TRIPPING THE LIGHT FANTASTIC, ONLINE LEARNING, AUTOPOIESIS, AND HYPERREALITY IN OPEN GAMEWORLDS

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The integration of serious game design, mixed reality, and simulation-based training has reached a critical point in evolution. Online learning designers who seek to create immersion and simulation to enable learning require a theoretical foundation that can integrate these related fields. Existing models for training that focus on learning objectives and competencies were not developed with advances in behavioral neuroscience, systems theory, and video game engagement elements in mind. Online design of learning experiences can be integrated with new technologies using an autopoetic hyperreality framework derived from work on problem-based learning and mixed reality. In this paper, we will explore the foundations for new models of design based on a fusion of user-experience literature and video game design to enable ways to increase the effectiveness of training through simulation.

KEY WORDS: open gameworlds, gamification, serious games, simulation, immersive technology, online learning

1. AUTOPOEISIS AND DIGITAL PROBLEM-BASED LEARNING

Training in the contemporary world is a career-long expedition into knowledge advancement. The era of attending college and then learning all further skills has been surpassed by a steady flow of learning that enables the continuous acquisition of skills. The concepts we have accepted in the learning movement that arose in the 1980s and 1990s (i.e., terminal competencies and learning objectives) were based on static job descriptions. There were identifiable targets of learning such as tasks (referred to as tacit

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instruction and procedures) that led to procedural training and theoretical elements, which we called didactic outcomes. Things seemed stable, in an era which spoke of Kirkpatrick levels of learning, where Level 1 outcomes involved how students felt about learning, Level 2 was about how they performed during the training, Level 3 was about completing the outcomes, and Level 4 was about how they used their education to work in the real world (Kirkpatrick & Kirkpatrick, 2016).

However, this was before Google Scholar and other credible search engines became available, and prior to the era of online discussion and streaming content delivery. It arose with the preconception that terminal competencies were stable and reliable beacons that could guide us in the design of learning. Out of this dialogue arose instructional design, which now featured media-rich content and the start of socially connected online learning. This model, where we establish a learning path for every student, as well as for thousands of students, which took most of them to the goal post, became eclipsed by realities on the ground. As technology improved at rates much faster than any educator in the 1980s could have imagined, we found that learning was changing; it started to focus on the integration of new technology knowledge. It became important for corporate trainers to certify employees for increasing levels of complex sub-tasks to assure quality compliance in the workplace.

At the same time that technology demanded workers consistently upgrade their skill set, the research literature on teaching and learning exploded. A coherent body of knowledge about how to teach using neurophysiological data arose and was exemplified at its outset by scholars such as William Clancey on situated cognition (Robbins & Aydede, 2008). In particular, this concept began to permeate health care education, where ideas such as problem-based learning, objective structured clinical examinations, and simulation took hold. Slowly, we moved away from the idea of assessing knowledge disconnected from practice and entered what I will call the simulation era. New engagement platforms such as Kahoots now entered higher education, with the use of clickers and other objects in lectures where they are mandatory for ongoing feedback (Dellos, 2015).

By the time we arrived at the year 2000, new genres of board and video games were emerging from Germany and the United States, respectively. The video game industry advanced through improvements in rendering visual environments and the board game industry was revived by a series of highly successful strategy games such as the Settlers of Catan. This shift in the entertainment industry resulted in a change in how we engaged for recreation; we could now role play in games and become part of the story rather than witnesses of it. Board games brought people together to enjoy strategy matches, which was a reaction to this rapid rise in the video game genre. Strangely enough, these two new forms of entertainment were built upon certain premises of multiple engagement loops and using narrative and aesthetics to invite players into an escape. It is not surprising that educators (such as myself) and psychology designers (such as Gabe Zichermann) would arise from the ranks and locate ways to introduce these highly motivational elements into learning and behavior change (Çiftci, 2018).

Clearly, the nature of entertainment shifted, now surpassing passive movie watching with games at a remarkable rate. Video game sales exploded over time, and those connected with lifestyle and behavior change moved the fastest. The highest selling video game of all time is Nintendo Wii Sports, with over 81 million copies sold, surpassing Mario Brothers and other current high-budget titles such as Assassin's Creed. It was inevitable that the entertainment industry and the learning field would eventually meet, as we sought ways to leverage student engagement (Ke, 2008). It seemed inevitable that we would eventually absorb high intrinsic motivation elements in teaching and learning; however, this progression ground to a halt when it met the intransigent nature of higher education, where passive learning shows its weaknesses (Freeman et al., 2014). Trained in the ways of the PowerPoint slide and simple presentation elements such as video and online curation, the old generation of learning professionals stumbled to integrate these elements. Given that many of the leaders in this space did not grow up on video games, it was no surprise that they would reject such ideas since they could not even make sense of them: enter the millennials who, on average, had over 10,000 hours of playing time on video games and now sensed a distinct disconnect with traditional learning (Deci & Ryan, 2000).

2. TRANSFORMATIVE IMMERSIVE DESIGN AND HYPERREALITY

Transformative immersive design is the newest model of learning experience, derived from its three terms. Transformation is about behavioral change, not restricted to learning but also extending into empathetic and virtual experiences (Fjaellingsdal & Klockner, 2017) Immersive design is the ability to create things in virtual space, whether it is text-based simulation or authentic virtual reality experiences. The new curriculum designers are no longer curators of text and images, but creators of “just-in-time” learning across both colleges and industry. It is no longer enough to curate content or distribute it, but engagement and achievement need to be nested within it. Immersive technologies, including extended reality (XR), virtual reality (VR), and augmented reality (AR), permit us to directly experience content, which no longer needs to be abstracted in the form of didactic explanation. You can see what it is to be the object of prejudice, to sit in the front seat of a police cruiser during a high-speed chase, or to witness surgery without cutting open a body.

Hyperreality is a term developed by Jean Baudrillard, which describes simulacra (Luke, 1991). A simulation is a high-fidelity imitation of what we see in the world. Simulated patients that medical schools train or hire, for example, are replicas of the real world, as realistic as possible. Simulacra, by contrast, have lost any reference to the thing they represent. The distinction is important; there is a central role of simulacra in shaping our world. Early authors said Disneyland was a simulacrum: an idea embodied in images and how it influences our behavior. We long to go to Disneyland, which does not refer to the place per se, but to an abstraction of what Disneyland represents. Photorealism in art, where we draw a picture of a photograph, is a form of simulacra. Conceive of simulacra as objects in a virtual field, a space. Think of hyperreality as living in a virtual space, one based entirely on fantastical objects.

Mixed reality (a blend of XR, AR, and VR) enables simulacra and can insert them into this virtual space. These mixed reality simulacra I will refer to as virtual learning environments (VLEs), which are a derivative of serious game researcher David Kaufman's gameworlds (Kaufman & Sauvé, 2010). A VLE is simply a fantasy world designed for learning, which is a subset of the idea of gameworlds, as alternate realities. Second Life, a popular immersive free download, is a gameworld. Within that gameworld, many things happen: people meet, have virtual sex, attend virtual lectures at Harvard, etc.; it is an umbrella. A VLE would be a dedicated form of gameworld. A hyperreal gameworld would be one in which the senses become disengaged from the real world. It is an abstract set, from which reality is derived. In simple terms, a VLE is a form of hyperreality designed to put the learner into an alternate world that the instructional designer populates with virtual objects. Virtual objects are elements of the VLE with which the player interacts.

A strong VLE builds life paths into virtual objects. A patient is created in the minds of the medical educator, who has a fictional life. Thus, that patient is a virtual object. Part of this fictional life is that the virtual object (patient) might have heart disease, and if untreated it will worsen and the patient will die. The notion of life pathing within VLEs is a critical design element for learning. A passive object will not respond to the learner's interventions; a student playing the part of a doctor merely observes. This is called branching simulation, where you view a video and then make choices that determine which new video segment will unfold. This is not a VLE. VLEs are active learning spaces, where every action the learner takes leads to a consequence in the gameworld. Thus, you are literally playing doctor in a VLE; in branching simulations you are simply witnessing the outcomes of decisions. Virtual objects should be complex, and depending on how you interact with them many different outcomes should occur. In contrast, branching simulations—as text-based simulations—are simply scripted encounters. VLEs are non-scripted and permit a wide range of player actions. Note how we can now use the terms learner and player interchangeably. In our continued discussion, we will use them as such.

Within a VLE, we have players. We use that term because they are actors within the simulation, not just decision makers. They are transformed by the environment.

Environmental transformation refers to the idea that in a VLE, players can earn money, unlock new quests, change their appearance, and interact as avatars with other players. This is not true of simulations as we know them in training. This is an alternate world with its own rules. Patients can be cured in minutes, not weeks, as we locate treatments through learning. Players can increase in ability over time, gaining skill points and upgrading their in-game items. In video games these might be better weapons or armor as seen in World of Warcraft or Diablo. World of Warcraft is an example of a massive multiplayer online role-playing game (MMORPG) and has a base of close to 10 million players around the world. In all MMORPGs there are many virtual objects that must be earned by the players' actions in the game. These earned virtual objects then might even have their own life path. A sword might increase in power as a player progresses. The concept of upgrading your clothing with “azerite” in the latest World of Warcraft edition is an example of such life pathing. The shoulder, chest, and head items you wear increase in power as you complete game objectives. Your ability to take on tougher in-game challenges is linked to the life path of the virtual object.

