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Generated questions learning model (GQLM): Beyond learning styles

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Abstract: The concept of learning styles in education is highly questionable when used to categorize students in particular ways and attempt to match them to corresponding forms of instruction. This paper argues that the various learning modalities called Learning Styles are only cognitive tools that all learners have access to and must use to process experiences and understand the world around. We further argue for a more basic theoretical model of learning prompted by teachers whose role is to understand the fundamental use of question asking and critical thinking skills in learning, and thus, engage the learners' curiosity into essential cognitive behaviors with which all forms of learning become possible and learners become well rounded.

Subjects: Behavioral Sciences; Education; Social Sciences

Keywords: critical-thinking; learning styles; question asking; student curiosity; socratic; student learning; collaborative learning; learning theories

1. Introduction

As far back as Plato, the record shows that human pondered upon their learning. All learning stems from two questions: Where does knowledge come from and how do people come to know? (Ertmer & Newby, 2013). Thus epistemology comes from two opposing positions—empiricism and rationalism. Empiricism is the view that experience is the primary source of knowledge (Schunk, 1991).

ABOUT THE AUTHORS

The Institute for Effective Thinking has for mission to develop research on educational challenges and the ideologies that become the foundation of curricula and influence policy and pedagogical strategies. We study strategies to encourage more inclusive and interactive teaching at the high school and college level. The Institute's members are educators sharing their ideas about their experience in the classroom. One of the subjects recently debated was the idea that we freeze students into specific learners categories, and that this long tradition of educational strategy may be more harmful than beneficial. Despite existing literature debunking the tenets of learning styles, the idea is still taught in educational training programs and regarded as positive for students, who define themselves in those terms. The authors strongly believe in the ability of students to be well rounded across skills if taught in a balanced and interactive manner.

PUBLIC INTEREST STATEMENT

We have been taught that we all have specific learner profiles. We thus promptly categorize ourselves into more kinesthetic, verbal, musical, number smart, or the like. Tests and entire curricula have been designed around that idea. Some researchers and educators however have been alarmed by the idea for many reasons, and wholeheartedly rejected these categories. We have toned down this opinion by proposing that each individual has all of the learning styles, but that the way we are taught, and trained emphasizes more one or the other. We believe that students can become well rounded in all those skills if their curiosity remains active, if they are taught interactively, and if the learning space is fostering question asking. Educational pedagogies embracing learning styles must stop boxing learners into narrow learning style categories and consider models such as the one proposed here to widen students' perception of their own learning ability.

Rationalism is the view that knowledge derives from reason without the aid of the senses (Schunk, 1991), that is, knowledge arises through the mind. Does knowledge come solely from some rational truths we are born with? Do we learn the rest through experience? Modern learning theories are at the intersection of these two opposite philosophical positions. The question, "how do humans gain knowledge?" is at the forefront of the philosophical debate surrounding learning theories. Yet, empirically we know that experiential learning afford us the ability to test the truth of logical arguments, to survive, to acquire skills, and to hone those skills as we gain more and more experience in using them, in other words, as we learn. This quest pervaded all disciplines and more so education, and the momentum ensued sparked the creation of a plethora of definitions for learning. However, De Houwer et al. (2013), in reviewing the literature and discussing the various problems with the concept of learning proposed a definition which they claim is functional and solves the problems of other definitions; mainly, they define learning as ontogenetic adaptation—that is, as changes in the behavior of an organism that results from regularities in the environment of the organism. We see fit to simplify their definition to focus learning in defining it as the acquisition of knowledge or skills through experience (Hume, 1748; Kolb, 1984, 1985; Lewin, 1951), observation (Chiesa, 1992, 1994; Hall, 2003; Skinner, 1938), change in behavior (Tolman & Honzik, 1930), or instruction (Atkinson et al., 1993). Thus, defining learning is quite different than addressing the question "how do humans learn" simply because the brain is a black box still largely impervious to our scientific theories.

It seems that the first stage to answering "how we learn" is connected to sense-experience. Hume (1748) contends that all knowledge is limited to sense-experience which begins with the distinction between impressions (including all our sensations and passions, more forceful and lively) and ideas (the faint images of these in thinking and reasoning). For Hume all ideas are copies of impressions. Essentially, Hume is arguing that no idea springs into existence from simply thought but instead, all ideas find existence from the things we experience. Thus, all learning is a manifestation of our senses as they engage with their surrounding. "In addition to the instructional environment, sensory preferences influence the ways in which students learn […] Perceptual preferences affect more than 70 percent of school-age youngsters" (Dunn et al., 1989, p. 52). To build any theory of learning, we must come to understand the role human senses play in creating experiences.

To date however, in the educational context and in connection to best teaching practices, many authors do define human beings as having learning tendencies, called commonly "learning styles." For example Payal and Shukla (2012) define learning style to be an individual's preferred and habitual approach for organizing and representing information. In that framework, learners seem to be channeled into naturally learning in a certain way rather than, as Hume proposes, being able to learn in many ways, through the experience of the senses.

Nonetheless, the road to defining learning in the academic context has been long and tedious. More so because research has focused on a number of varied areas and theories, and based on practitioners' empirical observations. Some of these observations by instructors highlight that fostering learning is contingent on a plethora of factors both in and outside of practitioners' reach encompassing mainly instructors' dispositions but more so the students' environment and their personal differences. This makes it difficult for practitioners to ensure and secure that learning happens (Wilson & Peterson, 2006).

In our contemporary education, students are no more spectators and consumers of content, but must know more about every aspect of our world from art and social fields to STEM fields and everything in between. They must integrate information in order to tackle increasingly more complex and novel problems, and that integrative learning process finds its accomplishment in critical thinking. Therefore, teachers must be familiar with various forms of learning theories and understand how to implement and design instruction to aid student learning. A teacher who is also an experimenter and who can constructively receive feedback from their classroom and outside observers is a successful educator. Teachers must be proactive in keeping abreast with the latest educational research findings and technological progress. In addition, efficient practitioners are comfortable teaching in diversity, are flexible, and hence versed into a range of pedagogical strategies making them capable to adapt to the content.

Thus, to address "how we learn," we propose to turn back the wheel a bit and explore truly how learning styles (as we define it i.e. natural cognitive tools or abilities) should actually be incorporated into how instructors shape teaching to promote learning process beyond the major learning theories. We will proceed in Section 2 of this essay to discuss the development of learning styles in the education community, and in Section 3 we explore the impact of learning styles on learning theories and address the question: do the learners become the style (or learning aptitude) that they have been told they have, and implement it in their learning processes, or should learners be shown how to engage with all of these aptitudes (as we define it) in the same way a carpenter interacts with his tools? Generally, education research seems to present the learner in the former, but we argue for the latter in a model detailed in this essay. Further, we propose in Section 4 a simplified model of learning, the generated question learning model (GQLM), showing that the heart of any learning must be how the instructor creates an environment to model critical thinking through generated questions, and that this theoretical framework provides the essence by which all learners, even with their unique profile, can use the entire gamut of their natural cognitive tools which every "normally" developed human is endowed with. We are exploring an interchange between "how curiosity arises by the sensory interactions with the environment" and question asking, to bring about learning. This we believe stands at the foundation of all theories explaining learning.

Historically, in an effort to energize learning in students, many theories have emerged across the century. These diverse theories and models for learning show stark differences as well as strong overlap. Ertmer and Newby (2013) propose that all learning theories can be divided under these three categories (Behaviorism, Cognitivism, and Constructivism), and as such these are among the most influential learning theories (Alzaghoul, 2012; Boghossian, 2006; Nagowah & Nagowah, 2009; Yilmaz, 2011). Following a survey of the conversation around learning theories (Bednar, Cunningham, Duffy, & Perry, 1992; Jonassen, 1991a, 1991b), we have selected the three major theories that have withstood the test of time, and remain largely accepted in educational fields to discuss in this essay. To parse them out, Schunk (1991) proposes to compare learning theories through the lenses of the following questions: how does a theory explain the occurrence of learning, what factors influence it, how does memory play a role in that learning, can the learned information bridge to other concepts and in what way, what specific type of learning is defined by that theory. Others (Ertmer & Newby, 2013) proposed also to consider what conjectures are made by the theory, and how they are applying to instruction and used to scaffold learning. Therefore, in Section 5 we will discuss how the proposed questions by (Ertmer & Newby, 2013) and (Schunk, 1991) are answered from Behaviorism, Cognitivism, and Constructivism, in comparison to our theoretical proposed model of generated questions. Finally in Section 6, we show that education practitioners play a key role in the development of the learning modalities through the GQLM to bring about critical thinking. Thus, we are proposing a learning model, in parallel to existing theories, which we believe redefines the idea of learning styles in a more comprehensive and coherent system which we model and apply to our modern classroom. Consequently, the goal of this essay is to put learning style into the correct relation to the learner and shed light on "how humans learn."

2. Learning styles and the learner

Learning styles or primitive forms of its concept existed since the 50s and before (Coffield, Moseley, Hall, & Ecclestone, 2004), but since its popularization in the 1970s the theory of individualized learning styles has greatly influenced education (Pashler et al., 2008). Dunn and Dunn (1978) were the first to propose learning style for the classroom (Coffied, 2004) as a theory to enhance learning due to a belief that instruction should be match to learn styles. Keefe (1979) defines learning styles as "characteristic cognitive, affective, and psychological behaviors that serve as relatively stable indicators of how learners perceive, interact with, and respond to the learning environment," which in some sense incorporates such learning theories as Behaviorism, Cognitivism, Constructivism. In search of a more effective theory, from Hume's epistemology came Kolb's Experiential Learning

Theory (1984), which engages four modes: Concrete Experience, Abstract Conceptualization, Reflection Observation, and Active Experiment. Kolb places these four learning processes on two axes ranging from people learning by concrete vs abstract experiences, while being either more active or reflective. Any learner then falls into this plane at some specific position, which is supposed to represent their experiential learning profile. Later, Kolb's theory was rerouted from its primary aim leading to the creation of the learning styles inventory (LSI): Accommodating, Converging, Diverging, and Assimilating. From those, the education field has adopted the idea of learning styles by creating learners categories instead of embracing the fact that all senses inform our learning as Hume intended in his rhetoric. An example is the Fleming's VARK model (Fleming, 2001; Fleming & Mills 1992) (which expands Barbe et al. (1979) categorization to include reading–writing preference learners) frequently and widely used to label students into various types of learning styles.

The story evolved simultaneously with Gardner (1983) with seven intelligences (which later evolved to nine) modalities (or preferred aptitude) from which other educators distilled three new general types of Learning Styles: Visual, Auditory, and Kinesthetic learning (Felder & Spurlin, 2005; Litzinger et al., 2007; Soloman & Felder, 2005; Zywno, 2003). These also were adopted by the overall Education community and aggressively pushed into new curricular strategies with an emphasis on teachers testing their students' abilities, and tailoring more personalized instructions by reinforcing the discovered learning profile of each student (Barbe et al., 1979). This has, though unintentionally, translated negatively into the classroom. Students are often categorized as one of type of learner, which, as many have decried, could largely impact their learning potential. However, it is important to note that this agenda was not the initial intention of Gardner who opposes the idea of labeling learners to a specific intelligence and believes that each student possesses a unique set of all intelligences.

