Knowledge and Power: Using Information Theory to Assess the Transactional Relationship between the Learner and the Knowledge Provider

The importance of surprise in learning

An ongoing debate continues among researchers about the advantages and disadvantages of various cognition-based methodologies used to inform the design of instruction. On one hand, the main critique of cognitive research is that it fails to account for the social and cultural dimensions that tend to mediate learning (Östman & Öhman, 2010). On the other, sociocultural research is often critiqued because it tends to overlook the individual dimensions of learning and that those individual differences can disappear due to an over reliance on social interactions and biases. The central question, then, is to investigate and assess individual differences through a sociocultural lens. This question requires an inquiry of methodological approaches to instruction that provides the requisite knowledge about how intrapersonal, interpersonal, and cultural dimensions influence and interact in the transactions that occur during the learning process with the knowledge that those interactions may be conflated if they are mediated.

Transactional learning theory proposes that the relationship between individuals is synergistic in that the sender and receiver each contribute to influence the understanding of content and context of a message (Dillard, 1982). Transactional theory arose from Rosenblatt’s (1986) examination of literary criticism in the teaching of literature as a social discourse. In that analysis he suggested that a reciprocal and mutually defined relationship exists between the reader and the literary text and argued that the term "interaction" conjures a picture of separate objects encountering one another and due to social influences often remained essentially unchanged. We agree with those who suggest that this definition is not only insufficient for literary criticism (Probst, 1987) but, as McLuhan (1964) often argued, we further submit that it is also misleading for many forms of instructional communication—especially those that are mediated due to the mutual shaping of the exchanges that occur between the learner and the knowledge provider.

The authors propose that one way to assess the value and impact of instructional message content and its impact, regardless of its purpose is to view the interactions through an information theory lens. In this context, the information and learning are defined as the measurement of what a person knew before the transmission/communication and what he or she now knows afterwards. George Gilder (2013) referred to this context as the ‘surprise’ that occurs when the receiver of information discovers what he or she did not know prior to that informational exchange. While Gilder was ascribing these surprisal moments to economics, we subscribe to the idea that his comments are easily translatable into various learning situations. Gilder’s comments were attributed to the concept of entropy, a maxim that defines what many refer to as the ‘lowest common denominator’ that emanates statistically from a number of different scientific axioms. In these contexts entropy has at least three different but relatable
definitions. In biophysics for example, entropy is a thermodynamic dimension that represents the point at which an ecosystem is no longer able to convert energy or heat into another physical object. It further equates to the degree of disorder or randomness of that ecosystem (i.e., it represents a statistical calculation of the gradual decline into disorder) that physicists statisticians often claim is occurring in the world we live in. It is based on the premise that the creation of the world is a random event that just as randomly may end one day.

Compression theorists borrowed the term to propose that entropy represents the point during the compression process the size of a file can be stripped down to a bare minimum prior losing minimal interpretability (referred to as ‘lossless compression’). In some cases, in fact, even ‘lossy’ compression may be acceptable based on a human’s ability to interpret the content of the file using minimal information. In communication law, entropy is the result of being able to bifurcate meaningful information from any noise that may occur in the channel. While transactional learning correlates in some ways to all three axioms, it is the latter that is most relevant to these discussions in that it represents being able to separate content or information that is the ‘surprise’ (high entropy) from whatever else exists in the channel (i.e., the ‘noise’ or low entropy) can potentially hinder the ability to translate and make valuable that information and convert it into knowledge and wisdom.

Using this definition, assessing the transactional communication that occurs between the learners and knowledge providers is a discovery of that which occurs in communication process that can potentially interfere with arriving at the desired outcomes. Further, we concur with McLuhan (1964) the medium that one uses to communicate a message influences how it is interpreted and understood. The value of our investigation into instructional transactions is to increase the ability successfully segregate out the noise/bias to make the surprise or eureka moments more discernable and assessable.

The two seminal instances in the learning process

Viewing learning from a global perspective, it is comprised of two distinct but important instances. The first relates to the initial communication process that occurs when brand new information is introduced. The second occurs when previously known information is reintroduced with the goal of making it routine so that it can be enacted upon or reacted to automatically. In the learning taxonomy this moment is sometimes referred to as the naturalization or automaticity phase (Bargh, 1989). During routinization the need (or the desire) for surprise is lessened and in fact can actually interfere with being able to discern what is new. In this case low entropy may be desirable, but if it is misused, overused, or in appropriately timed, it becomes a metaphor for the ‘noise’ in the channel.

In order to be able to properly differentiate between these seminal two moments a highly predictable communications channel is needed. It is also the premise behind the Artificial Intelligence (AI) movement that is rapidly entering the education and training domains. Predictability and routinization are the purview of robots. A human’s role in the initial communication learning cycle is to synthesize that newly communicated information and to
learn how to separate out the noise Sometimes these two moment occur simultaneously. In these instances, Al’s role is to provide redundant and repeatable information in an amount and at a speed that it becomes ‘profitable’ to the learning cycle by freeing up humans to decipher the surprises and take action when that new information is introduced.