Hyperreal learning states, then, are those where we immerse learners/players into a world where they can take on challenges, achieve objectives, and engage with life-pathed virtual objects that are all connected to learning; the more you learn, the more your power increases in the game. As such, hyperreal learning is about creating alternate realities where a player can immediately see the direct impact of learning through the acquisition of virtual objects and engaging with these objects as the core of the pedagogic experience. This implies, in turn, that players are not going to fit into a traditional learning design, where we identify objectives and move them into experiences such as reading or laboratories, or even active learning paradigms. This is a total re-thinking of education, as something that is player-driven within an artificial world, where each success or failure impacts how the player interacts with that world. As such, it requires a reassessment of how we design learning to fit into this space.

3. AUTOPOIESIS AND ATTRACTOR REGIONS

In a VLE, players have the freedom to explore and achieve in their own way. How do we ensure that players will learn what we need them to? How do we ensure that doctors trained in VLEs will perform the job we need them to do (i.e., diagnosis, treatment, critical thinking, soft skills, and counseling)? This is managed by recognizing that learning in such worlds is self-generated. Teams of learners working together can help each other learn by engaging in quests. How do we limit those experiences such that they can focus on what we need them to do? Let us accept that the simulation research literature assures us that for many things (but not all) simulations are equivalent to reality. Flight simulators used in training would be one example. Thus, we are not arguing that all things can be contained in a VLE, but that a blend of reality and hyperreality is our goal. Can we insert the real world into the VLE?

Traditionally, we try to insert simulations into the real world; they are excursions out of the world of the senses into a suspension of belief—a serious fantasy. Now, we are going to reverse all of this and say that the student will primarily exist in the VLE, not the external world, but that we will import elements of the real world into it. Thus, I am in a fantasy game where I am healing the sick, and my quests in the game are to not only treat virtual patients but also real patients. As I successfully treat real patients, my progress in the gameworld is increased. This is not far from what we do anyhow; this is Kantian philosophy. In the philosopher Immanuel Kant's philosophy of knowing (Kant, 1999), the world exists in our own mind anyhow, so medical education is simply creating a copy of the real world in our consciousness. As Kant said, we represent the world; we do not directly experience it. We do not see ultraviolet or infrared, we see data produced by instruments. Similarly, to understand this correctly, we create a fantasy reality for players in VLEs that imports external experience into its storyline, such as seeing patients. The story drives the learning, whether it is through interaction with virtual objects such as simulated hospitals or real patients in real hospitals. As Kant would say, we import what our senses tell us and create a world based on that. Hyperreality is just Kant, updated.

Autopoiesis means self-creating, and this is how the learner/player functions in VLEs. The learning cannot be scripted, i.e., presented in steps toward a defined objective because the player interacts with the world and changes the objectives consistently. The idea of learning objectives, which is central to instructional design, is far too limiting a construct to use in the complexity of hyperreal learning worlds. Instead, we build the world within domains of instruction. A domain is a grouping of ideas or facts, such as the anatomy and physiology of the heart, which is connected to facts about healthy diet, medications for heart disease, vascular pathology, and even psychology in the form of the role of stress on heart ailments. Thus, this associational map is a domain—a cluster of epistemologically related concepts (Fig. 1). The students move through this domain in a VLE, at their own pace, with their own professional objectives guiding them. The question remains, how do we insert learning objectives and competency statements into this world to guide learning? This is where we need to import another concept from physics: that of attractor regions, which we can also refer to as centers of gravity (Motter & Campbell, 2013).

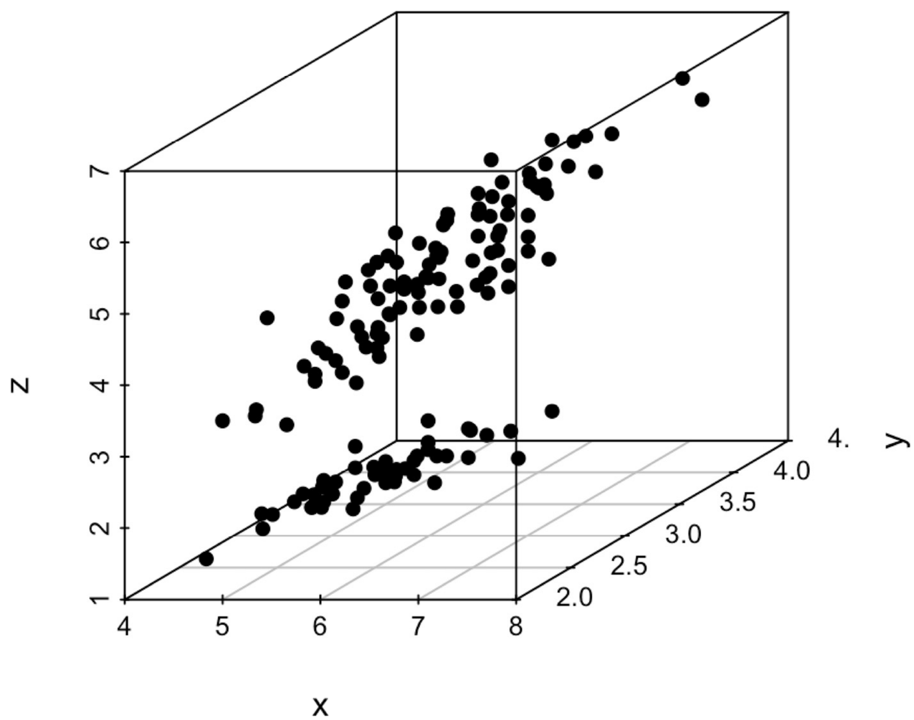

FIG. 1: Representation of an epistemological map of simulation

It can be noted from the scatter plot presented in Fig. 1 that one can position different concepts in relation to each other to form domains. Let us continue with the medical science analogy. In Fig. 1, the dots that are clustered close together are conceptually related; they could consist of the heart, vascular anatomy, cardiac disease, and cardiac pharmacology. The more distant points on the plot are things connected to the heart, but not as closely, such as psychology of illness, sociology of illness, diet and heart disease, or fitness in heart health. Thus, a domain of knowledge would be formed between the upper scatter points. An additional domain of knowledge could be imposed on the clustering we see at the bottom of the diagram.

As another example, if one views a network map, which depicts how often authors' publications are cited, it shows that certain authors have high citation rates. These are also analogous to domains of learning and show how concepts are related; in this case, in the form of publications.

Imagine a trampoline. Now put a single bowling ball on the right side of that surface. Its weight will depress the trampoline in that area. Now toss a marble onto that trampoline surface and you will see that it rolls in the direction you sent it, until it gets close to the depressed region the ball has created. It will then circle around that depression on the surface and eventually fall into the hole. That is how an attractor region works. It funnels objects into a space. The next step is to now see each domain of learning as a bowling ball. Imagine two bowling balls on that same trampoline surface. One ball weighs 10 lb and one ball weighs 100 lb. The 100-lb ball creates a huge surface depression; the 10-lb ball creates a smaller perturbation on the surface. Thus, a marble will fall into the deeper hole with greater velocity than in the smaller hole because there is more distance to roll and gravity creates acceleration. However, a marble will still roll into either hole; it depends on where it starts rolling on the surface. Thus, we can use the terms gravity and attractor region interchangeably in this discussion. Both will cause an object to behave in certain ways.

Lorenz attractors are a good model to use to envision autopoietic knowledge network domains (Motter & Campbell, 2013). The classic Lorenz attractor, which describes physics in chaotic systems, is depicted in Fig. 2, where it can be noted that there are two distinct regions within the space. Each of these regions would correspond to a given domain of knowledge.

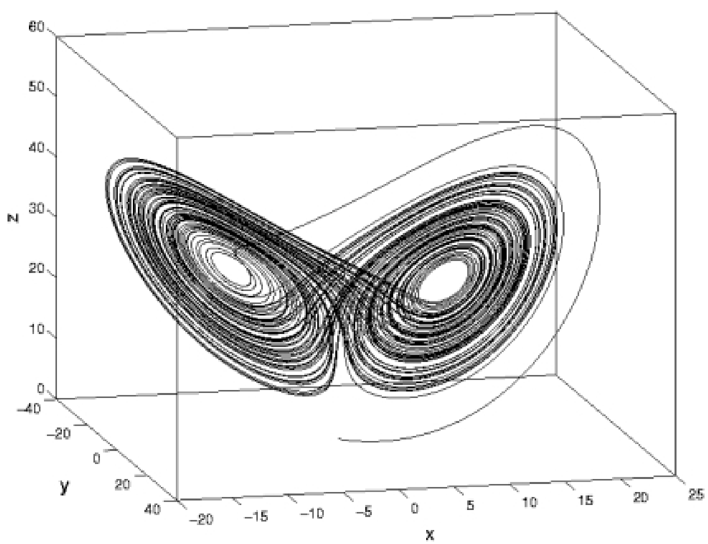

FIG. 2: Representation of a Lorentz attractor region

Another way to visualize domain relationships comes from digital marketing, where the term “pull” is used to denote attractor functions (Fig. 3). In Fig. 3, we see how various marketing regions interact, using point, path, and strange attractors. Strange attractors, in particular, describe complex systems. In marketing, we see companies, such as Apple, launching products where a variety of social elements affect a decision to purchase those products. These elements include more than just the lead idea, such as a new phone, and more than just the pathway, such as a marketing campaign. They also include a blend of other factors, such as market conditions, competitive advances, technological developments, and the sourcing of materials (Ducheneaut & Moore, 2005).

