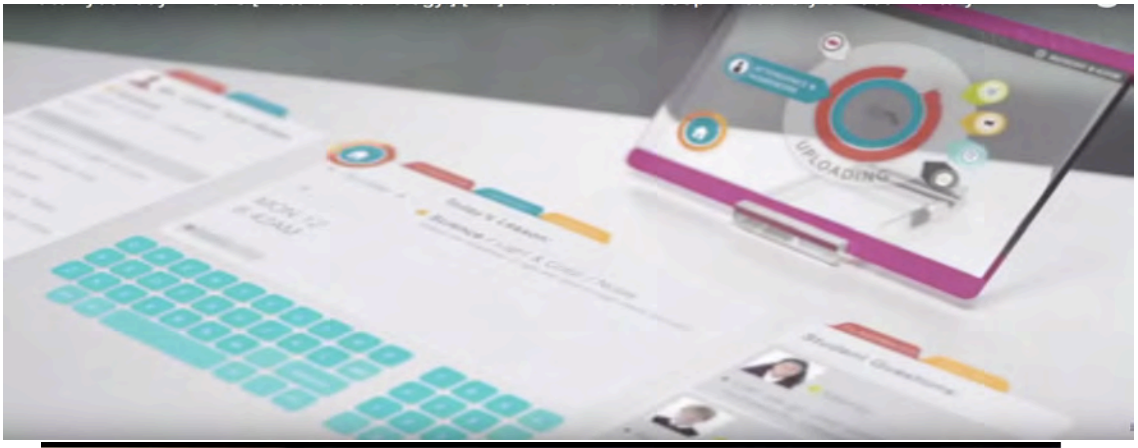
Content that previously would have been displayed in graphs, charts, and static images will come to life with holographic projection and simulation. Imagine working on a virtual human cadaver or analyzing a brain disorder as if an actual patient is lying on the table in front of you.

Online Learning Surfaces and Audio Enhancements

Take a moment to view The World of Glass, HD Documentary from Corning. While this innovation was envisioned a few years ago, it will soon become a reality. In fact, glass surfaces for displaying content are now being rapidly developed for average consumer use. That said, home, work and school environments of the future will likely include surround sound and content capability, accessible through multiple displays that can be viewed on just about any surface. We might even create a planetarium-like space, without the expense of building one. At the same time, students could conduct research or complete in-field work from the back of a car.



From the moment students arise, they are CONNECTED.



Not only can we expect online students to project content or dashboards on to their surface of choice, but they will have other options, such as consuming content from publications, much like the Harry Potter style magical newspaper previously described. The photos below are taken from Microsoft's vision of the future. Though not education-focused, this video, produced by Microsoft demonstrates the amazing realm of possibilities. (These photos can be found 4:15 minutes into the video).

Indoors or outdoors, any place can become an instantly connected Virtual Learning Environment.

IMPACT CONSIDERATION

According to Gartner, by 2020, 30 percent of web browsing sessions will be done without a screen.

New audio-centric technologies, such as Google Home and Amazon's Echo, are making access to dialogue-based information ubiquitous and spawning new platforms based on "voice-first" interactions. By eliminating the need to use ones' hands and eyes for browsing, vocal interactions extend the utility of web sessions to contexts such as driving, cooking, walking, socializing, exercising and operating machinery. As a result, the share of waking hours devoid of instant access to online resources will approach zero.

In addition to enabling content display on a variety of surfaces, the VLE of the future will integrate audio-centric technologies, much like John's AI-based virtual learning

assistant device or ViLA. In fact, by combining both, we can empower students to make learning – whether formal or informal, in the classroom or on the job – a connected, customized and continuous process.

Interactive Tools

The VLE must allow instructors to quickly pull in media-rich content that is either self-created or appropriately curated, while also delivered in multiple modalities, to ensure that their students can access, consume and apply it, as needed, using interactive digital tools carefully selected to optimize the learning experience. Here are a few of the "must have" tools currently at our disposal:

Virtual and Augmented Reality

Virtual reality (VR) facilitates an immersive and interactive, three-dimensional, computer-generated environment that enables us to seamlessly move about manipulating objects and performing certain actions – as if we are there – with the help of electronic equipment like headsets or special gloves. So, it is a unique technology for designing authentic learning scenarios, in which students can master knowledge and skills through deliberate practice, constant feedback and intermittent reward.