Teachers often try to assess the learning styles of their students and once identified, create curricula tailored to the assumed needs of their students (meshing hypothesis). The work of Sternberg et al. (1999), as detailed later, became the pivotal evidence used to support the varying forms of meshing hypotheses. The idea is that individuals differ early in how they are capable to learn, hence, knowing their learning style could help develop coping strategies to compensate for weaknesses and capitalize on strengths (James & Gardner, 1995). Thus, Gardner grouped human capabilities into seven categories under a model called Multi-Intelligence (MI) Theory (Christison, 1996) from which educators categorize students' learning styles as follows (Bogod, 1998; Pfeiffer, 2011):

Visual (spatial): *ability to perceive the visual*; thinking in pictures, creating vivid mental images to retain information (enjoy maps, charts, pictures, videos).

Aural (auditory-musical): *ability to produce and appreciate music;* thinking in sounds, rhythms and patterns (respond to music either appreciating or criticizing).

Verbal (linguistic): *ability to use words and language;* highly developed auditory skills, generally elegant speaker (think in words rather than pictures).

Physical (kinesthetic): *ability to control body movements and handle objects skillfully;* express self through movement, has a good sense of balance and eye–hand co-ordination (remember and process information through interacting with space).

Logical (mathematical): *ability to use reason, logic and numbers;* think conceptually in logical and numerical patterns making connections, curious about the world (ask lots of questions and like to do experiments).

Social (interpersonal): *ability to relate and understand others*; try to see things from other people's point of view, understand how they think and feel.

Solitary (intrapersonal): *ability to self-reflect and be aware of one's inner state of being;* try to understand inner feelings, dreams, relationships with others, and strengths and weaknesses.

Fundamentally the question that must be asked is: how do learning styles connect to learning theories? The Becta (2005) report makes the point that, "the term 'learning styles' has no one definition—in much of the literature it is used loosely and often interchangeably with terms such as 'thinking styles', 'cognitive styles' and 'learning modalities'." There is to date no single model, consensus, or clarity among scholars and educators around the concept of learning styles. Some adopt the idea of multiples intelligences, while others adhere to more neurocognitive or even environmental views. Depending on the educational, financial, or ideological stake, a profusion of theories and subtheories have emerged along with their materials, methods, and pedagogies, which confused academic circles and educators as to how to implement instruction for optimal learning. Becta (2005) has identified three inter-related elements of Learning Styles used by instructors to design tailored teaching to each specific learner:

- Information processing—habitual modes of perceiving, storing, and organizing information (for example, pictorially or verbally).
- Instructional preferences—predispositions towards learning in a certain way (such as collaboratively or independently) or in a certain setting (environment or time of day, for instance).
- Learning strategies—adaptive responses to learning specific subject matter in a particular context.

Felder and Silverman (1988) also contend that teachers should follow a similar format by proposing a "mix and match model" arguing that "a *learning style model* classifies students according to where they fit on a number of scales pertaining to the ways they receive and process information," and propose parallel for instruction, that is, "*teaching-style model,* which classifies instructional methods according to how well they address the proposed learning style components." Felder and Silverman (1988) support the meshing concept by arguing that teachers' instruction strategies can be better received by students' matching profiles. For example, a kinesthetic student would thrive on concrete content, while a visual one would perform best under visually prompted instruction.

Thus this construct historically helped span for a major push to design instructions tailored to individuals' particular learning style. As a result, the meshing hypothesis mentioned above was born and exploded in the educational literature and classrooms.

A more balanced approach to learning modalities (by modalities we mean the different learning styles) seems to be that of Barbe and Milone (1981) who propose that learning modalities are time and age-dependent, and fluid. In this more holistic view, research has suggested that each learning style uses different parts of the brain, and that by involving more of the brain during learning, we tap into all learning modalities and thus retain more of what is learned. Barr and Dowding (2015) point out that researchers using brain-imaging technologies have been able to find the key areas of the brain associated with each of the learning styles. In other words, a single brain may actually have all abilities, which may be a noticeable argument against learning styles. What then would be the impact of attributing a single learning style to each learner? In the next section, we lay out the disadvantages of a Learning Styles view of learning.

3. The limitation of the learning style theory to enhance learning

The work of Sternberg et al. (1999), and Gardner (1983) have laid the foundation on which the theory of Learning Styles sits. Currently, there are more than 70 different theories inspired by the original Learning Styles theory (Coffield et al., 2004) more or less derived from Gardner's tenets. This indicates that the issue is quite complex and creates confusion in the Learning Styles literature. This may be the writing on the wall due to the negative impact that learning styles bring to the field of education. Pashler et al. (2008) thoroughly examined Stenberg and his colleagues' evidence defending the Learning Styles hypothesis, and found various problems with their research. Subsequently, they made an argument cautioning against the wide use of the Learning Styles methodologies in the classroom. Their analysis included carefully breaking down Sternberg and colleagues' study (1999) revealing several fundamental issues (mishandled data, unclear outliers screening, and only marginal evidence found).

Moreover, White's (2005) critique of Gardner's approach on how we learn detailed a clear controversy attached to his MI theory, and the questions raised about Stenberg and colleagues' research put into question the benefit of the concept of Learning Styles for the learner. Though largely accepted by the Educational field, Gardner's theory remains debated (Collins, 1998; Klein, 2003; Peariso, 2008; Waterhouse, 2006). White (2005) looking closer at Gardner's entire work revealed the absence of concrete empirical study, across any wide range of cultures, helping to hone onto these specific tenets of intelligence. Gardner explains clearly that he chose these intelligence Learning Styles based on the fact that he *felt* "that these forms of knowledge are of tremendous importance in many, if not all, societies of the world…" (Gardner, 1983). However, to establish that, his criterion and basis are unclear and not founded in empiricist observations. While Gardner claims that his theory is based not only on the social but also on biological factors, he additionally does not submit any biological evidence for his claim. Consequently, though attractive, this theory must be taken with great caution because although there is ample evidence that individuals express preferences for how they tend to process information, few studies have found validity for that claim in using learning styles in education. There is no evidence identifying that teaching students in their individual learning style produces better outcomes, but there is empirical substantiation relating pedagogical problems to using learning style tasks (Klein, 2003). Also, Coffield et al. (2004) showed that none of the most popular learning style theories had been adequately validated through independent research. Moreover, the hypothesis that suggests that students learn best if they are taught in the method deemed appropriate for their learning style has been questioned (Pashler et al., 2008).

If one should design an experiment where students are placed within various learning categories according to their supposed learning style profile, and also matched with tasks outside of their style, one would expect that the students whose tasks are matched to their learning style would perform significantly better than those who are not. The fact that we have established that students are not exclusively biologically shaped in any one learning category, what may be actually found in such experiments is a performance that is not learning style-dependent. That is, for example, a visual student given an auditory task may outperform a student categorized as auditory just as well (Massa & Mayer, 2006). MRI studies have shown that different parts of the brain activate specifically corresponding to each of these conditions all in one single individual (Barr & Dowding, 2015), which is additional evidence that all individuals can use all modalities to learn.

Pashler et al. (2008) reported a number of well-designed studies, which showed that there is no connection between the learner's preference and matched instruction (Constantinidou & Baker, 2002; Cook, Thompson, Thomas, & Thomas, 2009; Massa & Mayer, 2006). As such, they concluded the absence of positive finding indicating that any applications of Learning Styles in classrooms are unwarranted and unfounded. In a similar way, Manolis, Burns, Assudani, and Chinta (2013) critic that, granting that the Kolb's model is the most widely accepted with substantial empirical support, theLSI is plagued with serious weaknesses. Similarly, Claxton (2009) and Geake (2008) uncovered vulnerabilities within theories such as VARK Learning Styles, and argued that they can only serve to label children and therefore restrict their potentially wider learning experience.

Since Learning Styles are based on individual preferences, the logical conclusion is that they are subjective. How then can we assess preferences that can evolve easily with every unique profile? The evidence used for learning styles come through the connection made between preference and specific aptitudes. Rayner and Riding (1996) argue, "while learners often have personal preferences about the types of learning experiences that they prefer, there is no research that supports the idea that people are somehow a certain type of learner." Perhaps, these learning categories then are just functionalities of the senses, which can be explored and expanded, but are not actual crystallized individual learning style intrinsic profiles.

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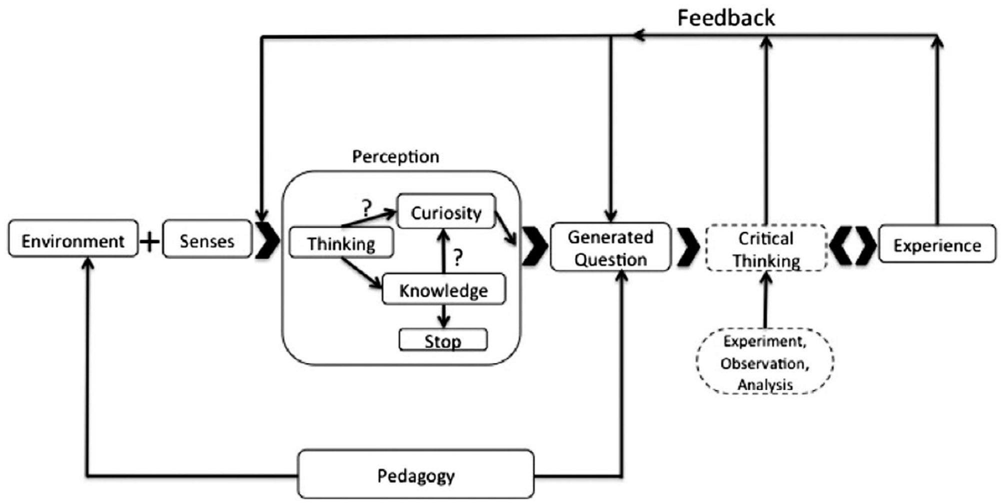


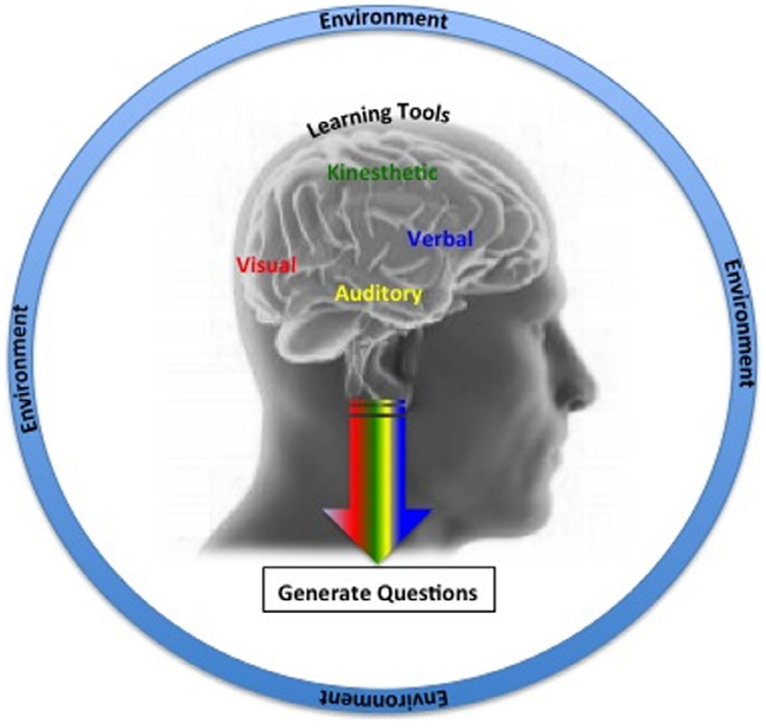
Figure 1. Generated questions learning model.