These ideas are premised on the assumption that robotic technology and its associated algorithms can assist with the extraction of surprisal information and make the routinization process all low entropy and reduce cognitive load. The authors caution that it is important, not to completely succumb to Al and turn over the entire learning process to robots and mindlessly ignore the fact that some form of filtering/bias may be present. This is the basis for the need to teach information literacy in our schools.

Artificial Intelligence has most recently become a major component of Alphabet’s (i.e., Google’s) long range business plan, as led by Ray Kurzweil and others. Previous theorists and statisticians played a significant role in influencing Kurzweil’s (Reedy & Galeon, 2017) ideas on Al and singularity. For example, statisticians Borel (1913) and Eddington (1927), who in the early 20th Century created the Infinite Monkey Theorem treatise to illustrate the timescales that are implicit in statistical mechanics. The Infinite Monkey Theorem proposed that it is possible to statistically demonstrate that, if one utilizes infinity as the multiplier a monkey hitting keys at random on a typewriter keyboard for an infinite amount of time will almost assuredly type any given text, such as the complete works of William Shakespeare. In fact, the monkey could type every possible finite text an infinite number of times. In this context, the concept represents a mathematical term with a precise meaning, and the ‘monkey’ is not an actual monkey, but a metaphor for an abstract device (i.e., a robot) that can produce an endless random sequence of letters and symbols. Google may have demonstrated their willingness to follow and support this idea when investigating their stated business model.

These ideas have become the foundation to many assumptions about learning, assessment, and testing and how they may, with the help of robotics, eventually eliminate all surprisal information in the instructional process and make all learning low entropy. The overarching intent is to take all randomness out of the learning process by making it totally predictable. In this view of using Al in teaching, there is no interpretation/synthesis needed. This view of learning suffices for routinized learning situations and ties directly with some of the potentially misguided behind the need for standardized testing. The assumption is that, if most or all learning can be routinized and made predictable, the need for human interactions in teaching and learning is lessened.

What that means for the future of education is still not clear but it does seem to cause one to pause and think about the ramifications of unthinkingly inserting teaching machines as the major knowledge providers in our society, the role of humans can be removed. We suggest that this line of thinking is potentially dangerous. The role of humans in this enterprise remains. It is humans who make assumptions, synthesize and tell the ‘story’ that is created in the learning cycle, not to be replaced by Al. To make this point, Gregory Bateson (as cited in Favareau, 2010)
an English anthropologist, back as far as the 1950s was asked if he thought artificial intelligence in computers was possible. He responded:

“I don’t know for sure, but if you ask a computer a simple 'yes' or 'no' answer and its response is 'that reminds me of a story', then it would be close.”

Bateson’s point was that it is up to humans to decipher/synthesize the surprises and takes action. The coding that comprises the algorithms that tells/programs/instructs the robot how to handle that which is routine and predictable is until now been the product of human intervention. This concept, too, is a part of the transactional learning theory that we are proposing.

Entrepreneurial thinking knowledge and the experience curve

In commerce the key to assessing success or prowess of a business is measuring what Gilder (2013) calls its ‘entrepreneurial’ knowledge –its intellectual property as protected by patents and copyrights, and its knowledge about its customers. In education we can borrow from this concept to assess the minimal prowess or learning gains and the extent to which those gains are maintained. We refer to these high entropic moments as reaching ‘intellectual entropy’. On the contrary, one might also refer to making everything in the classroom low entropic moments will certainly result in considerable numbers of lost opportunities, what Frank Lambert called ‘negantropy’ (Bloom, 2012). What he was referring to was that the danger of completely succumbing to the unfettered use of AI in the learning process (and everyday life for that matter) is that its entire premise relies on algorithms programmed by humans and the need to be cognizant that some form of filtering or bias may always be present, as noted in recent news articles about the issues surrounding social media. This becomes the foundational need to teach information literacy in our schools.

If one agrees that the value/prowess of a classroom experience correlates directly with the amount of ‘entrepreneurial’ (i.e., surprisal) knowledge that is gained, then, it is as the job of instructional designers and course developers to ensure that they avoid as much negantropy as possible by providing abundant opportunities to assist with the process of absorption and synthetization. It is also their role to help define the transactional relationship between the learner and the knowledge provider, especially when those transactions are mediated by technology, as asserted by McLuhan (1963) and others.