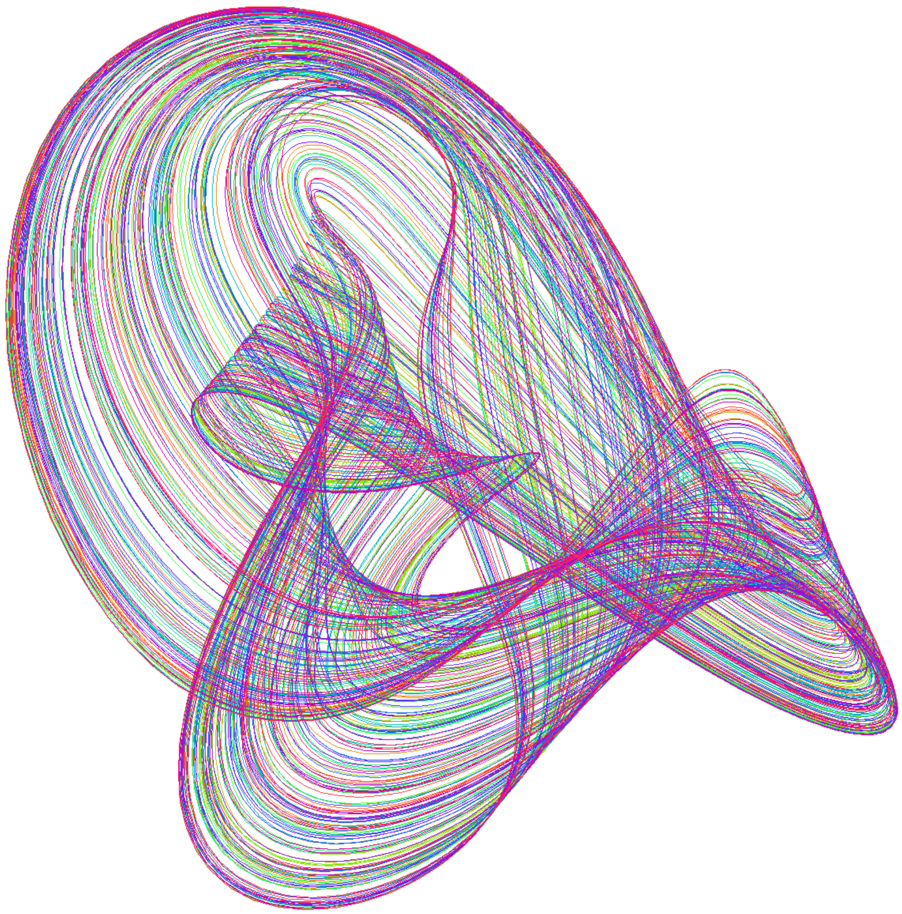

FIG. 3: Representation of an attractor map for the psychology of marketing

An attractor map for psychology can be developed, where stimuli we encounter create attractor fields. As depicted, typical stimuli have a weak attraction function when compared to atypical stimuli. The warmth we feel while sitting around a fire is eclipsed by the jabbing pain of smoke getting in our eyes as we sit. Atypical stimuli have a greater attractor power compared to those things we are used to. Similarly, we need to see domains of knowledge as nested groups of facts that embody specific attractor functions.

The next step is to see that learning would consist, in a VLE, of establishing a series of domains of knowledge and competencies. This means that learning design is building the world and then inserting attractor regions to increase the gravity in those topic areas. I can design 100 short case studies that we can insert into the VLE, which when completed ensure that the learner acquires skills. If you can spend enough time in simulations about heart disease then you will acquire the knowledge related to those simulations. This is problem-based learning (PBL), which was pioneered by the McMaster Medical School in 1967 and has since been implemented at Harvard, New Mexico, Mastricht, and other universities that are renowned for innovation (Barrows & Tamblyn, 1980). In PBL, students teach each other the subject material based on case studies. All that we have done in building a VLE is to link these PBL case study experiences into a coherent storyline. We have inserted this storyline into a digital medium and connected academic achievement to player progress in the storyline. Essentially, all education in this model consists of immersing students into the fantasy world from the first day of the class until their final graduation event. Every experience in learning is part of an ongoing storyline, which all occur in simulacra space, i.e., a hyperreal environment (Galarneau, 2005).

This is more than simple emergence, it shows how self-organization, what the Nobel-prize winning physicist Ilya Prigogine called "dissipative structures" is a profound element in learning (Gilstrap, 2007). A dissipative structure is one that creates self-organization. Self-organizational theory has developed into its own field of merit, which, for example, is used in creating networks of cell phones. Thus, one element germane to autopoietic learning is that of self-organization, which is not based on hierarchy but on interaction. Organic processes are said by Prigogine and his disciples to be self-generating and are an example of the organization of chaotic systems. Emergence refers to unplanned, unanticipated events during game play and other activities. Self-organization is the description of how emergence unfolds.

An example of autopoietic learning occurred in the gamified role-playing course Healer's Quest as a total university course conversion to a game. As we introduced case studies on cancer, some groups learned the relevant biology and then focused on the social and environmental links to cancer. Another group decided to explore alternative medicine to see if there was any evidential basis for these medications in cancer treatment. Another group looked at the psychological elements of cancer, i.e., the role of stress and depression during cancer diagnosis. I could not have planned this, and if I had, that might have shut the doors to other learning the groups designated as critical. That is self-organization. We simply do not know where a student will go with the knowledge they access as they encounter social, psychological, and historical data and then interact with other learners in a learning domain.

This might sound trivial until we consider the risks of failing to build autopoietic learning. Autopoietic learning is based on the fact that learners will move toward centers of gravity—attractor regions within a learning domain—defined by their need to know. This need to know drives exploration of the domain area, which is personalized for the learner. It is the highest level of personalization we can afford in education. A patient recounted a story to me in which she went to the clinic for a colonoscopy and they offered to give her an intravenous iron drip because they noted she was anemic in her blood workup. The next day her arm swelled up and she told the nurse at the clinic about it. The nurse said it was normal and to just take two Advil. The swelling continued and then she was admitted for an infection. The infection had spread to her heart, causing endocarditis. The endocarditis damaged both heart valves and now she had to go for open heart surgery to replace them. All of this from a routine visit to a screening center. Clearly, this incident is an example of how we must train health care workers to expect the unexpected, not to act according to a scripted algorithm. It demonstrates how our idealized simulations in training often have no connection to reality. In an idealized simulation, this patient was fine after the iron infusion. In real life, she faced major surgery in a way no designer could have imagined.

Autopoietec learning can reach much further than this. The fourth and sixth major causes of death in the United States are from medication reactions or adverse side effects. This number is appalling and it points to the need to create conditions for learning mindfulness in health care workers. Again, the way that we teach health sciences is often scripted: a patient has ailment *X*, which we treat using protocol *Y*. This reduces the patient to a statistical entity, one which has a given probability of being treated. However, patients are not numbers; each one brings a unique blend of risk factors, genetic endowments, and social determinants to the doctor. Personalization of medicine can only happen if we first personalize students' education. Autopoietic simulations can take doctors in training through a number of simulated scenarios as they develop ways to create their own form of mindfulness. We know that reducing patients or learning to simple flow charts for care fails to recognize the distinctive elements of each case. By limiting the learner we eventually limit the doctor who has learned.

Connecting domains is also helpful in analyzing organizational relationships, once the theme of network relationships is developed. Creativity and critical thinking lead to new ways of doing things. We cannot train any profession to do things that we see now; we must anticipate what they will eventually do. However, since none of us has that crystal ball to make that determination, we release the learner to discover it and build upon it. Scripted, sequential learning is a key feature of learning management software such as Desire to Learn, Moodle, and Blackboard, which are the top selling systems in the world. How can we begin to approach this form of learning using our current technology and convert some of these systems to autopoietic environments?

4. EVALUATION IN ATTRACTOR-DEFINED DOMAIN-BASED LEARNING

One of the key considerations in any form of professional training or medical/social/organizational uses of gameworlds is how we measure progress and fitness for practice. Classic evaluation systems such as examinations or laboratory reports do not suffice; they do not have the granularity that hyperreality systems do. Ongoing evaluation is possible and necessary in gameworlds, in which we no longer have to schedule benchmarking in the form of exit exams. While external verification exists, as in licensing exams, those can be treated independently of the learning experience in gameworlds. Let us focus on how we adjust our thinking about the measurement of learning.