As VR's first cousin, augmented reality (AR) is a digital tool that merges virtual reality with actual reality, by using computer-generated imagery – through such sensory mechanisms as sound, video, and graphics – to superimpose three-dimensional virtual objects over either a 3D real environment or a 2D surface. Thus, it enhances the user's perception of and interaction with the real world, by overlaying additional information that is not directly perceived, to deepen student engagement with the content. And as the following diagrams show, these technologies hold tremendous potential for effective learning, in line with the generally accepted Blooms Taxonomy.

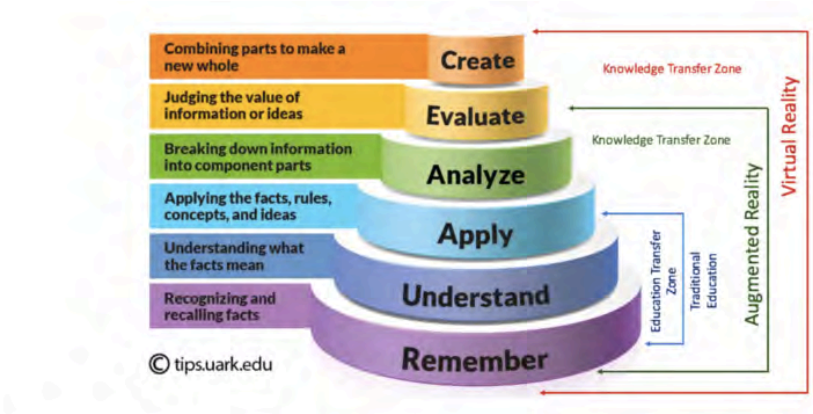


Diagram – Blooms Taxonomy from University of Arkansas with an overlay of AVR

Diagram – Blooms Taxonomy from Iowa State University with an overlay of AVR

Not surprisingly, these digital tools are becoming ever more popular among consumers of all ages. According to a recent article, VR and AR headset shipments will hit 100 million units by 2021; and IDC Technologies predicts that virtual and augmented reality are expected to become more mainstream over the next five years. Although these digital tools now cover the spectrum of design and cost, the average purchase price is also coming down rapidly as the quality improves and the sales volume increases. What's more, a recent report published by Gartner Research predicted that by 2020, 100 million consumers will use AR to enhance the in-person shopping experience, another indicator that portends its acceptance as a mainstream technology in every aspect of daily life.

Artificial Intelligence

Artificial intelligence (AI) is fast becoming a technology that powers multiple aspects of everyday life – from virtual personal assistants like Watson or Cognii; to chatbots, predictive purchase systems and smart home devices. As far back as the 1970s, researchers began exploring how machine learning, knowledge space theory, memory, and cognitive load theory might be used to create computer-assisted intelligent tutoring systems that provided a reactive learning environment.

Since then, online educators have expanded this notion, using AI to develop intelligent, data-driven learning platforms with an assortment of adaptive features to furnish virtual mentoring and information on demand, while supporting students around self-directed learning and assessment. Likewise, these platforms are mining vast amounts of data of all types – pulled from written, oral and transactional interaction – needed for analyzing and personalizing both the learning environment and the learning experience.

Predictive Learning Analytics

Each time a student interacts with a virtual learning environment, he or she leaves a digital footprint, which may be mined for data that reveals patterns, trends and associations related to human behavior and interactions. With the help of sophisticated learning analytics (LA) tools, we can then use this data to generate predictive models for customizing and optimizing the learning experience and environment to ensure greater knowledge acquisition, retention and recall.

The LA approach is particularly helpful for identifying students who appear less likely to succeed and empowering them with targeted interventions that will help them achieve better academic outcomes. Likewise, it can uncover specific units of study or course assignments found to be troublesome for students – which enables the instructor to modify the curriculum or learning activity for improved performance overall. LA also supports online peer- and self-grading as compared with instructor perceptions around a student's performance on any particular assignment.