Similarly, the work of Massa and Mayer (2006) challenges the notion that preference and abilities are closely related and throws doubt on their connection. Sternberg and colleagues (1999) performed a high abilities study where high ability students were matched with corresponding teaching, or high abilities students without matched corresponding teaching, and also students with low ability matched and mismatched as well; their results showed a tendency toward success for the high ability matched students. If we were to accept the Learning Styles hypothesis along with Sternberg and colleagues' (1999) study, what then should become of the low ability students? How would they be taken care of by the Learning Styles theory? If there are students out there without what it takes to receive matched instruction, where will they end up? That is, there are no methodologies of instruction that would be helpful to this group. If anything positive can be said about Sternberg and colleagues' (1999) conclusions, it is that it allows one to determine the potential weakness and strength of students' abilities, and then facilitates designing instructions for them to become better with their various cognitive modalities, but certainly not to cater to any single kind of ability.

All learners are capable of using all their abilities in concert (under adequate teacher guidance), and it cannot be correct to classify the learner in single learning categories. As educators, we know that some things cannot be disseminated to the learner through visual modalities, so if a learner were to only be visual, they could not easily make the adjustment to select a different learning modality that is needed to engage their learning. Another problem in our experience as educators (which many report), in which there is a difficulty in getting the learner to adopt a new learning strategy once they are convinced that they are one particular type of learner (Claxton, 2009). Though all students may have different forms or levels of these cognitive abilities, and may show tendencies, proceeding to base school reforms on the MI theory becomes a dangerous stretch where students may be boxed in and persuaded that their abilities could be limited. The stake is large and careful considerations must be applied before basing curricula and teaching pedagogies on Gardner's very subjective vision of human intelligence (White, 2005).

Seeing the evidence provided in the literature, we suggest that the Learning Styles theory, as is taught today, only serves as a deterrent to learning. Stahl (2002) contends that Learning Styles research has not yet been able to provide convincing evidence that matching a teaching pedagogy to a student's learning style has any merit. A learner's preference is based on previous personal experience more than it is on cognitive particularities (Payal & Shukla, 2012). Again, this concludes with a number of other research studies that the use of Learning Styles-based instruction in education is nonsensical. In the next section, we will discuss an approach that enhances learning by calling holistically on all of the learners' abilities.

Figure 2. Learning tools as opposed to learning styles, which come together to allow question asking.



4. A simplified learning model

Based on White's assessment and other literature, we have argued that Learning Styles cannot be a foundation for creating curricula. From our perspective, pedagogies can be simplified to prevent the learners' mind to be confused with so many of the methodologies cluttering the educational system. Geake (2008) points out that when pedagogies are multisensory, learning becomes more effective. Multisensory approaches have been shown to be valuable for example in literacy and language learning (Jubran, 2012). We contend that our model fosters students' basic abilities by appealing to their multiple senses through their engagement with the practitioners, and the environment as the class, and the material. The following GQLM outlines the concept:

4.1. Environment

Our learning model, as illustrated in Figure 1, starts first with the environment, which can be anything in the physical or metaphysical world, i.e. here, from the information that is being communicated in the classroom through various media such as demonstrations, lectures, videos, audio, and such, to the atmosphere fostered by the teacher. The environment evoked must surprise or attract the attention of the learner, without being incomprehensible (Berlyne, 1965; Malone, 1981; Piaget, 1952). Added to that are the senses available to the learner (Figure 2), which help process that environment. As Crogman, Trebeau Crogman, Warner, Mustafa, and Peters (2015) argue, good teaching and learning are based on four criteria that constitute an environment conducive to learning (comfortability, connectivity, preparedness, and organization), and coupled with effective teaching pedagogies, it leads to critical thinking. Comfortability and connectivity particularly are essential pillars to allow the students to be open to engage into the learning process. A relaxed student is one that has more mental room to ponder on the matter at study.

4.2. Perceptual and sensory

Changes in an organism's environment may result in response (De Houwer et al., 2013). As such, anything that provokes response in an organism is referred to as a stimulus, which can be internal or external. The response can be biological (internal to the body: hunger, distress), or behavioral (involving physical movements or reactions). An internal stimulus causes responses to protect an animal and maintain homeostasis. An internal stimulus causes responses to protect an animal and maintain homeostasis. However, to obtain an external stimulus/reaction chain requires the known animal's perceptive senses (hearing, sight, taste, smell, and touch) to be online, and carried and processed by the central and peripheral nervous systems (shown in Figure 1 as the learner's perception). As such, in Figure 1, a change in the learner's environment is sensed through their sensory receptors, which brings about a response. This interaction with the environment through the senses is bringing about *perception* (Figure 1), a basic *thinking* process helping to interpret what we sense (Shaw, 2006). When we encounter something we have already experienced, our memory is awakened since this knowledge is stored away. This is illustrated in Figure 1 by the arrow that goes to *knowledge*. Thus, from old knowledge, curiosity is awakened by the *question* generated (question mark), otherwise, the path ends caused by lack of interest, *Stop*. However, if we encounter the unknown (the first arrow in Figure 1 with a question mark), then the thinking process may generate new questions bridging to prior knowledge, thereby arousing curiosity (Loewenstein, 1994).

Although little is still known about the relationship between curiosity question, asking, and inquiry skills (Jirout & Klahr, 2011), observations so far seem to suggest that learning is impossible without curiosity (Kidd & Hayden, 2015). Hill and McGinnis (2007) define: "Curiosity, a state of arousal involving exploratory behavior, leads to thinking and thinking culminates in learning (p. 53)," Berlyne (1954, 1966) differentiates between human and non-human curiosity referring to it as epistemic when it comes to human cognition, and overall perceptual in all animals. Malone (1980) distinguished further by splitting the concept into sensory curiosity, which is about maintaining interest in the senses, and cognitive curiosity, referring to the semantic content of information. In Berlyne's (1965) model, perceptual curiosity arises from conceptual conflict, which then morphs into epistemic curiosity through question asking. Malone's model on his side starts with the sensory curiosity, which is aroused through environment as shown in our model, to bring about the cognitive state processes. Relating both Berlyne and Malone to our model, the cognitive state comes through the inquiry the learner is engaged in.

Loewenstein (1994) believes that curiosity is the intersection between cognition and motivation but arises as "a cognitive induced deprivation that arises from the perception of a gap in knowledge and understanding"; to this he proposes the "information-gap" perspective, which states that, in order for curiosity to be present, the learner must already have some level of knowledge. This proposition posits that curiosity only comes from the learner, while a more general search for information comes both from the learner and their environment. Loewenstein (1994) says that a small amount of information serves as a priming dose that greatly increases curiosity, which is verified in a study by Kang et al. (2009) showing that curiosity enhances learning; this is consistent with the theory that the primary function of curiosity is to facilitate learning. Aroused curiosity leads to inquiry and helps the learner to learn information that at first glance was not considered all that interesting or important. Thus the goal of any effective curricula (created environment) must simply be to entice and engage the curiosity of the learner rather than focusing on any preconceived special and individual skill (such as learning styles). Crogman et al. (2015) emphasize that idea by arguing, in the context of education, that students' curiosity is the first quality that must be engaged in educational environments for learning to take place.

Therefore, learning is a result of the questions we are able to formulate as the senses are influenced by the surrounding. Thus, the learner's preferences are tools used to gather and assimilate information (Figure 2). It is this ability of the learner, which can be perceived as if they learned in a single mode, however, fMRI studies confirm that learning is multisensory (Geake, 2008) in that different parts of the brain are activated corresponding to all modalities in one single individual (Barr & Dowding, 2015). Figure 2 shows that cognitive factors (learning modalities) questions arise as the learner interacts with the environment. We must think of these learning modalities as natural tools that learners can pull from their toolbox (Figure 2), and apply depending on circumstances rather than as traits that rigidly define them or their intelligence for that matter. We do not consider learning styles as something learners have as labels and that is specific to each learner but instead we refer to "learning styles" as learning tools that all learners possess, and are able to use provided their curiosity is aroused through some stimuli, which helps the learner to be inquisitive and ask meaningful questions.

4.3. Generated questions

The next stage comes with the questions formed from basic *thinking*. The learner's curiosity fosters question asking which in turn engages the thought process into critical thinking. Asking questions is the most fundamental driver for critical thinking to come about (Crogman et al., 2015). True education is more about critical thinking skills than being able to score well (Huitt, 1998). Critical thinking is organic, it is born from an enabling environment and benefits from its feedback; it brings to action, establishes previously held and new beliefs, enables or disables dispositions to use thought processes, and therefore is an important attribute for success in the twenty-first century. Consequently, educators must be careful not to shut down any question, which could otherwise thwart students' desire to ask anything in class (Willingham, 2009). Elder and Paul (1998) argue that, "No questions equals no understanding. Superficial questions lead to superficial understanding. Most students typically have no intellectual questions. They not only sit in silence; their minds are silent as well." Questions are the best tool to solve problems and define their boundaries. Answers satisfy the inquiry process or cause further quest and thinking (Figure 1). That is, human beings are not curious about what is known, but from what is known they generate new questions, which engages their curiosity (Jirout & Klahr, 2011, 2012). The GQLM shows this process by the arrow going from *knowledge* to *curiosity*, but also shows that curiosity cannot produce knowledge until after *inquiry* has occurred.

Additionally, researchers agree that curiosity provides a pathway for question asking to occur. Gruber, Gelman, and Ranganath (2014) contend that, "curiosity puts the brain in a state that allows it to learn and retain any kind of information, like a vortex that sucks in what you are motivated to learn, and also everything around it." The researchers found that, once the learner's curiosity had been piqued by the right question, they were better at learning and remembering completely unrelated information, and had an increased activity both in the hippocampus, the region of the brain involved in the creation of memories, and in reward and pleasure cortical circuitry (Gruber et al., 2014). Figure 1 shows that generated question is not only awakened from the learner's curiosity but it stimulates externally and internally. The practitioner uses pedagogy to assist the learner by fostering higher order questions (external stimuli), and offering feedback which is received and processed by the learner reflecting on the inquiry process; this draws the learners into deeper question for a more intensified thinking.