First, gameworld evaluation is based on learners completing quest lines and missions, not completing modules. Thus, the very nature of the design by the attractor region insists that we measure how many domain regions the students have encountered and how much they can complete simulations in a given time. Let us examine a prototypical attractor region in a gameworld (Table 1). Note that in Table 1, the attractor region is the general domain we wish the learner to master. Students should leave this experience knowing the anatomy of the heart and how it works. Each case study will lead the student into a problem that will drive learning about these things in order to solve it. This is not that new. McMaster Medical School has been using problem-based learning for many years. In Table 1, the gameworld is revealed in the value column on the right. Here, we can weigh each domain experience with a point value, indicating which case studies pay more dividends to the player for time spent. As the player advances through these case studies, their point value increases to a maximum score. Thus, each case is a partial score toward a maximum that would indicate evidence of mastering a given domain.

TABLE 1: Scoring values in simulation gaming

Attractor Region	Simulation	Value
Heart physiology	30-year-old man with swollen ankles	10
	67-year-old man with chest pains and racing heart rate	10
	22-year-old woman with abnormal valve sounds after an infection	60
	6-year-old female child with fatigue and lightheadedness	20
Heart anatomy	34-year-old male with a tumor in the right lung displacing the heart	10
	Pericarditis in a 15-year-old female	30
	55-year-old female with tachycardia	20
	2-year-old male child with a heart valve defect	–

Note that we do not use learning objectives in this design model. It is reasonable to ask how we define the learning, since there is a huge difference between the anatomical knowledge required by surgeons compared to support workers in a long term care home. We embed the learning in our simulacra, i.e., our cases of hypothetical patients. As the students solve each case they encounter the knowledge embedded in that decision. Each student will learn different things; some will remember the vessels of the heart, some will remember the vessels of the heart as a three-dimensional relationship. It is not necessary for all students to know all of the anatomy of the heart. We only need to be exposed to core ideas in training as applied to problem solving. At one point at McMaster Medical School the instructors had students learn about either the leg or the arm; both of which have a similar anatomical design. Later, if the students were to become surgeons, this could be sorted out when they had to access that detail level. In other words, we need not strictly define what is to be learned, if simulacra are driving the entire learning. The design key is to select the right representative simulations based on consultation with practitioners; this will ensure that learners encounter the right facts along the path.

Notice that unlike full simulations, simulacra are short 1–2 sentence cases. The idea is to keep the case short such that the learner is not led toward a specific scripted outcome. Let us look at the first simulacrum in Table 1: a 30-year-old man with swollen ankles. In the first phase of this inquiry a student or a team will identify causes of swollen ankles—from a sprain, to heart failure, to a host of other concerns. Then, the student will identify those things they need to know to make some distinctions. At this time, the hyperreality game engine will provide a way to interact with that simulacrum. The student will now be given a limited number of action points, i.e., things that can be done to locate more information on that patient. These are listed in a device menu, such as that shown in Fig. 4.

FIG. 4: Screenshot taken from the learning game, SOS, designed by the author

This screenshot shown in Fig. 4 was taken from our game, SOS, which was designed to learn how to manage the frail elderly. The small star on the upper right screen shows the value 2, indicating there are only two choices that learners can make to select a test for the patient. This is mid-game; the learners may have started with up to six action points in this game system. In Fig. 4, you can see that in the right-hand column that there is a cost of one action point per test. To order a neurological exam, you would spend one point. At that point, you will only have one point remaining. This kind of process, where the learner wishes to do many things but can only do a limited number, not only imitates the real world, where resources are scarce as is time, but it also makes the learner focus. This type of focus has been shown to deactivate default mode processing in the brain and stimulate the ventral striatum, the reward-learning center of the brain. Thus, making the student choose between equally attractive options is the way we now take domain-based cases and force the learner to interact. At a back-end analytic screen, which only the faculty member sees, we can determine what kinds of selections students are making, how long they take to do it, and how many cases they can solve per unit time. The small “time remaining” note on the bottom of the screen in Fig. 4 indicates that the student has, in this case, 40 minutes and 16 seconds left to complete this round of the game. By measuring how many cases are solved correctly per unit time we can measure an inferred mastery of content.

Figure 5 shows an analytic screen for another serious game version of this system. This being a personal coaching application, the faculty member can now see, for each area of case studies, how far the learner has progressed. Material and user analytics are provided, as shown in the left-hand column under the general analytics heading. These are high granularity data. We know from minute to minute, how players are progressing and we can determine where they are weak. We can then develop just-in-time updates to push out through the gameworld system to correct those weaknesses. In one period of testing, we determined that students were struggling with the idea of dehydration in the elderly, as evidence by the analytic fail rate on the case simulation. Therefore, the faculty developed a short burst module on how to identify dehydration more accurately, which then allowed them to track success in cases for that domain after the burst. In this case, the burst can be didactic (where reading is encouraged) or it could be developing some new cases that more carefully steer learners into the subdomain of fluid status and dehydration.

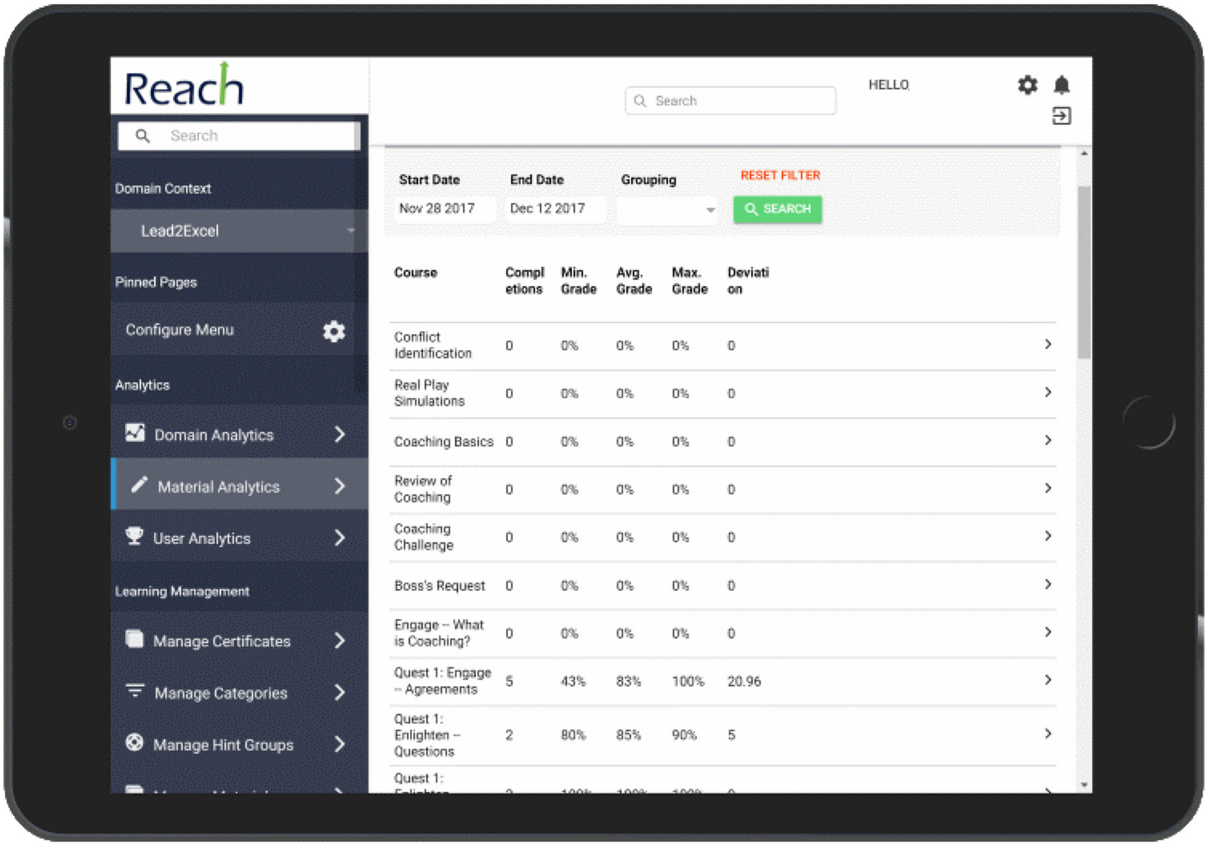

FIG. 5: Backend screenshot showing analytics from a simulation gaming platform creating a virtual internship

We know, minute to minute, how learners are faring in hyperreality space, which is a direct representation of how they will function in the real world. How learners engage with a simulacrum is very much how they will act in real life, and the literature on simulation is profoundly supportive of this contention. Exams are a thing of the past; it is daily, high granularity data collection that has surpassed them. This data collection need not end at the conclusion of training. It is best that learners continue in the gameworld throughout their careers, to collect data on how training is put to use after completion. These are Kirkpatrick Level 4 data; the hardest type to obtain in conventional training. We can now track learners for decades after training and identify gaps in practice, and then supplement the gameworld with new attractor regions. We can continuously monitor the effects of training. There is no end to training in a gameworld. Functional closures and pauses will occur, and there is a time when medical school is over. However, that does not preclude longitudinal tracking of performance in order to burst train professionals for the duration of their careers, or at least until they feel that they no longer need this system to inform them of gaps in their own knowledge.

5. PROBLEM-BASED LEARNING USING LEARNING MANAGEMENT SOFTWARE

PBL, as we discussed previously, forms the basis of autopoietic learning. In practice, this consists of connecting groups of learners in real time or digital space and having them solve problems by working as a team to research solutions. The evidence from this field shows that this process reinforces learning and recall through situated cognition. We remember things when they are part of a narrative more than if they are isolated facts. A typical PBL cycle is depicted in Fig. 6.