Video

According to studies conducted by Forrester Research – a digital marketing research company - the human brain processes images 60,000 times faster than text – which is why one minute of video contains the equivalent of 1.8 million words. Moreover, videos are 12 times more likely to be watched than text is to be read. Likewise, video enhances memory recall. In one Forrester survey, 80% of viewers polled recalled a video they had seen in the past 30 days. Consequently, it stands to reason that video technology offers ample opportunity to enhance the virtual learning environment.

There are more than a few promising options for incorporating video into the VLE – whether through live video conferencing, streaming or on-demand content. For example, video feedback enables music instructors to assess how students place their hands and assume the correct posture when playing an instrument.

Moreover, transcripts of video-recorded lectures and content are time-coded, making it easy for students to search and locate relevant information. Closed captioning, as well as time attributes and tagging for analytics and personalized instruction also make learning more accessible for *all* students, regardless of ability and learning preference.

Visualization

With "in the cloud" comes the ability to grab, create and share content by visualization, including charts, graphs and other illustrations. Visualization tools can vary based on content or course requirements (such as the top 38 design tools for visualization by Creative Bloq), and can be used free of charge or purchased for as little as $37 annually per individual.

For example, DataHero enables even the most technically challenged instructor to pull together data from cloud services for creating charts and dashboards. Exhibit, a fully open-source tool developed by MIT, makes it easy to produce interactive maps, along with other static graphics, such as flags pinned to countries or birthplaces of famous people.

Biometrics

Biometrics includes eye tracking and facial recognition software, as discussed earlier, used to rapidly authenticate online student identity, as well as monitor virtual class attendance against ongoing student performance.

Gamification/Simulations

In the future VLE, serious games and simulations will continue to play a massive role, given the many ways they support active and authentic learning experiences. To be sure, neuroscientific research continues to show that students are much more likely to acquire, recall and retain expert knowledge and complex skills through hands-on application and deliberate practice, within the context of real-world scenarios – also known as *learning by doing.*

What's more, the intersection between and among AR, VR and mixed reality (MR), will power an even more compelling experience, with designs that cover the spectrum from simple and organic, to complex and high-end. Still, regardless of the design, these

virtual enhancements can be highly immersive, engaging and customized when well-conceived.

Repositories of Curated Content

Ready access to high-quality resources and content repositories – many of which are free – will add tremendous value to the virtual classroom, as we transition from where we are now to where we must go in the future. In fact, we are already moving away from content provided solely by instructors and textbooks, to integrate interactive materials and content in a variety of formats.

Students in remote locations now have access to high-quality resources with technological capabilities that empower them to explore and construct knowledge on their own – which is significantly more difficult when the instructor owns and controls all classroom content. In today's drive to develop open educational resources (OER) and shared repositories, accessibility is at an all-time high – although, as it stands now, only a small percentage of instructors are taking advantage of these tools. With that in mind, next generation VLEs must have a seamless interface that not only displays available content, but also pulls it into the classroom, based on searches or lesson objectives. Resources can include but are not limited to:

- MERLOT II
- OER Commons with authoring tool
- Creative Commons
- Partner content
- In-house designed
- Outsource designed

Additional Considerations

The decision between using either internal or external resources for building and customizing the virtual learning environment will depend on both the required interface and the up-front design. Partnerships can be forged with leading companies and innovative startups, to co-develop the VLE of the future, with an emphasis on

outsourcing its design, build-out and/or implementation. Likewise, internal resources can be leveraged to create individual components; although this approach must be carefully planned when it comes to integrating the many moving parts – from third-party apps and API, to LTI and SDK needs – into one user-friendly system/platform that checks all the boxes.