4.4. Critical thinking

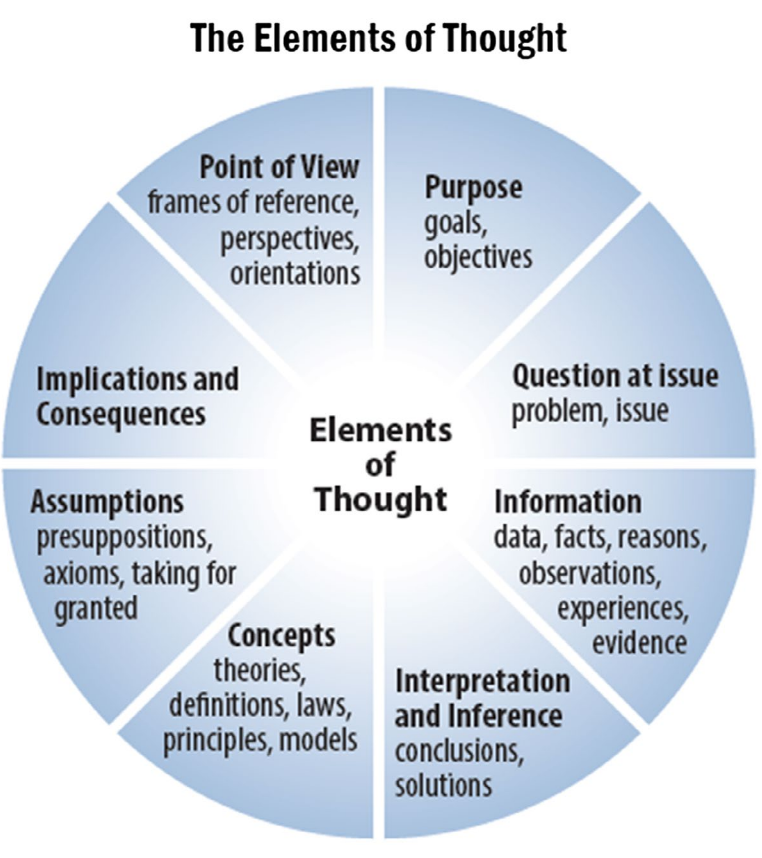
It does us well to recall that answers come as a result of questions generated through the pathways which create our experience or cause the *Critical thinking* processes to come alive as delineated in the following: "Description invites students to ask 'what', 'when', 'who', whereas analysis focuses on 'why' and 'how', and evaluation encourages students to think beyond the phenomenon by going deeper and asking 'what if'" (Crogman et al., 2015), creating a more refined experience. In Figure 1, the critical thinking process box's dashed lines show that critical thinking does not exist readily in human thought. Rather, it comes with experience and pedagogical instruction. Recall that books, research, and other means are answers to the questions we ask (Elder & Paul, 1998), and every question or idea comes from our experience through the sensory (Doorley, 2013; Roussou, 2004). Thus, thinking drives questions, which forms pathways of learning through the answers obtained from the critical thinking process.

Geake (2008) points out that the brain's interconnected functioning is unceasing, contributing to intelligence and thereby necessary for all school subjects, aspects of cognition, and domain-specific learning, such as music, math, physics, languages, etc. Critical thinking is possible due to our extensive neural interconnectivity (Geake & Dobson, 2005). Consequently, there are no individual modules in the brain, which could correspond directly to the school curriculum (Geake, 2009). Thus, we consider critical thinking as the way we create, use, and apply knowledge which leaves Bloom, Englehart, Furst, Hill, and Krathwohl's (1956) hierarchy, sometimes referred to as "taxonomy of the cognitive domain," intact. In Bloom's Taxonomy, "Creating" is at the top of the pyramid, considered to be the highest skill of human cognition. In the context of education, practitioners must strive to foster the finest skills, and we believe that question asking through critical thinking fosters just that. For creativity (or problem-solving) only comes about when critical thinking is achieved, and as such, what is often termed "creative thinking," we argue, is only a function of critical thinking. Crogman et al. (2015) have contended that the process of critical thinking might be best facilitated by a combination of Didactic and Socratic instruction. Our model shows that question asking is essential to enhance critical thinking skills. Therefore, educators who facilitate an environment that allows the learner to ask questions at the basic level, help the critical thought process of the learner in problem-solving and decision-making processes.

4.5. Experience

Kolb and Kolb (2012) related experience and learning by arguing that "it is a process whereby knowledge is created through the transformation of experience." Later, Hansen (2000) argued: "there is no meaning in a given situation until we relate our own experiences to it," thus experience acts as a feedback in the learning process. Experience contributes to create learning. From experiences, the critical thought process is influenced and new knowledge is created and stored in memory; it can also assist in the problem-solving effort of the learner (shown by the *feedback* arrow into the learner's perception and critical thinking–Figure 1). Human *experience* is the ultimate source and justification for all knowledge. *Experience* itself has accumulated in human memory and culture, gradually producing the methods of intelligence called "reason" and "science" (Shook, 2008).

Figure 3. The elements of thought within the critical thinker (Paul & Elder, 2001).



4.6. Feedback
The feedback loop potentially will either reinforce the learner's understanding, or force them to reassess it as new information is available (Taylor & Hamdy, 2013). The feedback loop (Figure 1), through experience and critical thought process, is important to create our experience or knowledge, which develops the critical thinker of Figure 3. This phase is crucial in the sense that "the learner articulates their newly acquired knowledge and tests it against what their peers and teachers believe (Taylor, & Hamdy, 2013)." Feedback allows the learner to reduce uncertainties (Malone, 1981).

4.7. Pedagogy
Pedagogy, creates or influences both the environment and the learner's critical thinking process. Thus, education practitioners' focus must be twofold:

- Inquesting student thinking, to help them detect where they lack knowledge, need more understanding, and appreciate what they already know.
- Stimulate the practice of Socratic questioning by simulating it for students to understand the process of critically thinking on their own.

Clearly, in this framework, there is a strong need for the practitioner to connect with their students (Crogman et al., 2015). Thus, being able to arouse students' curiosity about something they are naturally motivated to learn prepares them to learn what they would normally consider boring or difficult. Suppose a student likes football, and projectile motion is being taught in physics, the teacher relating this concept to football would better spark the student's interest. Thus, the educator is here personalizing learning and opening it up by arousing interest.

The practitioner (a key component to enhance student learning), should lead the students through a form of Socratic methodology by asking questions or performing a demonstration where students are asked to give predictions ahead of time (Crogman et al., 2015; Engel, 2011). A good demonstration often surprises students and draws them into wondering or speculating, thereby eliciting curiosity. The teacher must communicate effectively in order to engage the learner's curiosity. The practitioner utilizer pedagogy influences the environment, as a way to provide feedback to the learner's critical thinking (Figure 1).

4.8. Conclusion
Thus GQLM proposes that the educational practitioner morphs the environment to appeal the sensing by (1) generated questions, (2) new storyline and scenery, and (3) forming the learner as inquiry-based participant (pedagogy), interested in what they may not have first been interested in. Our model is supported by Berlyne and Malone's concepts in that it addresses their two components of curiosity. The sensory engaging with the environment reflects perceptual curiosity as described by Berlyne. This perceptual change is what Malone calls sensory curiosity. As we move from perceptual curiosity, the cognitive structure comes alive through questions and inquiry. Thus, Malone's cognitive curiosity is Berlyne's epistemic curiosity which draws out the learning critical thinking process. Our model identifies what curiosity is how and how it may relate to learning. Our model transcends these conceptual perspectives on curiosity by combining them in a new paradigm that applies curiosity to the classroom environment, and to what the educator should do to foster curiosity and thereby boost learning.

5. How the GQLM answers "how we learn"
Behaviorism, Cognitivism, and Constructivism, present similarities and overlaps with our vision of learning and touch in different ways on what we believe are the most important aspects of efficient teaching and learning. Ratna and Tron (2015) in their review pointed out each of the theories' weaknesses and strengths, but emphasized on Constructivist pedagogies as being the tenets to put forward in teachers training, thereby recognizing the importance of an active learner in the process of what they call "an open-ended learning experience". We must recognize the challenge of designing teaching around constructivist principles (Boghossian, 2006). Such challenges lead us to think that there are more fundamental roots to successful learning.

Our proposed model not only agrees and overlaps with major tenets of these theories but also focuses on what we think matters most in the way a practitioner sets up a learning environment. These models along with ours overlap in that they equate learning with creating meaning from experience in some form. However, we believe that our model touches on a more essential requirement for promoting learning, which is to arouse curiosity and desire to know by presenting conflicting concepts and teaching how to ask questions to resolve them. The question of what influences learning in each theory finds agreement within environment (Table 1, last question). Thus, the atmosphere one creates in class influences how learning occurs.

A behaviorist considers the mind as a black box that responds to stimulus in a quantitative way (Good & Brophy, 1990); that is, learning is the process of associating stimulus to response and it strengthens through reinforcement. In this case the learning is passive. Our model to the contrary stresses the importance of learners being active in their learning process, through question asking, when associating what they gather in their environment to the feedback they receive.

Table 1. Comparison of the GQLM with Behaviorism, Cognitivism, and Constructivism according to Schunk's (1991) qualifying questions

Factors for learning	Behaviorism model	Cognitivism model	Constructivism model	Generated questions learning model
1. How does learning occur?	By observing, integrating, and acting upon the probability of changes resulting from performance	By gaining discrete changes in knowledge	By being aware and cognizant of our experiences. The constructivists look at the learner as more than just an active processor of information; the learner elaborates upon and interprets the given information (Duffy & Jonassen, 1991)	Senses + environment = curiosity. By the questions generated inquiry comes about, which causes critical thinking to created new knowledge. By wondering, understanding, and retaining feedback to apply to the next situation
2. Factors influencing learning	Response adequacy (cognitive and physical); stimulus quality	Health of brain & cognitive structures; factors facilitating reception, organization, storage, and retrieval of information	How the learner is interpreting their experiences (memory, emotion, cognition)	The practitioners' ability to model and inculcate critical thinking and question asking. By the practitioner creating a safe environment in which students feel comfortable enquiring
3. Role of memory	Connecting to prior successful learning experiences to repeat or improve upon	Manages reception, organization, storage, and retrieval of information	Allows for connection to prior meaning	Brings back answers from previous questions and previous answers
4. How does transfer occur?	Acting further based on the feedback received	By proper communication between cortico-cognitive structures	By connecting meaning stemming from experiences	By encountering contrast and conflicts, asking, receiving feedback and applying to the next context aided by the practitioner
5. Best explained for which learning?	All	All	All	All
6. Assumptions relevant to instructional design	Instructor needs to understand how to convey quality feedback, how to teach meta-analysis of one's thinking upon performance	It is not about what learners do, but about the processes that allow to acquire information (Jonassen, 1991b)	The learner does not acquire but interpret the meaning of experiences; the learner builds knowledge gained by acting upon input to give it meaning; no "correct" meaning, learning is entirely subjective (Bednar et al., 1992)	Learners have the capacity to learn as many ways as there are assumed intelligences, curiosity aroused is the single most important driver of learning, it rests on the practitioner to build a world promoting curiosity
7. How should instruction be structured?	Provide capital feedback to help the learner assess if their response was adequate to stimulus, and practice adequate behavioral output	Adapt conveying of information to the learner's cognitive structures; help learner organize, integrate and connect new information (Bower & Hilgard, 1981)	By showing learners salient information from which they can actively extract their own meaningfulness (requires flexibility from the instructor); promote group work to confront other's meaningfulness and take a stand (Cunningham, 1992)	It should be structured around the practitioner playing a key role by facilitating and creating an environment in which students are comfortable. By weaving instruction with presenting provocative conflicting concepts and contrasts generative of questions

Most cognitive psychologists think of the mind as a reference tool to the real world; cognitive theory stresses the acquisition of knowledge and internal mental structures and, as such, are closer to the rationalist end of the epistemology continuum (Bower & Hilgard, 1981); it focuses on the conceptualization of students' learning processes and addresses the issues of how information is received, organized, stored, and retrieved by the mind (Stavredes, 2011). Learning is shaped by acquired learning strategies and prior knowledge and attitudes, and must be teacher-centered with information presented in an organized manner in order to optimize learning (Ratna & Tron, 2015). Our model is also teacher-centered where the educational practitioner creates or manipulates the environment to draw in the learner's curiosity; our model also recognizes the active part student plays in their cognitive processing of information. However, we add the emphasis on a dialog based on question asking to trigger this cascade of processes without which no learning can take place for all.