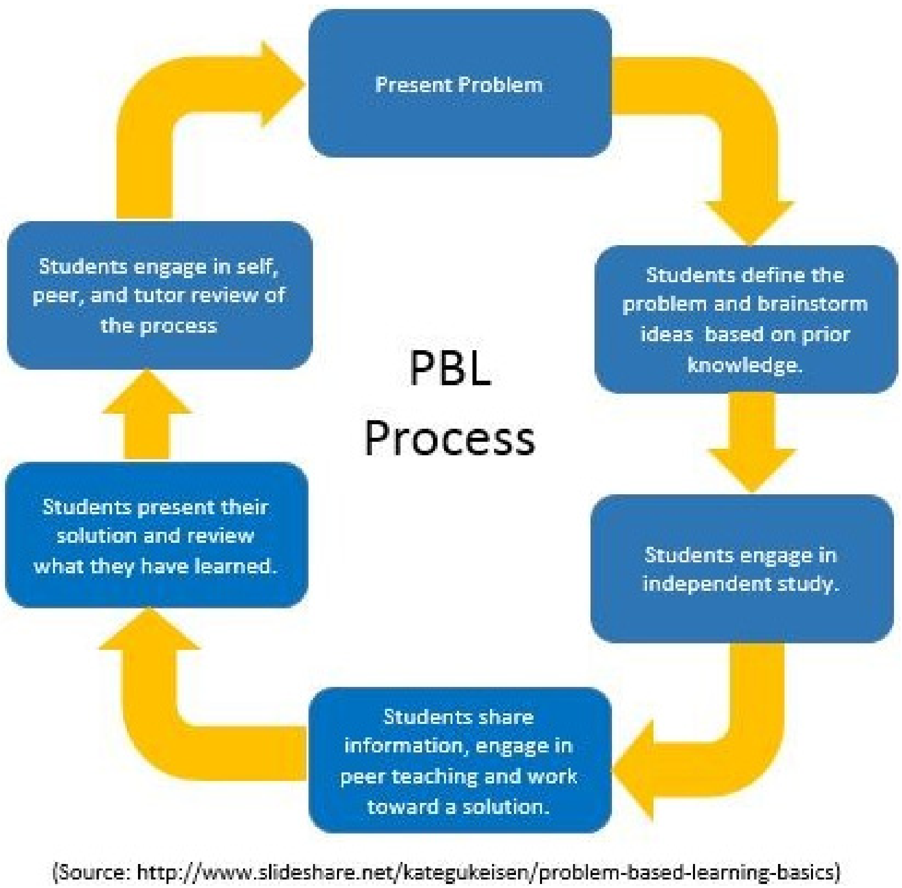

FIG. 6: Typical steps in problem-based learning [reprinted from Gukeisen (2013) under a Creative Commons Attribution 4.0 International license, https://creativecommons.org/licenses/by/4.0/]

Using LMS software such as Moodle, we can create discussion forums and then curate simulacra, whether they are images, text, or mixed reality experiences. The learners can then move across domains, selecting given simulacra case studies and working either as a team or individually to gain the information they need to solve the case. In PBL, solving the case is secondary; however, in hyperreality-based design it is central. The key is to research the solution and apply it, and then mark achievement as this continues.

What the designer needs to do here is to create sets of domains and then populate those with case studies or other forms of simulacra. The learner's role is to explore these domains by solving cases. Each case solution awards a number of points alongside evidence of research, such as completing templates to explain the reasoning behind a decision. This permits us to track reasoning processes; something we do not do in traditional learning. As designers, we want to know why a student made a decision to act in a case study; we wish to see the logic underlying those choices. Achievement benchmarking, in the form of awarding point values to specific domain solves, lets us determine solve rates. Each case has its own score; in the SOS app we developed it as depicted in Fig. 7. The student has solved a case and now has earned cryptocurrency, which denotes an achievement. Students can select cases of easy or hard difficulty, research the background, attempt to solve them, and then see their own progress. In our data collection we determined that the more that students played the game, the greater was the solve rate; there was a linear relationship between the amount of attempts and the overall score.

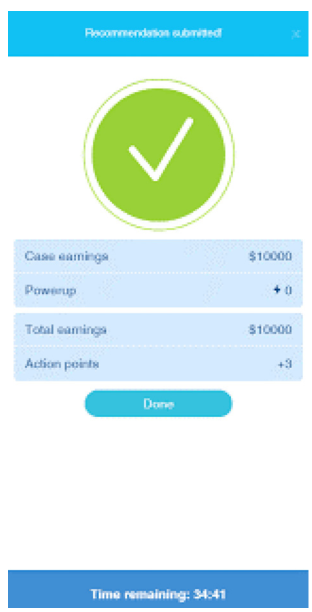

FIG. 7: Sample of simulation game scoring for the learning app SOS

Learning management systems (LMSs) can work but lack the narrative structure of domain-based gameworlds. This is where the integration of media in a “storified” design software suite is essential. We have had to build our own software, in which the cost ranged from $10 thousand to $100 thousand. However, once built, this narrative software with a game engine (in which the coding tracks achievements, awards, and learning progress) can be used for any content in the future. It is a one-time investment, which is far more flexible then a dedicated, single-subject simulator.

For designers without the capacity to create code due to budget restraints or institutional commitment to learning management software, we can use adaptive release to unlock new domains of knowledge as a form of reward for progress. Adaptive release is a rule set that all LMS have, in which we cannot view hidden parts of the course until we complete prior elements. One cannot do module B until we write a quiz on the content of module A. This adaptive release function permits us to curate the LMS with case studies that can only be viewed after the student achieves some success in previous cases. It is important to realize that this is a limitation of the design; it is not a truly open world. However, it does permit learners to enter autopoietic hyperreality in a rudimentary way.

One such model we designed for insurance industry training and also for geriatric-care education was based on using discussion forums alone. Each week, three new cases were put up on the discussion forums on a WordPress page. Each case paid a certain amount of in-game “gold.” The learners had to complete at least one case each week with a template debrief and explanation of their reasoning. They could progress to the next week, where three new cases were archived, only if they did one case. However, if they wished to maximize their earnings, they could complete all three cases and obtain a completion bonus. Each week the cases were harder. This is called titrated challenge, which means we gradually increase the challenge level over time as learners gain more experience. In the simulacra space, there was a narrative that was connected to the learning. In the case of the insurance course, the learners were building a virtual insurance company. As they earned virtual money by solving cases, they could then use that money to purchase virtual objects in the game, such as a Lear jet. Players could go shopping for various objects using the money they had earned. A Lear jet, when purchased, unlocked a series of insurance case studies related to travel insurance, which paid much more than the basic case studies.

Professor Deb Fels at Ryerson University converted her entire course in multimedia to a game system in which students build a company delivering multimedia services. Students could purchase upgrades in the game to advanced, or use their cryptocurrency for real world gains. One option was to buy more time to complete essays, delay assignment deadlines, purchase extensions on papers, and so forth. Professor Fels shared with me the fact that over her 20+ years of teaching that course, this was the first time she received 5-star ratings from her students on the course evaluation. Her enrollment doubled over the first 2 years of converting her course to an open world game.

In our work at Baycrest Health Sciences, The Grid and Hygiea open world games both featured similar designs for nurses and personal support workers in long-term care. The Grid game was something I was asked to design for an online virtual internship for a ministry-of-education approved program. In The Grid, I used a modular dungeon design with a background narrative set on a ship called the Aristotle, but this design was later changed by the team to a modern health care facility in hyperreal space. The design of virtual workplaces and health care is usually based on modularity as developed by pioneers such as Richard Bartle.

In each room of the dungeon map (Fig. 8), we located different types of virtual patients, which we refer to as virtual objects. As we populated the rooms with different non-player characters, such as patients with alcoholism, depression, physical disease, and other disorders it took on a living quality; we had created, without graphics, a virtual hyperreal space. In one ward we had cases related to psychosocial issues, in another ward we housed cases related to medical problems, and so forth. The students would then move through this virtual space in any direction they wished and encounter the simulacra. As they did so, they accumulated in-game currency, which could be added to a “loading program,” where readings and videos were curated. Completing a learning task in that space of the dungeon resulted in more gold and experience points being earned. Players could then obtain a set of goggles in my original design, which unmasked data related to each case. For example, the information on what drugs a patient was taking was concealed; however, if you purchased the pharmacology lens upgrade, you could now have that information revealed to you. Those upgraded lens items stayed with you from that point on, but were very expensive. This promoted other players buying different lens sets, such as information on mental status or emotional well-being related to that case. Now players could team up sharing their upgrades to gain increasing information about the case in order to manage the virtual patient. This concept of building a hyperreality space, and then populating it with virtual objects, is derived chiefly from dungeon games and is a strong foundation for creating autopoietic learning environments. In the final game, these were called “consults” and represented a real world briefing by an expert who revealed more data from the case.

FIG. 8: Dungeon map with virtual patients

As the complexity of the game increases, the cost for development increases as well. Simple games that permit learners to work with basic virtual objects can be built in an LMS. Games with multiple compulsion loops, which we will discuss subsequently, require coding and graphics. Much can be done with card games, LMS, and WordPress blogs. In fact, I would venture to say that serious game designers work with these extensively before they allocate funding for code building.