Borrowing from economics, the experience curve axiom holds that the efficiency of any experience increases by 20-30 percent with every doubling of information (Gilder, 2013). In the learning experience, the opposite of this axiom correlates directly with cognitive load. What can be absorbed or synthesized by an individual decreases by about 70-80 percent with every doubling of information. It is common knowledge that information overload is becoming an everyday experience. The body of knowledge is said to be doubling every eighteen months, thereby negating Moore’s Law. The need to bifurcate the routinized learning experiences and those that provide surprisal content is escalated in a world of ever increasing content that is
being presented in the classroom. In many cases, the learning experiences that are being provided are merely those in which the content is presented in a manner to assist with simply covering the standards with little focus placed on actual mastery (Junkin, 2019). In spite of over-depending on it presents many dangers, AI can play an important role in helping to maintain intellectual entropy for those moments where routinization is the goal. AI can become an effective learning provider in situations where maintenance of entrepreneurial knowledge gains is needed by becoming the primary learning provider. This will allow human teachers to concentrate on discovering and synthesizing the surprisal moments.

The focus of this process, when splitting the roles between machines and humans as knowledge providers, is to ensure that the former continuously examines the power of the various instructional transactions that occur. As long as humans are involved in processing and making judgments about information (Kurzweil notwithstanding) educators need to recognize that pressures to embed AI into our lives will not lessen but will become even more prevalent. The danger is that AI may be putting us to sleep and dis-incentivizing us to remain a part of the information/learning process.

Media and the messages – at the heart of Media Ecology in instructional design

The authors suggest that there are succinct, implied connections between mediated communications and their effect on instructional design. Mediated interactions and how they shape the message, the user, and their interpretations all have a place in decisions that are made about which media/technologies are best suited to the transactional experiences that occur in learning. We believe that exploring the characteristics of media is one way to assist with synthesis and attaining wisdom by helping to segregate low entropy ‘noise’ from high entropy ‘surprise’. George Gilder (2013) suggests that information itself does not inherit/acquire characteristics that interfere with its interpretation. It is the characteristic of the communication channel (i.e., the medium) that creates the confound. In short, it is the environment in which information is distributed/channeled that affects the levels of entropy. It is the role of instructional designers to disaggregate the two.

While it was Neil Postman (1970) who actually coined the term ‘media ecology’, Marshall McLuhan (1963) first suggested the concept of media ecology (without actually naming it) and how media shapes the interpretation of the message. If one agrees that humans need to always make choices on how to remove these confounds and identify the surprisal moments, then perhaps McLuhan was correct and the concept of media ecology can be applied to the teaching and learning situation. For our purposes, when we refer to media ecology we include ‘technology according to its broadest definition’. Media ecology, then, is the study of mediated transactions among people, their messages, and their messages systems. We study how media/technology can affect human perception, feelings, understanding and value as it relates to the learning environment. In the communication environment, the study involves viewing the transactions that occur between individuals and reality. Note that there is an implied
hierarchy. Those transactions involve content that generally occurs between the following (the correlation to education and training is noted in the parentheses):

- one person and another, (i.e., learner to learner, or learner and knowledge provider)
- individuals and groups, (the individual learners and other groups in the class)
- groups and culture (classes or groups and the content that is situated)

We seek to identify in these transactions the modifying role played by media/technology that transacts them. For instructional technology, the concept of media ecology is still in its infancy. In fact, it is difficult to identify more than a handful of academic institutions that teaches instructional technology that includes media ecology in its curriculum. If it is the mission of instructional technology to analyze both the learner and the mission then it follows that, in terms of information theory, the mission of instructional design is to create as many high entropy moments as possible in each transaction that occurs. In this process we are trying to remove the issues with interpretation and wrong inferences.

For humans, all communications are transacted using some form of medium, whether it is text, video, audio, interactive systems or a combination (i.e., multimedia). The fact that that medium lives in a digital or an analog world is only relevant as to the particular kind of noise/interference that modality brings to the table.

Epilogue

As humans we must keep reminding ourselves as to what we ‘own’ intellectually. In the classroom we cannot concede to AI mindlessly. One might concede that this mindlessness has actually given rise to the recent ‘mindfulness’ movement on psychology and teaching and learning. The axiom ‘knowledge is power’ may need to be changed to ‘wisdom is power’. When you separate/divorce information from wisdom you lose accountability. We must not sacrifice wisdom at the altar of ignorant power.

Technology is an incentive system and not an information system. Confectionary instructional design implies that being informed is the same thing as being knowledgeable. The entrepreneurial educator is the one who creates surprises. The entrepreneurial process is a method of unveiling surprises. Entrepreneurial heads and hands hold an astronomical amount of technical information, skills, intuitions, habits, and practical experiences that cannot be understood by any one or thing that has not pursued some experimental course of action. It is with that goal we are pursuing media ecology as an academic discipline with instructional design domain.

The interactions, how they shape the message, the user, and their interpretations, all have a place in decisions that are made about which media/technologies are best suited to the learning experience while maintaining the four relationships that exist in the learning cycle.
(i.e., teacher-student, student-student, and student-content, and student-computer) With this view we suggest that the purpose of entrepreneurship in instructional technology is to open up these possibilities to students in order to empower them.

References