Constructivists on their end believe that the mind filters input from the world to produce its own unique reality (Jonassen, 1991a). They emphasize knowledge of the real world by individuals' own interpretations of their experiences. This overlaps with our model, which argues that the learner's curiosity awakens from conflicts they experience in their environment, which prompts and facilitates the ability to generate questions. To tie it all, we propose that our model, getting back to the basics of curiosity, is at the root of Behaviorism, Cognitivism, and Constructivism.

Said differently, we suggest that the way an individual learns is quite simple. A child's curiosity is a result of inquisitive exploration through senses and engagement through basic questioning. Every child is like a blank check; Locke (1700) refers to this early stage as "the blank tablet" (as in Behaviorism). Infants are born into our reality where their basic senses help them interact with their environment. In this sense, the statement "experience is our greatest teacher" becomes applicable, for through what a child experiences repeatedly, they build long-term memory and learn to apply meaning to their experience (as in Constructivism). Logically, adults too still continue to learn in this very way. For example, when moving to a new place, we are prone to ask questions to get around. Therefore, learning is a result of the questions we are able to formulate as the senses are influenced by the surrounding. Together Behaviorism, Cognitivism, and Constructivism, show that learning is experienced through all the senses, and human cognitive and physical engagement with the world (Table 1, question 2 and 3). This in itself agrees with our simplified model: we are all of these senses, and we can use them all to come up with questions that will inform our knowledge of our environment.

If we accept that learning can only take place through senses, then right away the issue of how to foster real learning is simplified. Hume's argument about how ideas are born through experience comes to the center of the concept of learning. Henry (2007) contends that, "humans have evolved to build a picture of the world through our senses working in unison, exploiting the immense interconnectivity that exists in the brain." For instance, a large number of the worlds' children are born capable of seeing and hearing. This means that nearly all human beings are born with visual and auditory modalities in place. Therefore, we can assert that all humans come equipped with a set of tools, and a capacity to activate and use them from birth to learn about and function in the world through trial and error. In all humans the senses become the first stage to learning. Thus often, a curious child is driven by what they see and hear, which causes them to inquire through touch, taste, and smell. This enables the child to generate questions through these interactions of senses and incoming input. We therefore posit that the basic tools to learning are the senses, all of them, which we all have and are able to develop.

How does learning take place? Consider two children who interact with a photograph. One engages in question asking and discusses about the photo, in this case we argue that the child, through questioning, has generated learning. The eye is like a camera lens, which allows what is seen to be recorded by the brain. In a sense, we can say that the brain took a photo of what is seen through the eyes but learning does not happen until the child's curiosity is engaged. Let's consider Descartes (1644) famous maxim "I think, therefore I am"; he proposes that consciousness of one's existence is a process of mere thought. We suggest that a human being who cannot see, hear, smell, taste, and touch simultaneously cannot be aware of their existence because there will be no way to engage the thought process. Thus, learning only happens when thinking is engaged. For the second child who asked nothing about the photo, the information is stored in memory as an image soon forgotten, and only minimal learning can take place. Further, we contend that to recall information is not learning but learning comes about when knowledge is applied, questioned, or understood (as in Cognitivism). Thinking does not necessarily guarantee learning, but it is when thinking is structured to seek out answers to a question asked, or applied knowledge that learning happens.

Moreover, for White and Gunstone (1992), question asking is central to learning and should be a directed process where, as they propose, students should be specifically prompted with using more complex question words, which would force them to actually think deeper about their question on the subject at hand. Instructors should model proper critical thinking in showing how to use such prompts as "How does," "what if," "what might," and so on in order to produce more complex conceptual pathways in their questioning. King (1994) also supports this view by showing students' improvement through their use of similar question prompts akin Bloom's Taxonomy (Bloom et al., 1956). These students were able to achieve more distinctions and nuancing in their analyses of the quality of the material presented, and in their capacity to analyze information.

Further, in question asking, learning occurs through the direct investigation afforded by questions on what the learner experiences. Thus, the factors influencing learning are the capacity to retrieve and connecting prior knowledge to novelty, which creates a mental conflict generating a question. Memory allows to connect to prior knowledge and transfer occurs by being able to build upon what memory brings up, add new information to it, and anticipate forward novelty.

This model fits any learning occurrence; it assumes that learners have the capacity or is given the opportunity to connect concepts and generate critical thinking questions. Instructor should thus foster recall, connection, and interpretation of prior knowledge by helping transfer to novelty and create new knowledge by fostering proper question-asking strategies. Collaborative work here naturally comes alive between learners, as they witness each other's cognitive processes, questions, and perspective.

Our GQLM (Table 1) is foundational to Behaviorism since questions allow to assess personal performance in experience and improve upon them; to Cognitivism since question asking connects cognitive structures essential to reception, organization, storage, and retrieval of information providing a way to connect to novelty (Geake, 2004, 2008; Mather, Cacioppo, & Kanwisher, 2013; Wolf, 2007); and to Constructivism as question asking is the mechanism by which one looks for meaningful prior knowledge to help build and make sense of new information. Further, Boghossian (2006) showed that Behaviorism and Constructivism are incompatible with Socratic practice, however, the GQLM on the other hand is a method based on Socratic construction.

6. Learning style, the practitioner, and the generated question learning model

Keller (1979) says, "Learning theories and educational research often provide information about relationships among instructional components and the design of instruction, indicating how specific techniques/strategies might best fit within a given context and with specific learners." As we have seen so far, learning depends on the method, the instructor, and the background of the learner. It is well accepted in all disciplines that new learning builds on old learning; a student's prior knowledge will determine what level and type of instructional activities are most effective to optimize their learning (Pashler et al., 2008). Research has suggested that the conditions of instruction that are optimal differ depending on students' prior knowledge, and therefore would imply that some students would be inadequately prepared. Consequently, we must conclude that only one-to-one peered instruction would be the optimized way to instruct, which would probably be too costly to accomplish. Alternatively, we here argue that instruction that is fundamental to the very basics of how learners gather information will optimize learning for all individuals without needing to categorize their learning styles.

The role of the teacher is to help the learner to enhance all the tools they already have and provide them with new ones as well as the "How" to use them (Crogman et al., 2015). Thus, theories that classify individuals in fixed learning style categories confuse learning by falsely suggesting that there are learning preferences that categorize the learner by creating tailored instructions for these individual categories. This latter approach is more readily adopted instead of teaching that all the learning modalities are the very makeup of each individual and that all are accessible to the learner as tools.

Figure 4, places learning styles in the proper perspective to the learner. Creating the right environment means that all instructional pedagogies should lead and be based into question asking. The goal of every practitioner is to bring about critical thinking processing in the learner. The quality of the environment created is paramount for that to happen. The practitioner becomes the key to create the right environment to optimize learning potential (Crogman et al., 2015).

Figure 4 lays out the factors that make the best interactive classroom environment. At the foundation of Figure 4 is the supportive base of Figure 1: the GQLM, which provides the teacher with the tools (multisensory pedagogy) to foster the best thinking processes in the students, and provide a stimulus to engage the learner's curiosity. Supporting the teacher's context are also the PST variables (Crogman et al., 2015), used to transform the environment for learners to feels at ease (Table 2). The GQLM also shows what happens at the student's level (toolkit), making the best of and absorbing

Figure 4. Generated question learning model in the classroom.

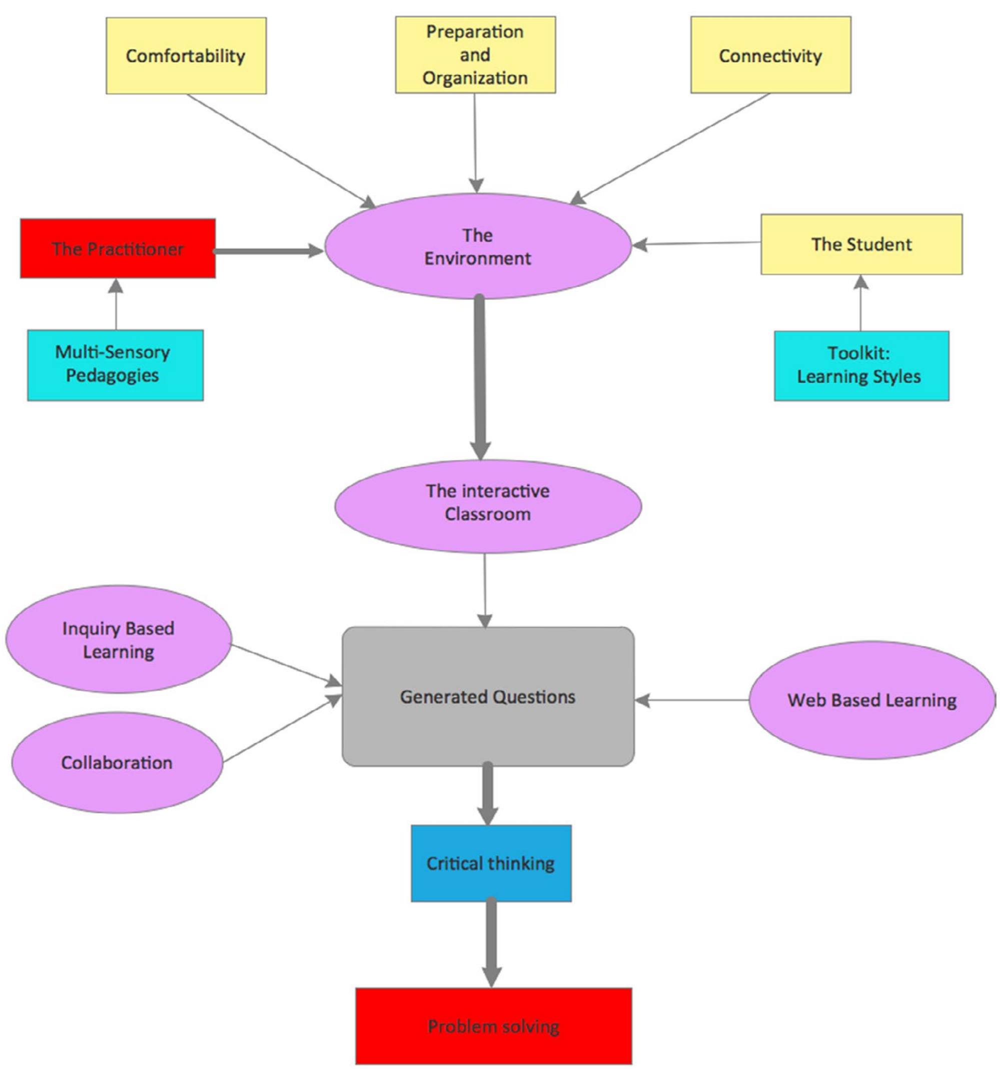


Table 2. Comparing students' two modes of their evaluation of their professor showing their experience with the characteristics of the Pseudo-Socratic concepts of teaching, after a semester of implementation of PST in physics classes

PST concepts	Open-ended comments (%)	Survey responses (%)
Comfortability	71	93
Connectivity	75	91
Organization and preparedness	48	74
Critical thinking	40	79

Note: Data is represented in percent of comments per class fitting under these 4 pillars.

the environment they find themselves in. This interaction of teacher and student makes the most interactive classroom and fosters the best support for critical thinking and problem-solving (Crogman et al., 2015). Without this question-generating paradigm, the classroom may not provide the best learning environment.