6. EMOTIONAL COGNITIVE DESIGN FOR SERIOUS GAMES

Over the past few years a shift in how we view the learner has occurred. The field of user experience has grown at a rapid pace, resulting in a movement toward emotional design. Emotional design is based on the theory that we primarily engage with the world through emotions rather than through cognition. Cognition in learning refers to the act of internalizing the world through memory and rehearsal of practice. Traditionally, education has focused almost exclusively on the content we are "pushing through," using receptivity as the metaphor underlying instruction. Students are passive in such learning; they "receive" knowledge. Although things are not as simple as this, there have been advances in active learning, for example, it still underlies this idea that the content of what we are teaching should drive the learning experience. Unfortunately, this is not how human beings act. There is accumulating evidence that every decision we make and every act of learning is driven by emotional needs (Csikszentmihalyi & Nakamura, 2014).

This goes far beyond the Maslow (1987) needs-based theory, which was based mostly on our needs. Needs have an emotional flavor, but are still primarily utilitarian. Needs are about survival and survival is about learning how to feed, form social units, and locate solutions to environmental problems. Maslow wrote extensively about self-actualization and his work is quoted in adult learning in this regard with some reservation. Malcom Knowle's "androgogy" (Knowles, 1983) certainly incorporates this thinking in comparison to pedagogy, which refers to teaching children. However, the transition from needs-based learning to user-centered learning design is a result of technological developments since the 1960s. A gap has developed, whereby educators who still use terms like androgogy and adult learning have not expanded their thinking to incorporate user-centered design. The proof is in what we see: stroll through any college and you will see room after room of lecturers speaking with students making notes. A brief break to do laboratory work or practicums is no change in approach; these are still instructor-led experiences.

User-centered design is about thinking about learning from the students' perspective. What things do they need to make the experience worthwhile? We wish to be time efficient and effective in training. Time efficiency is paramount. We cannot stretch a medical education to 15 years, since it already takes 3–4 years of undergraduate preparation, followed by 4 years of medical school and a 2–4 year residency to train a specialist. Thus, user-driven experience in learning must be time efficient, even if multi-year programs are needed. User-defined—as opposed to user-driven—experience has a roll in this now, in that it is the limitations of the human nervous system that stretch this out in the first place. If we could train doctors in 3 months, we would. However, the brain demands repetition, memorizing vast fields of knowledge, and learning how to make and evaluate decisions. This is the time-limiting factor for learning: the remarkably slow pace at which humans learn anything. We are not efficient learners; we are the products of evolution that rely upon a few key behaviors to survive. In the ancient world, over the past 10,000 years, learning has been primarily about acquiring a few key skills such as agriculture or hunting. Since the time of the enlightenment in the seventeenth century, learning has expanded due to the growth of science as a discipline and core human activity. Thus, matching time efficiency to simulation success is a core element.

With the growth of science and technology, the demand for learning is not as much needs based as it is content based. There is simply so much content in our lives, let alone professions, that it is impossible to keep track of it and relate it to our needs. How do I connect my knowledge of different facets of life, including developments in my own field, to a central theme? The constant influx of new ideas and technologies defies any consistent narrative. Each technology in itself generates a new set of needs. One now needs to know how to use email, social media, one's automobile global positioning system, how to maintain the right body weight, prevent the “preventable illnesses,” and/or do a fact-checking search on the Internet. It is no longer content driven, in that there is so much content that we now find marketing teams seeking to control cognitive space. Our attention is limited; we do not have the capacity to absorb any of the detail related to technology, only the surface features. We know a new iPhone exists and may do one thing well, but another phone might suit us more. Purchase decision shows us how we evaluate new technologies and what features we scan for to make the item relevant for us or for our target market. This leads to a superficial data-parsing mode of thinking, where we can only take in a limited amount of data since our cognitive load is so great. Superficial data parsing becomes a habitual way of viewing information; it is assigned a valence (emotional value) and this valence then drives our decisions. If phone A does what phone B does, but also does X, then our valence increases. Content parsing occurs in hyperreal space; it is based on symbols more than content. Symbols are quick to identify and reduce our cognitive load by making information easier to categorize.

However, we must connect valences to our emotional state, and this is where emotional grid diagrams arise in the behavioral neuroscience literature. Behavioral neuroscience is an emerging field that has its own doctors and scholars, which is based on understanding how our brain processes information and how we use that information in the real world. The findings from this field, which include analysis of the role of the neurotransmitters dopamine and serotonin, or the hormones such as cortisol and oxytocin, suggest that we make all of these surface decisions on the basis of an emotional scatter plot that links to valence, as shown in Fig. 9. The customer or learner—or anyone—navigates this grid in everyday life. In Fig. 9, on the horizontal plane, we see the valence of either unpleasant or pleasant experience as felt by the person. On the vertical plane, we see the intensity of the emotional experience plotted. For example, someone who is serene in life would tend to cluster on the right-hand side of the grid, and someone who is unhappy would cluster on the left-hand side. We can manipulate emotion on this grid by presenting emotional experiences, such as winning a lottery, or even increasing the chance of winning a lottery. This is the basic map of human emotion. Think of emotion as the sea, and feelings as waves on that sea. We can affect emotions in user design and then create feelings that trigger those states. This is the basis of what we refer to as emotional design. Emotional design can trigger learning in populations where traditional teaching does not provide appropriate cues, narratives, or processes, such as in women's competencies in science, technology, engineering, and mathematics (STEM) (Cheryan et al., 2011).

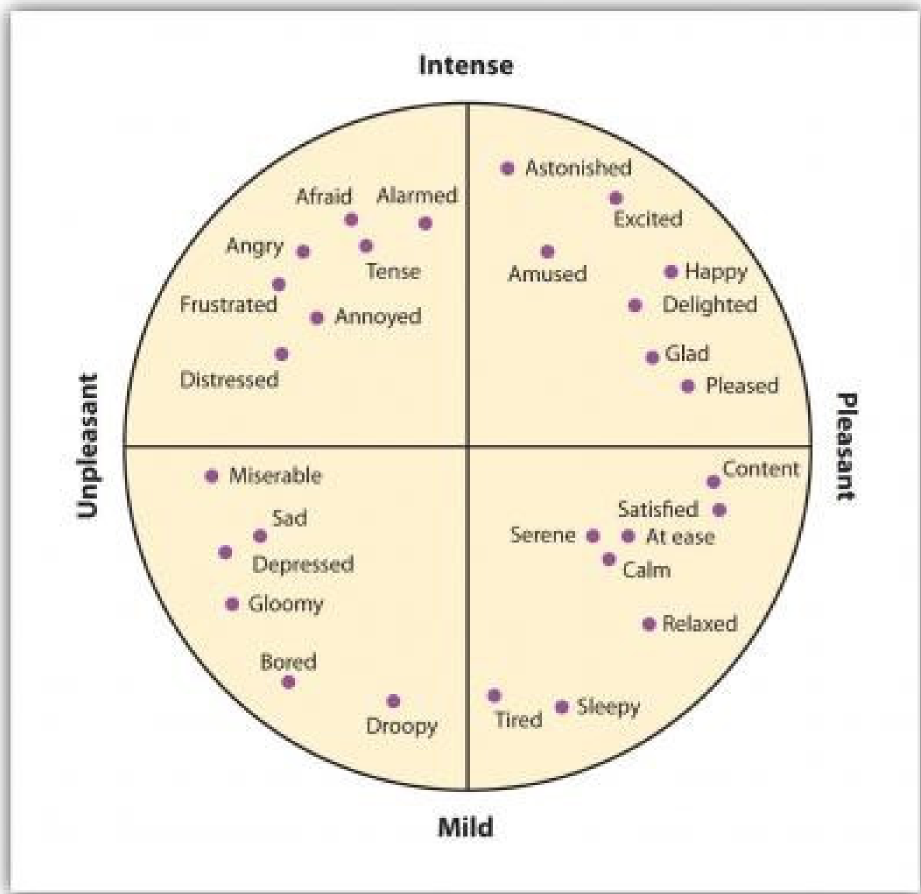

FIG. 9: An emotional scatter plot (B. Cugelman, AlterSpark)

Given what we know about the power of user design in emotional experiences, how can we take this information and apply it to learning in hyperreality? We have established the fact that emotional valence is a key determinant of engagement, to the point that we take considerable risks on social media to modify it. We also know that mentalizing functions are ways of creating social connection and inter-professional collaborations and even ways of modeling professional behaviors. We also can conclude that the emotional design of learning may be more important than the building of content. Content without emotional design lacks cognitive space and narrative structure. What steps can we take to build gameworlds with the specific goal in mind to nurture social connection, engage learners in narrative, let them interact with each other to challenge ideas, and reward learning with pleasant emotional states? I will ask you to think about learning design from this point forward as painting an emotional canvas.