Possible Platforms, Tools and Partnerships

Partnerships for **Platform and VR/AR/Gamification Design**

- Chetu does **custom LMS/SiS builds** as well as **AR/VR and gamification design**.
    - Free Project Manager with education-specific experience.
    - **Developer with complimentary PM, QA, and team lead at hourly rate of around $25**. They have over 1100 full time developers and have already created 16,000 apps.
    - Drexel University would own the intellectual property including source code. AND no licensing fees.
    - https://www.chetu.com/e-learning/lms.php
    - https://www.chetu.com/e-learning/sis.php
    - https://www.chetu.com/e-learning.php
    - https://www.chetu.com/solutions/ar-vr.php
    - https://www.chetu.com/gaming/design-and-development.php
    - Lloyd Hickey, lloydh@chetu.com, 954-296-0130, www.chetu.com

- Harbinger Group – Delivering next generation edtech solutions, Harbinger **partners with universities to build their platforms, digital learning solutions and content**. They can also interface to proprietary LMS and knowledge portals. Their platform designs are inclusive of elearning systems integration, conversational interfaces, knowledge portals, interactive videos, and learning analytics. They provide content development including digital learning object repositories, gamification and game-based learning, micro-learning development, augmented reality and VR development. They build custom conversational chatbots leveraging technologies like Microsoft, LUIS, api.ai, AWS Lex, Bot Framework and Botkit. All fully support 508 and ADA compliance.
    - Shrikant Pattathil, shrikant@harbingergroup.com

- Illumira by NJEdge, is a not for profit group started by presidents of all of the universities and colleges in New Jersey. They partner with universities to support content, collections, curation and compliance. Created for educators by educators, illumira is a **digital asset management system, media repository and publishing offering** for streaming and archiving videos, audio, documents, and images. They offer a cloud-based service and will tightly integration with any LMS. They ensure ADA 508 compliance. Costs are approximately $4 per FTE per year with discounts for larger institutions or $1 per FTE per year (or revenue sharing model).
    - Grant Hansen Hansen@illumire.com, 973-453-5242

- Canvas – Fastest growing LMS in U.S. today. Their D2L Brightspace platform – St. Leo University video. They were looking to create a digital eco-system and do away with their current LMS…. What You Need to Know About Building a Net-Gen Learning System

Tools

- Bulb – Students and educators curate, create, share and showcase their work. **Lifetime professional portfolios** portal covering elementary and secondary to higher education and lifetime learning. Students can curate, create, share and showcase their best ideas and lifelong

content. The portfolio doesn't cease to exist once the student graduates. University **costs** are around $2-$3 while a student and then the individual pays $0 to keep their portfolio as it currently exists or $15 a year to be able to continue to build it.
    - Bob Bush, CTO, bob@bulbapp.com; R. Scott Harris, VP of Marketing, scott@bulbapp.com

- Binumi – A digital storytelling platform to improve the quality of online learning content. The production of hypermedia applications is a complex and expensive task, requiring both technical skills and communicative abilities. Reviews of these e-learning applications across universities have indicated that the rate of take-up is slow, due to numerous technological challenges involved. Binumi overcomes these hurdles by providing content, easy to use tools and publishing environments all in one place, allowing adoption without specialized IT, filmmaking or creative skills. The platform enables students and educators to create multimedia movies that combine footage, image, sound, music, text, and narrative. This cloud-based platform combines content (over 3.5 million royalty-free footage, image and audio clips), a drag and drop editor and secure video walls for submitting and viewing final projects.
    - Anthony Copping, CEO and Founder, Anthony@binumi.com, 203-903-0944

- Nester – An A.I. software using face recognition to determine if students are paying attention and are engaged. Two London universities are testing it as an A.I. led MOOC.

- Nureva – Span Software offers an expansive digital canvas on which to share ideas, collaborate on designs and solve problems. Traditional classrooms would have expansive wall canvases from 40' to 200'. Online students can **virtually collaborate** from home.

- Odigia – Odigia goes beyond the textbook by providing instructors and students digital learning and **teaching tools** that were developed to enhance the way they: access, modify and engage students, foster collaboration during the course, track progress and understanding of content, and apply knowledge.
    - Joshua Moe, josh@odigia.com, 336.462.8056 x700

- Yup – A personalized inquiry model-based company that provides instant **tutors**. Utilizing text chat, students instantaneously get the help they need. When a student gets stuck on a problem, they open the app, take a quick snapshot of the problem and submit. Within minutes, a tutor comes online to walk them through the process of solving the problem. This is a startup company funded by AT&T. Consideration should be given to working with them to take this concept to provide collegiate level tutoring.