Concerning the place of curiosity in the GQLM, Figure 4 describes what happens in Figure 1 just before generated questions. From Figure 1, the pedagogy enters through the practitioner both in shifting the environment to surprise the learner, or through generated questions to engage the cognitive aspect of curiosity (see Figure 4 by IBL, collaborative learning, web-based learning). Figure 4 shows that the interactive classroom is where the first part of curiosity is aroused which is the same as the interaction between the environment and learner's perception for Figure 1. The second part of curiosity is showcased as generated questions through critical thinking in both figures. GQLM, we believe, is a very robust model in that it functions at various levels of the learner's learning.

Newborns and toddlers' curiosity is what Berlyne describes as perceptual; when observing their state of curiosity with novelty, first reactions are majoritarily governed by an anxious cautionary state facing the new discovery (Borowske, 2005; Scarr & Salapatek, 1970). In the GQLM framework applied at this level, the learner, having less access to expressive language may internalize their questions. Spelke and Hermer (1996) show the importance of language in human development by undertaking experiment with rats to show that their non-geometrical modules (concrete concept or object such as a rock; further, it allows one to compute their orientation in relation to a wall) cannot talk to their geometrical ones (abstract concept or object such as color concrete concept or object such as a rock; further, it allows one to compute their orientation in relation to a wall) and the same process is observed in humans from newborn to toddler but at six years this is no longer true, those areas are now communicating (Kalia, Legge, & Giudice, 2008). That is humans are able to integrate geometric information (the short wall on the right) with the non-geometric information (the blue short wall, not the white) (Fernyhough, 2008). The researchers hypothesized and showed that this was as a result of language development. As consequence, one can observe a clear development in the learner's ability to formulate questions in response to their curiosity development. Thus, the transition to language in toddlers should correlate to Berlyne (1954) and Malone's (1980) second aspect of curiosity. From toddler to preschool where the learner's access to language is facilitated, more basic questions can be asked to aid their exploration, and experience can help rationalize anxiety-generating encounters (Borowske, 2005). One finding of cognitive research is that curiosity tends to decrease with age because children become cautious (Hutt & Bhavnani, 1972), however, question asking stands as a method to counter this effect. Thus, although instruction can help the preschooler, curiosity seems much more impacted by instruction beyond preschool all the way to adulthood because of the interaction afforded by questions, facilitated by a growing language capacity in teacher student interaction. At this stage, both types of curiosities are now at work (Berlyne, 1954), and children are able to formulate better critical thinking questions. Willingham (2009) argues that questions stimulate curiosity, principle which is at the root of the GQLM in the utilization of question asking. As such, the GQLM finds itself relevant at the various stages of human development. In Figure 4, we delineated how to bring about critical thinking as a result of generated questions. The world of educational pedagogies traversed a number of phases pertaining to the development of best teaching practices. Geake's (2008) reports of MRI studies confirm that multi-sensory pedagogy approaches lead to effective learning, as input modalities in the brain are interlinked through visual, auditory, motor, and verbal sets.

As far as question asking is concerned, as the trends evolved, educational practitioners have come to favor interactivity over traditional teaching which consisted of consumer-students being taught "at," and receiving limited coaching on how to ask questions (Chin & Brown, 2002). We know now that more interactive approaches and question asking modeling produce more proactive learners (Marbach-Ad & Sokolove, 2000).

Some have had reservations about the feasibility of spending time on question asking, especially in large classrooms, however, researchers have suggested that an adapted question asking pedagogy can accomplish much at any level, and in any classroom setting (Crogman et al., 2015; Dennick & Exley, 2004). Large universities' classes are a result of resources limitations creating obstacles to implementing effective teaching, and thereby exacerbating the difficulties students have in developing a deep understanding of fundamental concepts. It is at this stage that students need to develop or to learn how to ask questions that would aid their learning and for practicing this important cognitive behavior.

Asking meaningful questions requires students to first consider information being presented in a lecture or textbook, determine areas of confusion, and structure a question to help clarify their thinking (Miyake & Norman, 1979). Thus, the questions that students ask help instructors better understand students' thinking, thereby making possible instructional decisions that are better tailored to their needs (Crogman et al., 2015; Etkina, 2000; Etkina & Harper, 2002; Heady, 1983).

Furthermore, teaching how to ask more higher order level question has been shown to be extremely beneficial to students. Extensive research has now shown that students who were taught and made use of these thinking tools were more autonomous in their learning (Marbach-Ad & Sokolove, 2000), remembered the material better (Davey & McBride, 1986a, 1986b; King, 1989), and were able to connect, solve, and apply concepts and problems more meaningfully to their learning and assignments (Dori & Herscovitz, 1999; Harper, Etkina, & Lin, 2003; King, 1991).

The instructor's function is to promote a classroom discourse that stimulates question asking as well as higher level cognitive and metacognitive talks, by for example, having students write their questions before performing an activity to help them direct their own inquiry and use these questions as a springboard for investigation and discussion. The illustration of an interactive classroom by Crogman et al. (2015) details different ways to foster question asking. Practitioners must model question asking for the student to see, based on instructors' use of inquired-based pedagogies. The ability to formulate questions is a skill, which needs to be taught; therefore the practitioner must provide examples of how to form questions (White, 1977). An interactive environment fosters question asking, which causes students to verbalize their ideas, reflect on the thinking they have engaged in, and externalize mental activities that are usually unseen (Chin, 2002).

Table 2 taken from Crogman et al. (2015) demonstrates that students' learning was achieved when they became comfortable to form a connection with the practitioner, in a class that emphasized interactivity through the Pseudo-Socratic method. This method emphasizes interaction and question-asking behavior, that when merged with enquiry-based learning and did active practices makes question asking become central to learning. In this study, more than 90% of students reported that one-on-one interactions with the instructor helped their success in the class, their connection to the professor and their classmates. About 90% of the students reported that it was easier to engage in peer-to-peer work, which they claim was effective in their understanding of the subject matter. Further, other strategies such as *just in time learning (JTL)* were tested on the same students to promote question asking in this class. Students were asked to write down three things they had learned from that particular day's lecture, or to write questions (using web-based technology such as Moodle, Canvas, or Blackboard, etc.) they would like the instructor to answer during the upcoming class period. More than 60% of students in this class did both and found the method helpful to them being active in class when their questions were discussed. Colbert, Olson, and Clough (2007) also used web-learning and found that students pay more attention in class at those times when questions they, or their peers, asked are used within instruction. Further, they found that web-based generated questions help improve teaching in large lecture classes and engage students in the intellectual enterprise of learning a particular discipline. Instructionally speaking, JTL allows for real-time feedback and affords a starting point for the next lecture when some questions seem to be more ubiquitous.

Thus from the literature cited in this paper, learning styles are various ways or modalities through which the learner gathers and uses the information conveyed by instruction, intentionally tailored to suit each student's learning style profile. The way Learning Styles are adopted by the education community to categorize the learner strips individuals from their capacity to use their entire gamut of senses and learning modalities. The role of the instructor is not to tailor instruction to anyone's particular profile, but to promote question asking in order to recruit all the cognitive aptitudes of the learner and help develop the entire breadth of their learning abilities. We ask again the fundamental question: how do learning styles connect to learning theories? We stress that to learn, a student must be active, a chooser, and owner of their own experience. They all grapple with information in a unique way, we say, with all their tools (all their senses, abilities, and intelligences) used conjointly to perceive and interact with their environment. In this light, these aptitudes combined turn learning into an action through which questions are generated, analyzed, and answered to create new knowledge. The closest learning theory to this perception is Constructivism which stands on the shoulders of Behaviorism and Cognitivism, borrowing the idea that learning is essentially a personal approach to the world. We add, and it sets us apart from these main theories, that it doesn't happen in a vacuum, but that the practitioner is essential in triggering the right intellectual shock generative of questions through which the learner actively seeks to know. In that the learner comes to life (Bransford, Brown, & Cocking, 2000), and here learning theories and the idea of learning style meet, this time in the right context.

7. Conclusion

Payal and Shukla (2012) conclude that, from the findings of Coffield et al. (2004), "the consistency of visual, auditory and kinesthetic preferences and the value of matching teaching and learning style were all 'highly questionable.'" White (2005) contends that there is as much intelligences as there is problems to solve, and that human beings are capable of much more than tackling challenges through the means of a specific set of intelligences as delimited, for example, by Gardner (1983). Cook et al. (2009) reported that the design based on Kolb's concrete-abstract dimension showed no support for their predictions. Further, if we accept the premise that learning happens through questions, then we can simplify our teaching methodologies to be Socratic, Pseudo-Socratic (Crogman et al., 2015), or Inquiry-based because all these, by design, base learning upon questions and explorations through which learning best happens. We consider question-asking behaviors to be enough to learn in collaboration with our various modalities mediated by our senses. However, we are refuting the way educators have used Learning Styles to fix learning into categories and argue that learning happens only, or better, by distilling information through these modalities. We have demonstrated that, for a large part, classifying learners into the various learning categories has been non-effective, even in some cases harmful (Payal & Shukla, 2012), and appear somewhat fictitious.

We may say that a learner is visual because they retain and recall information through seeing pictures or graphs, but this preference may be recruited by the learner because of the present circumstance or task at hand, or because of their background. As was pointed out earlier, retention of knowledge occurs through repetition. A person given a song's lyrics can only learn the words and know the meaning of the song, but there is no insight into the tune until they hear the melody. Hearing the song, and learning to sing along adds more dimensions, and by seeing the song in a video then it becomes possible to make even further associations to remember the song, hence, the act of repetition. There is only shaky evidence in the literature that supports the need for learning categorization as proposed and used by educational circles today. Evidence seems more to suggest that all individuals can and will utilize the various modalities when the occasion or the need presents itself. We have argued that human learning is driven by senses and thus we contend that these various learning styles are only tools, available to all through all of our sense, which educators must help the learner to enhance holistically.

We recommend that Future research considers applying the GQLM in diverse and changing environments starting with preschool to middle school, to test its feasibility. Researchers should investigate curiosity in children as they experience unfamiliar situations, especially in the school context, and observe the questions students generate by themselves and as result of the pedagogy. Other studies may consider the impact of practitioners using GQLM and question asking as a way to draw out the learner's curiosity to compare performance differences by age, socioeconomical status, and curricular subjects. The limitation of this model will depend on the effectiveness of the effectiveness of the practitioner's question asking, and the way they shape the environment to reach diverse groups of learners. It will depend on their ability to create meaningful tasks to capitalize on novelty, complexity, ambiguity, and surprise.