7. THE ACHIEVERS, COMPETITORS, EXPLORERS, AND SOCIALIZERS MODEL AND PLAYFUL DESIGN

Given that we can now envision curriculum design as something occurring in a hyperreal space, it has taken on field properties. Think of your learning experience as a dimensional space that learners will navigate, rather than as a sequence of facts, as the field represented by Fig. 10 suggests. In Fig. 10, each of the mountains in the field (the raised sections) represents the depth of a given domain of knowledge we would like students to explore. The small bulge shown in the panel on the left-hand side might be a superficial view of the sociology of heart disease, indicating, for example, how hypertension is higher in some populations. The next two cones we see in the panels in the middle and on the right-hand side are fields where related concepts demand more participation in learning with borrowed concepts from sociology (shown in blue), but also concepts (shown in white and light blue) that might represent anatomy and other sciences. Remember that this content is nested in simulations; all of these states in the total field of learning are collections of simulacra.

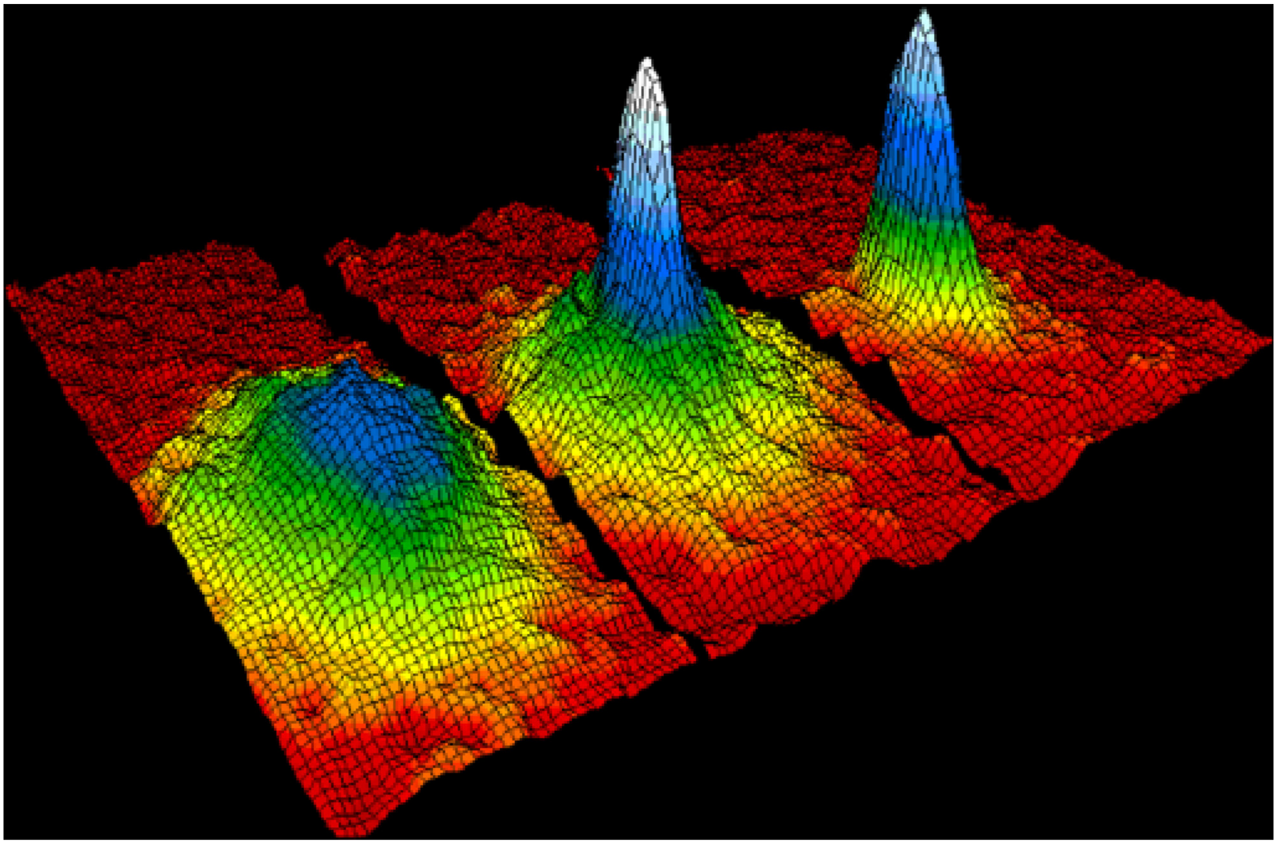

FIG. 10: Representation of a field model of epistemological domains

Using our rules of digital engagement, we now must construct an emotional design for this field that generates not only motivation but also retention of ideas and skills acquisition. In order to create what we might call playful design—that is, a build based on learners enjoying the experience—we create an emotional symphony. The key elements of this symphony are going to be based on Richard Bartle's player types, which are based on the types of people who enjoy dungeon exploration games. His now famous taxonomy includes four major groups: achievers, competitors, explorers, and socializers (ACES) (Bartle, 1996). There are other player typologies proposed, such as the hexad system suggested by Andrzej Marczewski (2015), but those refer to player experiences rather than a model for design that I have found useful here. There are many more player type descriptions in Marczewski's work that are worth considering in building emotional design.

The Bartle player typology permits us to attach learning experiences to an emotional design document, such as that depicted by Zenn (2017). The ACES model for emotional design in hyperreality space refers to the four activities of achieving, competing, exploring, and socially connecting. Our design for open world learning then creates opportunities to participate in learning using any combination of these core emotional activities.

Achievement design infers that we build many sub-goals and player-compulsion loops into a gameworld to denote achievement and to broadcast those achievement progress analytics in our game engine. Competitive design means that we also provide opportunities for learners to compete with each other or with fictional entities, which we will call “game bosses” after the tradition of video game development. Exploration elements will have players moving through the learning domains to satisfy curiosity and increase engagement as well as permit non-sequential or situational learning to occur. Finally, social elements will connect learners to each other or to broader communities to satisfy the need for recognition, support, and/or companionship. The specific types of activity profiles that one can explore in design are derived from the previously suggested elements. For example, using exploration we can enable players to review new data, collect virtual objects, unmask hidden elements of content, or discover new connections between fields. Collaborative learning might prompt us to build discussion threads, commentaries, user-generated content portals, or most valuable player mentorships. The specific activities are not important at this point; it is the idea that we build learning based on the ACES foundation, which then curates the learning experience within emotional events.

Building gameworlds using the ACES model is a matter of designing multiple compulsion loops that address all four player types. Compulsion loops are things you do in a game that make you want to keep playing. Going to a slot machine is one example we are familiar with: we deposit coins, our reward centers get activated, we lose, we try again, and we win a bit. The losing makes winning exciting, since it is the prevalent activity. Winning is financially rewarding but it is only so because the default state is loss. This is a simple compulsion loop. In a video game, killing a monster and looting the body for gold and items is a popular compulsion loop. In Super Mario, collecting power ups and making it through difficult passages is a loop. In Wii fitness games getting a score for doing a physical challenge is a loop. Good game design for open worlds demands multiple compulsion loops, what the industry might refer to as a conglomerate of player satisfaction. Similarly, we need to integrate learning goals with the ACES model for a user-activity profile, and then create multiple compulsion loops within the gameworld. The framework looks very different from traditional learning design. It has been used for learning with seniors in a modified form, where the elements of the ACES model form a design principle for universal access (Duplaa et al., 2017).

This paper has introduced a new way of envisioning education, as a personalized excursion into an alternate reality made possible by advances in online technology. As educators seek new ways of understanding teaching and learning in an era where engagement, soft skills, and skill rehearsal are prioritized over content distribution, coding design teams must adapt. The failure to adapt will result in an under-utilization of technology and costly errors in trying to make antiquated models fit. With a focus on entertainment as a form of learning and its integration with simulation, trainers will be equipped to generate user experiences that transcend traditional boundaries between technology and training.

8. DISCUSSION

Open gameworlds provide a micro-internship for training, but they have uses that extend beyond that of job skill rehearsal. Compliance training and other mandatory employee certification can take place using this model. Compliance training, in particular, faces strong resistance in that it often consists of short bursts of data followed by review quizzes; gameful design approaches can help mitigate this resistance (Landers & Armstrong, 2017). Narrative and exploration have been used to build game experiences that rely upon this foundation, rather than on “fact dumping” and “test out” models to improve engagement for wider organizational traction (Klabbers, 2006).

This view of learning is derived from a deeper philosophical concept (Sharma, 2018). The idea of biocentrism developed by Robert Lanza has gained considerable gravity on its own in the physics community (Lanza & Berman, 2010). Lanza's view is that life creates the universe. Neil DeGrasse Tyson, the famous astrophysicist argues that the entire universe may be a simulation (Moskowitz, 2016). In a true simulation, knowledge of this would be concealed. He implies that we created nature, not that nature created us. Biology is the basis of cosmology for Lanza. This conceptualization is very helpful in enabling us to address learning as something that occurs in a hyperreal space. In Lanza's cosmology, we create nature because it is what we are at our core. Nature does not create consciousness, our world is consciousness.

There is a strong correspondence between biocentrism and aboriginal learning in Canadian First Nation's peoples such as the Ojibway. In many aboriginal ways of learning, all things must be connected to nature in the form of a relationship. For example, if learning about metals, one would focus on where metals come from, how they are created in nature, how we extract them, and how we use them. This connects all learning to a storyline about creation in natural worlds. Nature functions as autopoietic hyperreal states do, by driving all learning using attractor regions.