- Einstein Analytics – A.I. on a CRM, Salesforce Launches Einstein Analytics

Additional AR/VR Platforms and Tools

- Zspace – **VR monitor/PC device** that allows access to virtual reality, wearing glasses that enables the user to still see the room. It basically turns viewing into a 3D experience. They have **3rd party content** that works with these devices. Stanford and Harvard use these glasses in medical courses.

- Co-Spaces – Provides students and educators with a new dimension of **creativity tool** enabling them to design immersive stories, virtual exhibitions, and program VR games. Users create VR Worlds in the browser or table app through simple drag and drop controls. Use the mobile app to explore their own creations in the 360 or virtual reality mode. This tool was mentioned several times during the second webinar of the OLC Immersive Learning series as the platform the university/college was using to build virtual reality content for courses. Licenses are in bulk with **costs** approximately ranging from $75 for 50 or less to $675 for 450 users. Volume discounts are also available.
    - Thomas Glaser, Head of User Experience, Thomas@delightex.com, +49 89 2155 35490

- ViziTech USA, AR and VR Learning **Platforms** and **content developers**. Examples, Horse larynx surgery, complete human cadaver, VR Experience and more…. develop content for Zspace - Joe Hutcheson, jhutcheson@visitechusa.com, 706-818-5632 or Stewart Rodeheaver, President, csr@vizitechusa.com, 404-725-5104.

- FlyVR- China has developed the first AR Holographic Box, which allows 360-degree viewing and interaction. This is best for the physical classroom. However, their **Multi-user Connected Teaching space** is software for a virtual reality, real-time human-computer interaction virtual space like a panoramic classroom and a VR Smart Lab. Their SAAS Cloud platform is a VR Teaching cloud with application store, lesson preparation system, and cloud storage. Jiao Tong University developed VR 981 Underwater Drilling System to simulate actual operations via video and virtual scenes for rapidly improving the students' awareness of underwater operations and measures to prevent dangerous situations. Shenzen University established a VR Rail Transportation System to experience operations and Tongji University developed a VR Sewage Treatment System.
    - Minsi Shi, ESO, shiminsi@xunfeivr.com
- Veative - High-quality 3D, virtual, augmented and mixed reality **content and teaching tools**. Veative has hundreds of VR modules in science and mathematics. While they sell kits for institutions, their product for online students **costs** $29 a year and provides the VR Learn Library, VR simulations and labs, analytics, reports and learner feedback and VR viewer and controller they can use with their phones.

*Any price information noted is subject to change.

References and Resources

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Videos

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https://youtu.be/aJu6GvA7jN8

HP Classroom of the Future
https://youtu.be/mPUfwX4Nqy8

e-Classroom: The Future of Education https://youtu.be/KskZkNOe_qY	Future e-Learning Experience for 22nd Century https://youtu.be/Cw8c7Q-WIJQ
Esco Empowering Education https://youtu.be/a3RHgN2GRc0	The World of Glass, HD Documentary-Corning https://youtu.be/E03HFA923kw
MIT For Credit MOOC	Tec de Monterrey https://youtu.be/PcOt8rHuPHk

Webinar Content

1. Kaltura Classroom of the Future webinar
2. OLC Immersive Learning Webinar Series: Webinar 2

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About Drexel University. *Founded in 1891, Drexel University is a top-ranked, regionally accredited, comprehensive research university, located in the heart of Philadelphia and recognized for its commitment to experiential learning, leading-edge academic technology, and use-inspired research. It is also known as a pioneer in technology-enhanced education for adult professionals, having launched its*

first fully online degree program in 1996. With approximately 26,000 students, Drexel is one of the nation's 15th largest private universities and was recently ranked 14th on U.S. News & World Report's list of "Most Innovative Schools." drexel.edu

About Drexel University Online. *Drexel University Online (DUO) is a division of Drexel University, responsible for student recruitment and retention, in more than 150 high-quality online graduate and undergraduate degree and certificate programs. As such, DUO provides the university and its colleges with expert market research, strategic marketing, enrollment, communications, instructional design, strategic partnerships, and program development support, clearly focused on creating an exceptional virtual learning experience for over 7,000 fully online Drexel students, from all 50 states and more than 30 countries. online.drexel.edu*