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References

Alzaghoul, A. F. (2012). The Implication of the learning theories on implementing e-learning courses. *The Research Bulletin of Jordan ACM, 11*, 27–30.
Atkinson, R. L., Atkinson, R. C., Smith, E. E., & Bem, D. J. (1993). *Introduction to Psychology* (11th ed.). Fort Worth, TX: Harcourt Brace Jovanovich.
Barbe, W. B., & Milone, Jr., M. N. (1981). What we know about modality strengths. *Educational Leadership, 38*, 378–380.
Barbe, W. B., Swassing, R. H., & Milone, Jr., M. N. (1979). *Teaching through modality strengths: Concepts and practices*. Columbus, OH: Zaner-Blosner.
Barr, J., & Dowding, L. (2015). *Leadership in health care*. London: Sage. ISBN 978-4739-0455-2.
Becta. (2005). *Learning styles: An introduction to the research literature*. Retrieved 2015, October 17 from http://dera.ioe.ac.uk/14118/1/learning_styles.pdf
Bednar, A. K., Cunningham, D., Duffy, T. M., & Perry, J. D. (1992). Theory into practice: How do we link? *Constructivism and the technology of instruction: A conversation* (pp. 17–33). ISBN 1136612270, 9781136612275.
Berlyne, D. E. (1954). A theory of human curiosity. *British Journal of Psychology, 45*, 180–191.
Berlyne, D. E. (1965). *Structure and direction in thinking*. New York, NY: Wiley.
Berlyne, D. E. (1966). Curiosity and exploration. *Science, 153*, 25–33. http://dx.doi.org/10.1126/science.153.3731.25
Bloom, B., Englehart, M., Furst, E., Hill, W., & Krathwohl, D. (1956). Taxonomy of educational objectives: The classification of educational goals. *Handbook I: Cognitive domain*. New York, NY: Longmans Green.
Boghossian, P. (2006). Behaviorism, constructivism, and socratic pedagogy. *Educational Philosophy and Theory, 38*, 713–722. doi:10.1111/j.1469-5812.2006.00226.x
Bogod. (1998). *Learning styles and multiple intelligence*. Retrieved from http://www.ldpride.net/learningstyles.mi.htm
Borowske, K. (2005, April 7–10). *Curiosity and motivation-to-learn*. In *Comunicación presentada a la ACRL Twelfth National Conference,* Minneapolis, MN.
Bower, G. H., & Hilgard, E. R. (1981). *Theories of learning* (5th ed.). Englewood Cliffs, NJ: Prentice-Hall.
Bransford, J. D., Brown, A. L., & Cocking, R. R. (Eds.). (2000). *How people learn: Brain, mind, experience and school* (Expanded ed.). Washington, DC: National Academy Press.
Chiesa, M. (1992). Radical behaviorism and scientific frameworks: From mechanistic to relational accounts. *American Psychologist, 47*, 1287–1299. http://dx.doi.org/10.1037/0003-066X.47.11.1287
Chiesa, M. (1994). *Radical behaviorism: The philosophy and the science*. Boston, MA: Authors' Cooperative.
Chin, C. (2002). Student-generated questions: Encouraging inquisitive minds in learning science. *Teaching and Learning, 23*, 59-67. ISSN 0129-7112
Chin, C., & Brown, D. E. (2002). Student-generated questions: A meaningful aspect of learning in science. *International Journal of Science Education, 24*, 521–549. doi:10.1080/09500690110095249
Christison, M. A. (1996). Multiple intelligences & second language learners. *The Journal of the Imagination in Language Learning, 3*, 8–12.
Claxton, G. (2009). *3.4 Cultivating positive learning dispositions*. In H. Daniel, H. Lauder, & J. Porter (Eds.), *Educational theories, cultures and learning: A critical perspective* (p. 177). Abingdon: Routledge.
Coffield, F., Moseley, D., Hall, E., & Ecclestone, K. (2004). *Learning style and pedagogy in post-16 learning: A systematic and critical review*. London: Learning and Skill Research Centre.
Colbert, J. T., Olson, J. K., & Clough, M. P. (2007). Using the web to encourage student-generated questions in large-format introductory biology classes. *CBE-Life Sciences Education, 6*, 42–48. doi:10.1187/cbe.06-07-0171

Collins, J. (1998). Seven kinds of smart. *Time Magazine, 152*, 94–96.

Constantinidou, F., & Baker, S. (2002). Stimulus modality and verbal learning performance in normal aging. *Brain and Language, 82*, 296–311. doi:10.1016/S0093-934X(02)00018-4

Cook, D. A., Thompson, W. G., Thomas, K. G., & Thomas, M. R. (2009). Lack of interaction between sensing–intuitive learning styles and problem-first versus information-first instruction: A randomized crossover trial. *Advances in Health Sciences Education, 14*, 79–90. doi:10.1007/s10459-007-9089-8

Crogman, T. H., Trebeau Crogman, A. M., Warner, L, Mustafa, A., & Peters, R. (2015). Developing a new teaching paradigm for the 21st century learners in the context of socratic methodologies. *British Journal of Education, Society & Behavioural Science, 9*, 62–95. doi:10.9734/BJESBS/2015/17825

Cunningham, D. J. (1992). Assessing constructions and constructing assessments: A dialogue. In T. M. Duffy & D. H. Jonassen (Eds.), *Construtivism and the Technology of Instruction-A Conversation* (pp. 34-44). New Jersey, NJ: Lawrence Erlbaum Associates.

Davey, B., & McBride, S. (1986a). Effects of question-generation training on reading comprehension. *Journal of Educational Psychology, 78*, 256. doi:10.1037/0022-0663.78.4.256

Davey, B., & McBride, S. (1986b). Generating self-questions after reading: A comprehension assist for elementary students. *The Journal of Educational Research, 80*, 43–46. doi:10.1080/00220671.1986.10885720

De Houwer, J., Barnes-Holmes, D., & Moors, A. (2013). What is learning? On the nature and merits of a functional definition of learning. *Psychonomic Bulletin & Review, 20*, 631–642. doi:10.3758/s13423-013-0386-3

Dennick, R., & Exley, K. (2004). *Small group teaching: Tutorials, seminars and beyond*. Routledge. ISBN 1134398557, 9781134398553.

Descartes, R. (1644). *Principles of Philosophy, in descartes: Selected philosophical writings, 1988*. (J. Cottingham, R. Stoothoff, & D. Murdoch, Trans.). Cambridge, MA: Cambridge University Press.

Doorley, R. (2013). *Sensory play: Early exploration through the senses*. Retrieved from http://www.pbs.org/parents/child-development/sensory-play/developing-and-cultivating-skills-through-sensory-play/sensory-play-early-exploration-through-the-senses/

Dori, Y. J., & Herscovitz, O. (1999). Question-posing capability as an alternative evaluation method: Analysis of an environmental case study. *Journal of Research in Science Teaching, 36*, 411–430. doi:10.1002/(SICI)1098-2736(199904)

Duffy, T. M., & Jonassen, D. (1991). Constructivism: New implications for instructional technology? *Educational Technology, 31*, 3–12.

Dunn, R., Beaudry, J. S., & Klavas, A. (1989). Survey of research on learning styles. *Educational Leadership, 46*, 50–58. ISSN 1531-2488.

Dunn, R. S., & Dunn, K. J. (1978). *Teaching students through their individual learning styles: A practical approach*. Reston, VA: Reston Pub. ISBN 0879098082 9780879098087.

Elder, L., & Paul, R. (1998). The role of socratic questioning in thinking, teaching, and learning. *The Clearing House, 71*, 297–301. doi:10.1080/00098659809602729

Engel, S. (2011). Children's need to know: Curiosity in schools. *Harvard Educational Review, 81*, 625–645. doi:10.17763/haer.81.4.h054131316473115

Ertmer, P. A., & Newby, T. J. (2013). Behaviorism, cognitivism, constructivism: Comparing critical features from an instructional design perspective. *Performance Improvement Quarterly, 26*, 43–71. doi:10.1111/j.1937-8327.1993.tb00605.x

Etkina, E. (2000). Weekly reports: A two-way feedback tool. *Science Education, 84*, 594–605. http://dx.doi.org/10.1002/(ISSN)1098-237X

Etkina, E., & Harper, K. A. (2002). Closing the feedback loop in large enrollment physics courses. *Journal of College Science Teaching, 31*, 476–480.

Felder, R. M., & Silverman, L. K. (1988). Learning and teaching styles in engineering education. *Engineering Education, 78*, 674–681.

Felder, R. M., & Spurlin, J. (2005). Applications, reliability and validity of the index of learning styles. *International Journal of Engineering Education, 21*, 103–112.

Fernyhough, C. (2008). *A thousand days of wonder: A scientist's chronicle of his daughter's developing mind*. ISBN-10: 1583333975. New York, NY: Penguin.

Fleming, N. D. (2001). *Teaching and learning styles: VARK strategies*. Christchurch: Author.

Fleming, N. D., & Mills, C. (1992). Not another inventory, rather a catalyst for reflection. *To Improve the Academy, 11*, 137–143. http://digitalcommons.unl.edu/podimproveacad/246

Gardner, D. L. (1983). *Frames of mind: The theory of multiple intelligences*. London: Heinemann.

Geake, J. (2009). Neural interconnectivity and intellectual creativity: Giftedness, savants and learning styles. *The Routledge international companion to gifted education*, 10–17. https://e-publications.une.edu.au/vital/access/manager/Repository/une:5706;jsessionid=51867A97CFACAB3FCD7F200A9BF1CF96?exact=sm_title%3A%22Neural+interconnectivity+and+intellectual+creativity%3A+giftedness%2C+savants%2C+and+learning+styles%22

Geake, J. G. (2004). How children's brains think: Not left or right but both together. *Education 3–13, 32*, 65–72. doi:10.1080/03004270485200351

Geake, J. G. (2008). Neuromythologies in education. *Educational Research, 50*, 123–133. doi:10.1080/00131880802082518

Geake, J. G., & Dobson, C. S. (2005). A neuro-psychological model of the creative Intelligence of gifted children. *Gifted and Talented International, 20*, 4–16.

Good, T. L., & Brophy, J. E. (1990). *Educational psychology: A realistic approach* (4th ed.). White Plains, NY: Longman.

Gruber, M. J., Gelman, B. D., & Ranganath, C. (2014). States of curiosity modulate hippocampus-dependent learning via the dopaminergic circuit. *Neuron, 84*, 486–496. doi:10.1016/j.neuron.2014.08.060

Hall, G. (2003). *The psychology of learning*. In L. Nadel (Ed.), *Encyclopedia of cognitive science* (Vol. 2, pp. 837–845). London: Nature Publishing Group.

Hansen, R. E. (2000). The role and experience in learning: Giving meaning and authenticity to the learning process in schools. *Journal of Technology Education, 11*, doi:10.21061/jte.v11i2.a.2

Harper, K. A., Etkina, E., & Lin, Y. (2003). Encouraging and analyzing student questions in a large physics course: Meaningful patterns for instructors. *Journal of Research in Science Teaching, 40*, 776–791. doi:10.1002/tea.10111

Heady, J. E. (1983). Teaching embryology without lectures and without traditional laboratories–an adventure in innovation. *Journal of College Science Teaching, 23*, 87–91. ISSN-0047-231X.