Physicist David Bohm describes the “implicate order” as an underlying connectedness that occurs in physics, where consciousness is a component of this space, not simply a Kantian interpretation of the senses. In his discussions with Jiddhu Krishnamurti, the Hindu Vedic philosopher, they arrived at a convergence (Krishnamurti & Bohm, 1999). Consciousness has field properties and the connections between real world events are not purely Newtonian, there is an underlying order to the universe that connects often distant physical objects. This resonates with John Stewart Bell's theorem (Lindley, 1996), which suggests that physical connection between objects is not a necessary causal link. He uses the term quantum entanglement to describe how physically separate objects such as electrons can influence each other. Many experiments have confirmed Bell's theorem, and these might apply to more than only subatomic worlds. The implications of such discussion are profound; it means that if we shift the rotation of a single electron in an electron pair (all electrons exist in pairs, one with up-spin and the other with down-spin), its partner will reverse its rotation. He uses terms like “super-determinism” to describe this relationship. Although viewed as innovative or extravagant by physicists, it does point to a view coherent with that of biocentrism or DeGrasse Tyson's simulation world. That is, what we do is determined not by our own free will but by a force that not only dictates how objects interact but predetermines the very act of thinking about this.

How do these views help us understand autopoietic hyperreality? If we now see students as agents within a given VLE, then what we know about biocentrism can help us design learning. For example, by creating a gameworld that is connected to nature, aboriginal students can anchor their learning in their own tradition of thought. David Bohm's idea of the implicate order suggests that groups of learners interact in non-rational ways; they enable each other's growth in a way that we cannot easily build into learning design if it is scripted. Marvelous accidents in training, where synergies between learners lead to unplanned development, need to be fostered. You never know, going into a team, what interactions and creativity will be unleashed. Autopoietic learning means that we have a general plan for learning, but that new things can grow that we did not anticipate. I can provide a couple of examples to illustrate this.

One student I had when I was teaching biology to nursing students came from Palestine, where he had served in the Jordanian army as a medic. He took my regular, lecture-based course and fared poorly, with a grade of C in the first term. Then, by happenstance, he appeared in my gamified biology course that featured problem-based, small group simulation gamification, which I will describe subsequently. This time, the entire group turned to him for advice in every simulation because he had been out there treating wounds for years, unlike the other students in his team. Thus, the autopoietic event here was that his capacities were unleashed through the game system, and as a result his grade went up to a B in the next term. I could not plan that a former medic would show leadership in a learning game in basic biology. I did not even know who my students were as I designed the game; however, the self-organizing element of autopoiesis led to this student unfolding as a learner and to the group's enhancement of learning through his experience.

Another example of autopoietic learning occurred in the same gamified role-playing course as we introduced case studies on cancer. Some groups learned the relevant biology then focused on the social and environmental links to cancer. Another group decided to explore alternative medicine to see if there was any evidential basis for these medicines in cancer treatment. Another group looked at the psychological elements of cancer and the role of stress and depression during cancer diagnosis (deep stuff). I could not have planned this, and if I had, that might have shut the doors to other learning the groups designated as critical. That is self-organization. We simply do not know where a student will go with the knowledge they access as they encounter social, psychological, and historical data and then interact with other learners in a learning domain.

Semiotic resonance (SR) consists of two words: semiotics, which is the study of signs and symbols; and resonance, which refers to the act of some part of the game resonating—or triggering identification—with the player. Semiotic resonance designs are based on the deliberate creation of symbols for the real world, such as an avatar that represents the player, to induce a state of immersion in the game progress. Semiotic resonance takes this one step deeper than rehearsal or captivity builds: the goal is to provide symbolic landscapes that trigger our innate desire to create mythology and engage in storytelling. However, it goes deeper than this. This is where we must again turn to psychology and philosophy, both that of aesthetics and metaphysics, to make any sense of the design process. Semiotic resonance is a “thinking person's design,” which is based on understanding common mythologies, such as the nature of conflict in storytelling, the narrative of human life over history, and the things that really make us human. Semiotic resonance goes far beyond simple storytelling; its aim is to trigger deep psychological experiences, such as redemption, loss, love, happiness, longing, rage, hopelessness, surrender, and wisdom.

We developed this idea as I worked with addiction medicine, where the metaphors for treatment are rather medical and difficult to connect to greater ideas. At first, it was fairly simple: patients were to view their illness, addiction, as a kind of prison. They were to view their treatment as a key to escape. Thus, the basic principle in the game design was based on imprisonment and escape. These ideas are present in the great literature through the ages, from the work of Homer on down: that of emancipation. Slavery has been with humanity for over 5,000 years, from the many African countries to South America and to seventeenth century Europe. There is no culture that has not taken slaves, all with their own rationalizations. Thus, slavery is so core to the human experience that the concept resonates with players. That is, they see a reflection of their own lives in it: slavery to a job, to alcohol, to success, to debt, etc.; they are all metaphors that have come from this ancient practice. If I were a student of Carl Jung I would call them archetypes.

These are the Joseph Campbell (1968) mythologies, they are core to human life and have been passed down in art, literature, and perhaps even in our genome. Their origin is not our concern; it is the prevalence of these mythologies in human life that are the focus. To build VR gameworlds that have no connection to age old stories, metaphors and narratives such as emancipation from bondage ignore the common core of human nature. Great movies such as Star Wars resonated with fans not just because of the plot line, but because of the underlying mythologies expressed. Yoda connected us to the mythology of the martial arts master, the idea of the learned ancient who has great powers. The battle between the Empire and the Rebellion symbolized our historical struggles, in which good and evil were at war (think of the American decision to enter the Second World War). The love between the Princess and Luke Skywalker, depicting a tragedy where love could be felt but not consummated, and the vastness of space depicting awe and wonder at the universe, were all resonant structures in my view. They appeal to us because we use the same myths, albeit in different themes, to make sense of our lives. Science is discovery, medicine is bringing order into chaos, and commerce is creating something where once there was nothing. These mythological structures drive our lives, and gameworlds that fail to tap into them are missing much of the value that hyperreality holds.

In order to design using semiotic resonance, we need to position all of the learning experiences within a deeper narrative that is clearly defined using mythological themes. These can be derived from any culture, and approximating that mythology can unlock powerful SR. For example, we could use a theme of imprisonment for addiction, but if it was designed for First Nations' learners, this theme could incorporate imagery and legends based on Cree or Algonquin native culture. In the design of our addiction games, I researched the ancient Roman mines, where slaves were imprisoned for life. These metaphors were powerful when used to induce resonance in players. Every in-game action they took was designed to liberate them from slavery.

Ancient Greek mythology is a good place to start if you do not have a story writing background, which few trainers do. Heroism, characterized by bravery, strength, and morality is a powerful theme. Generosity, faith, love, and sacrifice are all equally compelling SR elements. The theme of love can be quite expansive, as in the story of Psyche and Eros. The goddess of love, Aphrodite, was jealous of Psyche, the most beautiful mortal. Thus, she sent her son Eros (named Cupid in Roman lore) to seduce Psyche and destroy her. However, Eros fell in love with Psyche and this angered Aphrodite. Eventually, Psyche is sent on three major quests to win Eros's love, which she completes and they live happily ever after. The idea of a quest to find love and win the beloved is so core to the human experience that to fail to consider it in building a gameworld is regrettable.

A mythography is a collection of myths that might encompass all of Homer's work or capture the early battles of Krishna as he speaks to Arjun in the Vedas, asking whether it is ever right to kill. Religious symbols and mythological elements tend to mix; the idea of universal love (Agape) versus passionate love (Eros) is so deep in our language that it is easy to coax it out in the gameworld. Universal themes of salvation, regret, longing, and deeper truth are all strong SR elements. In short, SR design is not purely based on job skills or fantasy engagement; it is based on evoking powerful emotions that are central to the human experience.

There are many views of what myths do for us; the position I take here is called the “functionalist” approach. This means that some anthropologists suggest that myths play a role in society. Subjective truth as a model for behavior encapsulates this discussion as espoused by Eliade and others. Myths bind us together in common understanding; across time, these change and reflect technology or regional variations but are unifying within a given cultural group. Creation myths explain our origins, such that we can share knowledge within groups. I am using a functionalist mythological design philosophy and suggesting that in order for gameworlds to be effective, this must be deliberately established. Not only that, but it must guide the development of themes and narratives. Themes and narratives are simple window dressing in rehearsal games, are absent in captivity games, but are core to SR games.

9. CONCLUSIONS

Autopoietic designs, at their best, resonate with these psychological processes, but we need not be as philosophical about it. However, it is useful to understand that everything we do in life is created, that we synthesize happiness, despair, and hope; these are neurological events at the very least. Gameworlds can function to create nested emotional experiences that trigger higher motivation to learn. Instrumentalist views of learning, where we treat the mind like a *tabula rasa*, need to give way to a more informed discussion that encompasses emotional neuropsychology, mythological structures, and professional mastery, and is truly holistic. Gameworlds, at their heart, should trigger a strong identification of what someone hopes to become and then provide a gateway to realizing those identified goals. Gameworlds are developed in coherence with the principles of positive psychology with a view toward a long journey toward mastery of the two worlds: the one of the self and the one of what we wish to be.

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