Henry, J. (2007, July). Professor Pans' learning style' teaching method. *The Telegraph, 29*. Retrieved from http://www.telegraph.co.uk/news/uknews/1558822/Professor-pans-learning-style-teaching-method.html

Hill, M. E., & McGinnis, J. (2007). The curiosity in marketing thinking. *Journal of Marketing Education, 29*, 52–62. doi:10.1177/0273475306297385

Huitt, W. (1998). *Critical thinking: An overview. Educational psychology interactive.* Valdosta, GA: Valdosta State University. Retrieved 2015, October 17 from http://www.edpsycinteractive.org/topics/cogsys/critthnk.html

Hume, D. (1748). *An inquiry concerning human understanding, 1955*. Indianapolis, IN: Bobbs-Merrill.
Hutt, C., & Bhavnani, R. (1972). Predictions from Play. *Nature, 237*, 171–172. http://dx.doi.org/10.1038/237171b0
James, W. B., & Gardner, D. L. (1995). Learning styles: Implications for distance learning. *New Directions for Adult and Continuing Education, 1995*, 19–31. doi:10.1002/ace.36719956705
Jirout, J., & Klahr, D. (2011, Fall). *Children's question asking and curiosity: A training study*. Talk presented at the Society for Research on Educational Effectiveness Fall 2011 Conference, Evanston, IL.
Jirout, J., & Klahr, D. (2012). Children's scientific curiosity: In search of an operational definition of an elusive concept. *Developmental Review, 32*, 125–160. http://dx.doi.org/10.1016/j.dr.2012.04.002
Jonassen, D. H. (1991a). Evaluating constructivistic learning. *Educational Technology, 31*, 28–33.
Jonassen, D. H. (1991b). Objectivism versus constructivism: Do we need a new philosophical paradigm? *Educational Technology Research and Development, 39*, 5–14. doi:10.1007/BF02296434
Jubran, S. (2012). Using multi-sensory approach for teaching English skills and its effect on students' achievement at Jordanian schools. *European Scientific Journal, 8*, 50–60. ISSN 1857-7881.
Kalia, A. A., Legge, G. E., & Giudice, N. A. (2008). Learning building layouts with non-geometric visual information: The effects of visual impairment and age. *Perception, 37*, 1677–1699. http://dx.doi.org/10.1068/p5915
Kang, M. J., Hsu, M., Krajbich, I. M., Loewenstein, G., McClure, S. M., Wang, J. T. Y., & Camerer, C. F. (2009). The wick in the candle of learning: epistemic curiosity activates reward circuitry and enhances memory. *Psychological Science, 20*, 963–973. doi:10.1111/j.1467-9280.2009.02402.x
Keefe, J. W. (1979). *Learning style: An overview*. In *NASSP's Student Learning Styles: Diagnosing and Proscribing Programs* (pp. 1–17). Reston, VA: National Association of Secondary School Principles. http://eric.ed.gov/?id=ED182859
Keller, J. M. (1979). Motivation and instructional design: A theoretical perspective. *Journal of Instructional Development, 2*, 26–34. doi:10.1007/BF02904345
Kidd, C., & Hayden, B. Y. (2015). The psychology and neuroscience of curiosity. *Neuron, 88*, 449–460. doi:10.1016/j.neuron.2015.09.010
King, A. (1989). Effects of self-questioning training on college students' comprehension of lectures. *Contemporary Educational Psychology*, 14, 366–381. doi:10.1016/0361-476X(89)90022-2
King, A. (1991). Effects of training in strategic questioning on children's problem solving performance. *Journal of Educational Psychology*, 83, 307–317. http://dx.doi.org/10.1037/0022-0663.83.3.307
King, A. (1994). Guiding knowledge construction in the classroom: Effects of teaching children how to question and how to explain. *American Educational Research Journal, 31*, 338–368. doi:10.3102/00028312031002338
Klein, P. (2003). Rethinking the multiplicity of cognitive resources and curricular representations: Alternative to learning styles and multiple intelligences. *Journal of Curriculum Studies, 35*, 45–81. doi:10.1080/00220270210141891
Kolb, A. Y., & Kolb, D. A. (2012). Experiential learning theory. In *Encyclopedia of the Sciences of Learning* (pp. 1215–1219). New York, NY: Springer.
Kolb, D. (1984). *Experiential learning: Experience as the source of learning and development*. Englewood Cliffs, NJ: Prentice-Hall.
Kolb, D. (1985). *Learning style inventory: Self scoring inventory and interpretation booklet*. Boston, MA: McBer & Company.
Lewin, K. (1951). *Field theory in social science*. New York, NY: Harper & Row.
Litzinger, T. A., Lee, S. H., Wise, J. C., & Felder, R. M. (2007). A psychometric study of the index of learning styles. *Journal of Engineering Education, 96*, 309. http://dx.doi.org/10.1002/jee.2007.96.issue-4
Locke, J. (1700). *An Essay Concerning Humane (sic) Understanding*. London: Awnsam & John Churcill.
Loewenstein, G. (1994). The psychology of curiosity: A review and reinterpretation. *Psychological Bulletin, 116*, 75–98. doi:10.1037/0033-2909.116.1.75
Malone, T. W. (1980, September). What makes things fun to learn? Heuristics for designing instructional computer games. In *Proceedings of the 3rd ACM SIGSMALL symposium and the first SIGPC symposium on Small systems* (pp. 162–169). New York, NY: ACM.
Malone, T. W. (1981). Toward a theory of intrinsically motivating instruction. *Cognitive Science, 5*, 333–369. http://dx.doi.org/10.1207/s15516709cog0504_2
Manolis, C., Burns, D. J., Assudani, R., & Chinta, R. (2013). Assessing experiential learning styles: A methodological reconstruction and validation of the Kolb learning style inventory. *Learning and Individual Differences, 23*, 44–52. doi:10.1016/j.lindif.2012.10.009
Marbach-Ad, G., & Sokolove, P. G. (2000). Can undergraduate biology students learn to ask higher level questions? *Journal of Research in Science Teaching, 37*, 854–870. http://dx.doi.org/10.1002/(ISSN)1098-2736
Massa, L. J., & Mayer, R. E. (2006). Testing the ATI hypothesis: Should multimedia instruction accommodate verbalizer-visualizer cognitive style? *Learning and Individual Differences, 16*, 321–335. doi:10.1016/j.lindif.2006.10.001
Mather, M., Cacioppo, J. T., & Kanwisher, N. (2013). How fMRI can inform cognitive theories. *Perspectives on Psychological Science, 8*, 108–113. doi:10.1177/1745691612469037
Miyake, N., & Norman, D. A. (1979). To ask a question, one must know enough to know what is not known. *Journal of Verbal Learning and Verbal Behavior, 18*, 357–364. doi:10.1016/S0022-5371(79)90200-7
Nagowah, L., & Nagowah, S. (2009). A reflection on the dominant learning theories: Behaviourism, cognitivism and constructivism. *International Journal of Learning, 16*, 279–285.
Pashler, H., McDaniel, M., Rohrer, D., & Bjork, R. (2008). Learning styles concepts and evidence. *Psychological science in the public interest, 9*, 105–119. doi:10.1111/j.1539-6053.2009.01038.x
Paul, R., & Elder, L. (2001). *The miniature guide to critical thinking: Concepts & tools. Foundation Critical Thinking*. ISBN 0944583105, 9780944583104.
Payal, R., & Shukla, S. C. (2012). Learning styles in education. *International Journal of Research in Education and Social Sciences, 2*, ISSN: 2249-7382.
Peariso, J. F. (2008). Multiple intelligences or multiply misleading: The critic's view of the multiple intelligences theory. *Online Submission*. ERIC Number: ED500515. http://eric.ed.gov/?id=ED500515
Pfeiffer, L. G. (2011). *A comparison of the preferred learning styles of year 5, year 7 and year 9 students in science using the science laboratory environment inventory (SLEI) and a cooperative learning unit of work based on multiple intelligences* (Doctoral dissertation, Curtin University, Science and Mathematics Education Centre). Retrieved 2016, April 17 from http://espace.library.curtin.edu.au/cgibin/espace.pdf?file=/2012/07/06/file_1/186433
Piaget, J. (1952). *The origins of intelligence in children*. New York, NY: International University Press. http://dx.doi.org/10.1037/11494-000
Ratna, S., & Tron, B. (2015). *Learning theories: Implications in teacher education*. Retrieved 2015, October

21 from https://www.academia.edu/6730061/Learning_Theories_Implications_in_Teacher_Education
Rayner, S., & Riding, R. (1996). Cognitive style and school refusal. *Educational Psychology, 16*, 445–451. http://dx.doi.org/10.1080/0144341960160409
Roussou, M. (2004). Learning by doing and learning through play: An exploration of interactivity in virtual environments for children. *Computers in Entertainment, 2*, 10–10. doi:10.1145/973801.973818
Scarr, S., & Salapatek, P. (1970). Patterns of fear development during infancy. *Merrill-Palmer quarterly of behavior and development, 16*, 53–90.
Schunk, D. H. (1991). *Learning theories: An educational perspective*. New York, NY: Macmillan.
Shaw, J. M. (2006). *Unifying perception and curiosity* (Unpublished Doctoral dissertation). New York, NY: University of Rochester.
Shook, J. (2008). The greatest humanist: William James. *Free Inquiry, 29*, 52-53.
Skinner, B. F. (1938). *The behavior of organisms: An experimental analysis*. New York, NY: Appleton-Century.
Soloman, B. A., & Felder, R. M. (2005). *Index of learning styles questionnaire*. NC State University. Retrieved from http://www.engr.ncsu.edu/learningstyles/ilsweb.html
Spelke, E. S., & Hermer, L. (1996). Early cognitive development: Objects and space. In R. Gelman & T. Kit-Fong (Eds.), *Perceptual and cognitive development* (pp. 71-114). San Diego, CA: Academic Press.
Stahl, S. A. (2002). *Different strokes for different folks?* In L. Abbeduto (Ed.), *Taking sides: Clashing on controversial issues in educational psychology* (pp. 98–107). Guilford, CT: McGraw-Hill.
Stavredes, T. (2011). *Developing cognitive, social, and teaching presence online.* 27th Annual Conference on Distance Teaching & Learning, Capella University. The Board of Regents of the University of Wisconsin System, Madison, WI.
Sternberg, R. J., Grigorenko, E. L., Ferrari, M., & Clinkenbeard, P. (1999). A triarchic analysis of an aptitude–treatment interaction. *European Journal of Psychological Assessment, 15*(1), 1–11. doi:10.1027//1015-5759.15.1.3
Taylor, D. C., & Hamdy, H. (2013). Adult learning theories: Implications for learning and teaching in medical education: AMEE Guide No. 83. *Medical Teacher, 35*, e1561-e1572. doi: 10.3109/0142159X.2013.828153
Tolman, E. C., & Honzik, C. H. (1930). *"Insight" in rats* (Vol. 4, pp. 215–232). Berkeley, CA: University of California, Publications in Psychology.
Waterhouse, L. (2006). Inadequate evidence for multiple intelligences, mozart effect, and emotional intelligence theories. *Educational Psychologist, 41*, 247–255. http://dx.doi.org/10.1207/s15326985ep4104_5
White, J. (2005). *Howard Gardner: The myth of multiple intelligences*. Institute of Education: University of London. ISBN 0854737243, 9780854737246.
White, R. T. (1977). An overlooked objective. *Australian Science Teachers' Journal, 23*, 124–125.
White, R. T., & Gunstone, R. F. (1992). *Probing understanding*. London: Falmer Press.
Willingham, D. T. (2009). *Why don't students like school?: A cognitive scientist answers questions about how the mind works and what it means for the classroom*. San Francisco, CA: John Wiley & Sons.
Wilson, S. M., & Peterson, P. L. (2006). *Theories of learning and teaching: What do they mean for educators?* Washington, DC: National Education Association. Retrieved from http://arc.duke.edu/documents/Wilson%20teaching%20and%20learning.pdf
Wolf, C. (2007). *Construction of an adaptive e-learning environment to address learning styles and an investigation of the effect of media choice* (Thesis). RMIT University, Australia.
Yilmaz, K. (2011). The cognitive perspective on learning: Its theoretical underpinnings and implications for classroom practices. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas, 84*, 204–212. http://dx.doi.org/10.1080/00098655.2011.568989
Zywno, M. S. (2003, June). A contribution to validation of score meaning for Felder-Soloman's index of learning styles. In *Proceedings of the 2003 American Society for Engineering Education annual conference & exposition* (Vol. 119, pp. 1–5). Washington, DC: American Society for Engineering Education.